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The phantom deficits of USS pension

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The Phantom Deficits of USS Pension

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The Phantom Deficits of USS Pension

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Abstract

Contrary to public perception, this article finds Universities Superannuation Scheme (USS), the largest defined benefit pension in UK, is more likely to be in surplus rather than deficit. Evidence is provided to show that neither low gilt yields nor high valuations imply low future returns on equities. Falling interest rates since 1980s are essentially the result of successful monetary policies to control inflation, whereas the declines after quantitative easing are to prevent debt deflation. In both cases, the economy benefited and firms made healthy profits. Such findings shed light on the current industrial debate as to whether gilt yields are appropriate discount rates for valuation of defined benefit schemes. Finally, evidence also indicates that gilt yields and downward biased discount rates form the basis of its valuation. Long-dated index-linked gilt yields were found to explain 99% variation of past liabilities of USS. Since falling interest rates do not imply lower future returns, the liabilities have been hugely overstated, giving rise to large and volatile deficits.

Keywords: pension, defined benefit, discount rate, risk-free rate, equity risk premium

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Note for those who are familiar with USS valuation:

The liabilities used in the paper are obtained as explained below:

2011 - 2013 liabilities (based on 2011 triennial valuation, 2012-2013 monitoring)

2014 - 2017 liabilities (based on 2014 triennial valuation, 2015-2017 monitoring)

If the actuarial valued figure of 67.5 is used for the 2017 liability, the R-square of model (6) in Table 6 reduces to 97.5%.

If the liability of 2011, 2014 and 2017 use the monitoring liabilities (33.1, 48.8 and 72.6 respectively), the R-square reduces to 97.2%.

In both cases, the key message remains the same: USS valuations in 2011-2017 are predicated on falling interest rates.

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Abstract

Contrary to public perception, this article finds Universities Superannuation Scheme (USS), the largest defined benefit pension in UK, is more likely to be in surplus rather than deficit. Evidence is provided to show that neither low gilt yields nor high valuations imply low future returns on equities. Falling interest rates since 1980s are essentially the result of successful monetary policies to control inflation, whereas the declines after quantitative easing are to prevent debt deflation. In both cases, the economy benefited and firms made healthy profits. Such findings shed light on the current industrial debate as to whether gilt yields are appropriate discount rates for valuation of defined benefit schemes. Finally, evidence also indicates that gilt yields and downward biased discount rates form the basis of its valuation. Long-dated index-linked gilt yields were found to explain 99% variation of past liabilities of USS. Since falling interest rates do not imply lower future returns, the liabilities have been hugely overstated, giving rise to large and volatile deficits.

Keywords: pension, defined benefit, discount rate, risk-free rate, equity risk premium

1. Introduction

According to its annual reports, Universities Superannuation Scheme (USS), the largest defined benefit pension in UK, has been under funding crisis in recent years. In response to the reported deficits, Universities UK (UUK), the sponsors, decided in January 2018 to switch the scheme to defined contribution after April 2019. This subsequently prompted over 60 universities and colleges to carry out strike actions a month later. A study of the annual reports of USS shows something peculiar; although the assets of USS have increased by 85% to £60bn between 2011 and 2017, its liabilities have more than doubled to £72.6bn in the same period. The increase in liabilities cannot be explained by inflation, wage growth and rise in memberships while the other factors such as life expectancy remain unchanged.

This article finds that lower discount rates due to falling gilt yields were the primary reason for the rise in liabilities in recent years. In particular, a simple model that uses index-linked gilt yields as discount rates is found to explain 99.3% variation of liabilities of USS in the past seven years. Moreover, current low gilt yields do not imply low returns on other assets such as equities, and thus the liabilities are overstated. Therefore, USS is more likely to be in surplus rather than deficit.

Generally speaking, interest rates contain information indicative of economic wellbeing and hence future equity returns; see Estrella (2005). The falls in interest rates since the 1980s, however, are primarily due to reasons that are conducive for economic growth. As Carlstrom et al. (2009) and Wright (2011) show, monetary policies and economic developments in the recent decades have successfully not only controlled the inflation but also reduced its uncertainty. In the case of quantitative easing (QE), an extraordinary form of monetary policy, long-term risk free rates were

deliberately kept low for continual economic growths, which in turn benefited equity markets. As Mishkin (2008) concludes, price stability and benign economic growth are mutually reinforcing.

In the above, the falls in interest rates are driven by general supply and demand factors affecting both safe and risky assets. As Caballero et al. (2017) points out, specific supply and demand factors with impacts largely on only the safe assets also explain the decline in risk-free rates, especially since the millennium. An important case is the rise in international reserve accumulation by China as well as the other emerging economies in the aftermath of the Asian financial crisis. This increased demand on US dollars drives up the US Treasury prices and in turn lowers gilt yields through international linkages. Another case is the drive to de-risk portfolios that prompts many defined benefit fund managers to purchase long-dated gilts irrespective of price; see for example Joyce et al. (2009) and Greenwood and Vayanos (2010). In both cases, falling gilt yields are not indicative of weak economic growths.

A common actuarial practice is to associate high asset valuations with low returns in the future. Contrary to such view, Ibbotson and Chen (2003) argues that long-term stock market returns are determined by the productivity of firms in the real economy. The empirical findings of this article are supportive of Ibbotson and Chen. After 1970s of high inflations, the average real returns on US and UK equities has stabilized at around 5% in the past three decades. Higher valuations such as low dividend yields in the case of US equities are the result of higher growths, which is consistent with the Miller and Modigliani (1961) theory. Associating high valuations with low returns, on the other hand, is implying that dividend yield would revert to its long term mean. Implicit in such a view is that markets are inefficient and high valuation is a sign of overvaluation.

The findings presented in this article have several implications for the pension industry as well as related literature. First, as the Pensions Regulator (tPR) in UK acknowledges, there is at present an industrial debate on the approach to discount rates.¹ This article sheds light on the debate by showing that low gilt yields do not imply low returns on equities. Consequently, risk-free rates should not be the basis of discount rates for valuing promised benefits. Such findings contrast sharply with many recent works on the funding deficits of defined benefit schemes; see for example Novy-Marx and Rauh (2009, 2011) who calculate the liabilities of state employee pensions using zero-coupon Treasury yields as discount rates. While zero-coupon Treasury yields reflect the risk of the payments from a taxpayer perspective, it is not considered here as the promised benefits will be paid by the scheme's assets accumulated through contributions and investment returns.

A related issue on the determination of discount rate is the equity risk premium. Towards the end of last millennium, Blanchard et al. (1993), Siegel (1999) and Fama and French (2002) and others were suggesting a significantly lower risk premium due to the observed lower equity returns and relatively high risk-free rates. Ibbotson and Chen (2003) and Faugere and Erlach (2006), however, use supply-side growth model to estimate an equity premium that is not much lower than its historical average. Using more recent data from 1965 to 2017, this article finds that the average of US and UK real equity returns since 1990s has remained similar to its long-term historical average, thereby providing further evidence against the claim of declining risk premium.

This article also highlights the need of continual research with respect to the financial economics of prudence and self-sufficiency as required by tPR for defined benefit pensions. Day (2003) points out in an actuarial convention that many modes of actuarial thought are indefensible when examined with

¹ For further details of the industrial debate, please see the Annual Funding Statement for Defined Benefit Pension Schemes published by the Pensions Regulator in May 2017.

the latest findings of financial economics. Also, Clark and Monk (2006) highlights the shortcomings of actuarial and accounting practices as well as the issue of trustee competence in making optimal decision for defined benefit schemes. For example, a liability-driven investment approach that buys gilts irrespective of price is highly suboptimal.

The paper is organized as follows. The next section introduces the relevant institutional backgrounds whereas Section 3 explains the reasons for the long term decline of interest rates. After the study of expected long term equity returns in Section 4, the funding deficits of USS are investigated in Section 5. Finally, Section 6 concludes with some discussion.

2. Institutional background

2.1 USS

The Universities Superannuation Scheme (USS) is the largest defined benefit pension scheme in the United Kingdom with £60bn under management as at 31 March 2017. Its members include academic and academic-related staff from universities established mainly prior to 1992.² The predecessor of USS is the Federated Superannuation Scheme for Universities, which offered retirement benefits in annuity with no indexation to cost of living. The high inflations during especially late 1960s and 1970s rendered the retirement benefits insufficient for the rising costs of living. Consequently, the USS was introduced on 1 April 1975, offering members final salary retirement benefits indexed to inflation.

In January 1997, USS joined other defined benefit schemes by taking part in contribution holiday, with its contributions reduced from 18.55% to 14% of payroll. This contributed to the projected scheme deficit after USS experienced losses resulting from the 2007-2008 financial crisis. As a result, several changes were implemented in 2011. However, the ongoing weak economic performance after the financial crisis led USS to identify continuing deficits, which culminated in further negotiations, industrial action, and eventually more changes being implemented in 2015. The final-salary scheme is now replaced with the hybrid of Career Average Revalued Earnings defined benefit plan on the first £55,000 of payroll and defined contribution for payroll over £55,000. Employee contributions rose to 8%, and employer contributions from 16% to 18% of payroll. In 2017, USS reported the largest ever deficit of a defined benefit scheme in the UK. Overruling objections from University and College Union (UCU), the USS Joint Negotiating Committee announced to close the defined benefit part of the pension. In response, UCU balloted successfully for the recent industrial action.

2.2 Industrial debate on discount rate

A crucial element in the projected deficits of USS is the close association of gilt yields with the discount rates used in the valuation. Due to quantitative easing, riskless interest rates in world major economies have been in sharp declines. Since long-dated riskless interest rates are used to discount the promised pensions to obtain a present value of the liability, many defined benefits have changed from surplus into deficit as a result of falling interest rates; see for example Clark and Monk (2006) and Novy-Marx and Rauh (2009, 2011). However, questions arise as to whether low riskless interest rates are suitable discount rates to value liabilities of defined benefit schemes. As the Pensions Regulator (tPR) acknowledges in its 2017 Annual Funding Statement for defined benefit pension schemes,

² Staff in the post-1992 universities are mostly members of the Teachers Pension Scheme.

The current debate on the approach to discount rates focuses on whether historical relationships between gilt yields and returns on other asset classes still hold true for the future. Proponents of a 'gilts plus' approach (typically meaning a fixed margin above gilts) argue that the historical relationship still holds and low gilt yields mean low returns on other asset classes. Opponents say that the gilt market is distorted and the historical relationship broken.

It is useful here to clarify the aim of this article is to investigate whether the assets held by USS are sufficient to pay for its promised pensions in the future. In this context, as described by tPR on funding defined benefit plans, an appropriate discount rate should be representative of '*the yield on assets held by the scheme to fund future benefits and the anticipated future investment returns*'.³

The approach to discount rate described above differs from many literature in which riskless interest rates are used to value the liabilities of defined benefit schemes. For example, Novy-Marx and Rauh (2011) calculate liabilities of US state employee defined benefit pensions using discount rates that reflect the risk of the payments from a taxpayer perspective. Assuming the promised benefits have the same default and recovery characteristics as the US federal republic, zero-coupon Treasury yields are used as discount rates to obtain a value of \$4.43 trillion for the promised liabilities. Instead of considering a discount rate that reflect the risk of sponsors, the approach here follows that of Novy-Marx (2015) and use a discount rate that is representative of the returns on assets held by USS.

3. Interest rates

This section identifies the factors that explain the long term decline of interest rates, and investigates the impact of QE on the relationship between gilt yields and equity returns.

3.1 Long term decline of interest rates

Generally speaking, interest rates contain information indicative of economic wellbeing and hence future equity returns. Various studies such as Harvey (1988), Estrella and Mishkin (1996) and Estrella (2005) show, a steepening (or flattening) yield curve as a result of higher (or lower) yield on long-dated government bond is a sign of an improving (or worsening) economy, which tends to be associated with a better (or worse) outlook on equity returns. Slopes of yield curves associated with economic cycles, however, cannot explain the long term falls of 20-year gilt yield from over 17% during oil crisis in 1970s to the present level of less than 2%. Instead of the slope of yield curve, the level of inflation, its past variation and a trend starting in October 1992 when inflation targeting was adopted in UK are found to explain 92.7% variation of gilt yields from 1965 to 2017; see Table 1. Figure 1 below illustrates how the two models reported in Table 1, namely Eqn2 and Eqn3, fit the yields.

< Figure 1 >

The results in Table 1 show that the reason for the long term decline of interest rates is the reduction in the level and uncertainty of inflation, which has fallen from over 25% in 1970s to a current level that is close to the target of 2%. The achievement of price stability can be attributed to successful monetary policies that has been implemented in both UK and other economies as well as other developments. For example, Carlstrom et al. (2009) find that the inflation persistence in the United

³ See code of Practice No. 3 by tPR on funding defined benefits

States has declined significantly since the early 1980s as a result of more aggressive central bank responds to inflation. Exchange rate pass-through to domestic prices brought by growing international trade is another contributing factor that helps lower the inflations; see Campa and Goldberg (2005) and Choudhria and Hakurab (2006). Technology can also help to reduce inflation as Dupor et al. (2009) find that a positive technology shock significantly and rapidly reduces inflation.

Table 1

	Eqn 1	Eqn 2	Eqn 3
Constant	4.547** [6.185]	3.206** [4.740]	6.115** [14.878]
Inflation	0.566** [7.988]	0.338** [4.711]	0.249** [7.265]
Variation of past inflation		1.053** [6.290]	0.673** [6.035]
Trend			-0.235** [-13.536]
R-square	0.593	0.732	0.927

*In the regressions, the dependent variable is monthly 20-year gilt yield whereas the independent variables are level of inflation, variation of inflation in past seven years and a trend starting in October 1992. The annual rate of change in RPI is used as the inflation whereas the trend first takes the value of zero and then increases by a twelfth after each month from October 1992 onwards. The t-statistics in brackets are obtained using the Newey-West procedure with 36 lags. ** indicates significance at 1% level.*

The trend coefficient in Equation 3 in Table 1 indicates that UK gilt yield, for reasons other than the level and variation of past inflations, has been falling by an average of 0.235% a year since the policy of inflation targeting was adopted. It accounts for about 5.9% of the 7.5% fall in gilt yield between October 1992 and December 2017. Three reasons are provided to explain the significant trend coefficient. The first reason is the reduction of inflation uncertainty and anchoring of inflation expectations, but such factors are not reflected in the level and historical variation of early inflations. In this regard, Wright (2011) finds that the term premiums have declined internationally during the 1990s and 2000s, especially in countries in which inflation uncertainty have been reduced due to substantial changes in the monetary policy frameworks. Hordahl and Tristani (2012) find that post 1999, the long-term inflation expectation in the United States and the euro area have remained well anchored, which is favourable to reducing long-term interest rates as a result of reduced inflation risk.

The second reason is the extraordinary monetary policy of quantitative easing (QE) in response to the 2007-2008 financial crisis. Despite the fact that policy rates of major economies were at near zero levels, prices continued to fall and recurrence of great depression brought by debt deflation became a real possibility. Consequently, major central banks purchased huge quantities of long-dated government bonds. Joyce et al. (2011), Gagnon et al. (2010) show that the large scale asset purchases operated through a portfolio-rebalancing channel, successfully lowered the term premiums and hence interest rates on longer term bonds.

Finally, the fall in interest rate was also driven by forces that cannot be attributed to a slowdown in the economy concerned. As Caballero et al. (2017) points out, the savings glut of China and the other emerging economies in the aftermath of the Asian financial crisis raised demand for US dollars and drove up the Treasury prices, which in turn lowered gilt yields through international linkages. On the other hand, the pension reforms in the United Kingdom in 1990s and 2000s have caused yields on long-dated gilts to fall; see Joyce et al. (2009) and Greenwood and Vayanos (2010). In particular, the

Pensions Act of 2004 introduces the concept of self-sufficiency in which the portfolio of a defined benefit scheme should comprise of low risk assets so that there is a low probability of ever requiring additional employer contributions. Consequently, according to an investment report by Schroders in 2016, the private sector defined benefit schemes own an estimated 80% of the long-dated index-linked gilt market and the potential demand is almost five times the size of the market.⁴ Such structural imbalance prompts many pension fund managers to purchase long-dated gilts irrespective of price, causing yields to remain depressed relative to economic fundamentals.

3.2 Quantitative easing

Wong et al. (2016) shows that QE has significantly changed the transmission mechanism between credit and liquidity risks in the interbank markets. Specifically, credit risks were driven by liquidity risks during the crisis prior to QE. The transmission mechanism reversed after large scale asset purchase program was started by the Bank of England. Similar evidence is found here; QE has effectively reversed the correlation between gilt yields and equity returns, as described by the equation below.

$$r_{t+1} = -0.21 + 1.49y_t + I_t(25.80 - 7.20y_t) + e_t \quad (1)$$

$$[-0.03] \quad [2.53] \quad [2.55] \quad [-2.53]$$

In the above equation, r_{t+1} and y_t are equity returns and 20-year gilt yields respectively, whereas I_t is an indicator function that takes on a value of one after August 2007, the month regarded by many as the beginning of the financial crisis.⁵ The estimate is based on a sample 636 monthly observations from 1965 to 2017. Newey-West t -statistics are reported in square brackets. Prior to QE, high gilt yields are associated with high equity returns; the relationship becomes negative post QE.

The reason for the negative relationship between gilt yields and equity returns is that long-dated interest rates were deliberately kept low by QE to stimulate the economy. Indeed, interest rates are often used as a monetary policy tool to fine tune the economy. Conventionally, short interest rates will be raised (lowered) if there are risks of overheating (recession) in the economy. In the process, interest rates tend to lag behind the economy, and thus are regarded by King and Watson (1996) as a lagging indicator.

QE also changes the relationship between gilt yield and dividend yield. For several decades, gilt yield is higher than the dividend yield, which is sensible since equity returns comprise of capital gains as well as dividends. This makes the two assets close substitute for each other that gives rise to arbitrage activities as studied by Clare et al. (1994) based on sample from 1968 to 1992. However, it is noticeable that since late 1990s, gilt yields have been declining drastically. After quantitative easing, gilt yields are even lower than dividend yields, which are relatively stable throughout the period.

$$dy_t = 1.84 + 0.28y_t + I_t(1.45 - 0.21y_t) + e_t \quad (2)$$

$$[4.18] \quad [7.56] \quad [2.92] \quad [-2.09]$$

⁴ See "Pension funds and index-linked gilts: A supply/demand mismatch made in hell" by Schroders, 2016. Available at: <http://www.schroders.com/en/sysglobalassets/schroders/sites/ukpensions/pdfs/2016-06-pension-schemes-and-index-linked-gilts.pdf> [Accessed 25 Feb 2018].

⁵ Qualitatively similar results are obtained when other cut-off points (January of 2010, 2012 and 2014) in addition to August 2007 are considered.

To illustrate the change in the relationship between gilt yield (y_t) and dividend yield (dy_t), the above equation is estimated. I_t is an indicator function that is defined in the same way as in equation (1). The coefficient 0.28 of y_t indicates a positive relationship prior to the financial crisis. Post QE, the level of dividend yield rises by 1.45 and the slope declines significantly by 0.21, which implies that the correlation between gilt yield and dividend yield has effectively disappeared.

To sum up the above empirical evidence, QE has fundamentally altered the relationship between gilt yield and equity return, rendering the former unsuitable as discount rate for valuation of defined benefit schemes.

4 Stock returns

This section builds on the preceding analysis to show that when prices are stable, long term expected equity return is driven by factors which are distinct from those that determine riskless interest rates.

4.1 Long term expected returns

With Treasury yields at relatively high level in 1990s and equity returns declining to their new lows in US, many papers were written on the decline of equity risk premium and lower future returns; see for example Blanchard et al. (1993), Siegel (1999), Wadhvani (1999), Jagannathan et al. (2000) and Fama and French (2002). In contrast to such view, Ibbotson and Chen (2003) argue that the supply of stock market returns is generated by the productivity of the firms in the real economy. By decomposing the 1926–2000 historical equity returns into various supply factors such as inflation, earnings, dividends, the P/E, the dividend-payout ratio and so on, they estimated that the equity risk premium is only slightly lower than the pure historical return estimate. As the preceding section shows that the long term decline of interest rates is primarily due to reasons that are conducive for economic growth, if the theory put forward by Ibbotson and Chen were right, the equity returns would stabilize as steady economic growth and price stability has been broadly achieved for the last two decades. To find out if this is the case, the following Gordon (1962) growth model is used to calculate the required equity returns for the UK and US using samples from January 1965 to December 2017.

$$E(r) = \frac{D}{P} + g \quad (3)$$

In (3), D , P and g are respectively the next period dividends, current price and growth of dividends. Table 2 reports for the various sub periods from 1970 to 2017 the equity returns (both nominal and real), average yields on government bonds and risk premium defined as the difference between equity returns and bond yields. During 1970s, interest rates and nominal equity returns were high as a result of high inflations caused by the oil crisis. Real equity returns, however, were low. The 1980s was an exceptional decade that witnessed the highest nominal and real equity returns as the inflation has been considerably reduced in both countries. From 1990 onwards, as discussed in the previous section, monetary policies together with increased international trade and technological advance have brought inflation successfully under control. While there exists a small difference between the two countries, the average of UK and US equity returns remain remarkably stable during the past three decades, at around 5.3% and 7.5% in real and nominal terms respectively.

The expected return estimates presented in Table 2 are consistent with several papers that are supportive of Ibbotson and Chen (2003). Hassapis and Kalyvitis (2002) used a growth model to find

that real stock price changes and output growth are strongly related in the G-7 economies. Mauro (2003) reported similar association between real output and stock returns in emerging economies as well as developed economies. Faugere and Erlach (2006) use a supply-side growth model to show that the stock market returns depend on GDP per capita growth. Despite several recent financial crises in the last two decades, notably the burst of dot-com bubble and the recent financial crisis followed by the Great Recession, monetary policies have been successfully applied to stabilize the economy. Against such a backdrop, once the risk of high inflation has been evidently eliminated in 1990s, the equity returns remained broadly stable.

Table 2

		1970-79	1980-89	1990-99	2000-07	2008-17
UK	Equity return	15.80	18.10	9.24	6.96	6.88
	Gilt yield	11.94	11.14	7.96	4.64	3.23
	Risk premium	3.86	6.96	1.28	2.32	3.65
	Inflation	12.59	6.90	2.97	2.06	2.06
	Real equity return	3.20	11.20	6.27	4.91	4.82
US	Equity return	9.99	11.15	6.64	8.15	7.96
	Treasury yield	7.52	10.59	6.64	4.66	2.55
	Risk premium	2.47	0.56	0.00	3.49	5.41
	Inflation	7.36	5.10	2.93	2.81	1.61
	Real equity return	2.63	6.05	3.71	5.34	6.35
	Average equity return	12.90	14.63	7.94	7.56	7.42
	Average real equity return	2.91	8.63	4.99	5.13	5.58

Monthly data is used to obtain the figures reported in the Table. The UK sample is sourced from Thomson Reuters Datastream whereas the US from Robert Shiller online data. To obtain the equity returns $D/P + g$, first calculate g as the geometric growth rate of dividends. D/P is obtained as the arithmetic mean of dividend yields, which are the product of 'historical' dividend yield and $(1+g)$. The historical yield is the ratio of the trailing twelve months' dividends to price. The Gilt and Treasury yields are arithmetic average of 20-year gilt yield and 20-year Treasury yield respectively. The risk premium is defined as equity return minus the respective risk-free interest rate. The real equity return is obtained by subtracting inflation from the equity return, where inflation is calculated as the geometric growth rate of price index. CPI and RPI are used for US and UK respectively; in the latter case, 0.8% is subtracted from the calculated inflation. The average return is the average of US and UK real returns.

Gilts plus prior to QE

The basis upon which yields on long-dated government bonds can be used as discount rates must be supported by evidence not only in UK, but also in other similar financial markets such as the United States. The risk premium in Table 2, defined as equity return minus risk-free rate, corresponds to the 'fixed margin' that is added to the yield on government bond in the gilts plus approach. Therefore, the changing risk premiums from decade to decade in both US and UK is evidence against the validity of the approach for valuing defined pension plans, even prior to QE.

4.2 High valuations and future equity returns

It is common in actuarial practice to regard the current low dividend yields as signs of overvaluation. According to the Gordon growth model in (3), if dividend growth stays constant, future return will be lower by an amount current dividend yield is below its long term average. If dividend yield reverts to its long term average while growth remains unchanged, returns will be even lower in the future. Such views, however, are inconsistent with the results presented in Table 3 below.

Table 3

		1970-79	1980-89	1990-99	2000-07	2008-17
UK	D/P	4.98	4.87	3.92	3.09	3.52
	g	10.81	13.23	5.32	3.87	3.36
	Nominal return	15.80	18.10	9.24	6.96	6.88
	Real return	3.20	11.20	6.27	4.91	4.82
US	D/P	4.00	4.20	2.44	1.60	2.12
	g	5.98	6.95	4.20	6.55	5.84
	Nominal return	9.99	11.15	6.64	8.15	7.96
	Real return	2.63	6.05	3.71	5.34	6.35

The figures are reported using the same data as in Table 2. Dividend yield is calculated as the product of reported dividend yield and $(1+g)$, where g is the geometric average annual growth rate of dividends. D/P is the average of monthly dividend yields in each sub period. Nominal return is obtained as $D/P + g$ whereas real return is obtained by subtracting inflation from nominal return.

Table 3 reports for the various sub-periods from 1970 to 2017 the dividend yield (D/P), dividend growth (g) and nominal equity returns. As discussed previously, equity returns in both UK and US have stabilized from 1990s onwards. Although the dividend yields in US are lower than those in UK, the dividends in the former were growing at a faster rate, especially in the last two decade. This is consistent with the Miller and Modigliani (1961) theory, in which a low dividend yield implies a high growth rate of future dividends if markets are efficient. As pointed out by Ibbotson and Chen (2003), the prediction of declining equity return by some literature is predicated on the violation of the Miller and Modigliani theory.

A couple of points should be noted here with regard to the high valuation of US equities. First, stock repurchases for tax purposes during recent decades in US are likely to have depressed the dividend yield; see Jagannathan et al. (2000). The resulted lower dividend yield, however, is not due to mispricing or change of fundamentals of the firms. As Miller and Modigliani show, stock repurchases would give rise to a lower dividend yield but higher growth, rendering the expected return unchanged. Therefore the valuation of US equities may not be as high as it appears to be.

The other point is on the well documented findings that value stocks have a higher return than growth stocks. However, there are two reasons why such findings should not be translated into lower discount rate for the valuation of defined benefit pensions. First, much of the research that leads to the value anomaly is based on short term, cross sectional returns. Whether the stock market in a faster growth economy (e.g. US) would have a lower long term return than one in a slower growth economy (e.g. UK) is an entirely open question. Second, the so called value premium can be partly attributed to the value stocks being more risky (Zhang, 2005) and partly due to mispricing (Piotroski and So, 2012). The case of mispricing often has much larger impact on the returns and it occurs when, for example, low dividend yield stocks have low growth. There is no sign of mispricing between US and UK equities, as the lower dividend yield of the former is associated with a higher dividend growth rate.

Looking ahead

Table 4

	Dividend yield	Dividend growth	GDP 2017	GDP 2018-20
UK	3.65	6.74	1.7	1.48
US	1.84	8.13	2.3	2.42
World	2.32	9.07	3.6	3.68

Figures in the second and third column are respectively the reported dividend yields as at 31 December 2017 and dividend growth forecast. The annual geometric growth rate of forecast dividends from December 2017 to December 2019 is used as the dividend growth forecast. The GDP figures are growth rates. The dividend yields of UK and US stock markets are sourced from Thomson Reuters Datastream and Robert Shiller online database respectively. All other figures are from Bloomberg.

Table 4 provides the reported dividend yields as at December 2017 of equity markets in UK, US and the world as represented by the MSCI World Equity Index. Consistent with the preceding value-versus-growth analysis, equity markets with low (high) dividend yield is expected to experience high (low) dividend growth, which in turn is proportional to the growth rate of the underlying economy. The expected returns according to the Gordon growth model is around 10%. Adjusting for possible bias in analysts' forecast, the expected returns based on predicted dividend growths are consistent with the historical expected return of approximately 7.5% reported in Table 2 and 3.

5. Deficits of USS

In recent years, the liabilities and deficits of USS have been large and volatile; see Table 5 below. This prompted exchanges of letter in August and September of 2017 between the Chair-Elect of Work and Pensions Committee and the Pensions Regulator (tPR) on among others the issue of sustainability of defined benefit pensions in the UK.⁶ The following month saw the Financial Times published an article which points out that tPR has a 'weaker' view on USS because of the substantial increase in the size of the scheme's liabilities in recent years, which can be seen from Table 5 outstripped the growth in the scheme's assets between 2014 and 2017.⁷

Table 5

	2011	2012	2013	2014	2015	2016	2017
Liability	35.3	43.7	50.1	46.9	57.3	59.8	72.6
Assets	32.4	33.9	38.6	41.5	49.1	49.8	60.0
Deficit	2.9	9.8	11.5	5.4	8.2	10.0	12.6
IL20	0.71	-0.01	-0.27	-0.04	-0.90	-0.96	-1.68
Inflation	4.1	3.5	2.8	1.7	0.1	0.3	2.1

The liability and assets are in unit of £bn from the annual reports of USS. Deficit is obtained as the difference between the values of liability and assets. IL20 and inflation refers to yield on 20-year index-linked gilt and the annual rate of change in CPI respectively. Both IL20 and inflation are obtained from Bloomberg.

⁶ The letters are available at <https://www.parliament.uk/documents/commons-committees/work-and-pensions/Correspondence/Letter-from-Chair-to-Pensions-Regulator-re-Universities-Superannuation-scheme-14-08-2017.pdf> and <https://www.parliament.uk/documents/commons-committees/work-and-pensions/Correspondence/Letter-from-Pensions-Regulator-to-Frank-Field-re-Universities-superannuation-scheme-07-09-2017.pdf> [Both accessed 2 March 2018]

⁷ Available <https://www.ft.com/content/210b1d6c-adbd-11e7-beba-5521c713abf4> [Accessed 8 March 2018].

5.1 A simple model

A simple model is used to investigate the reason for the substantial increase in the size of the liabilities of USS. Let B be the benefits in real term to be paid over T years, and r the discount rate. Using binomial expansion for approximation, the liability can be written as

$$L = \sum_{t=1}^T \frac{B}{(1+r)^t} \approx BT \left[1 - \frac{T+1}{2} r \right]. \quad (4)$$

Take log, (4) becomes

$$\ln(L) \approx \ln(BT) - \frac{T+1}{2} r. \quad (5)$$

Let $r = y + m$ where y and m are gilt yield and fixed margin respectively. To fit the model to the real data, annual variations need to be taken into account. Let j denote the year. Then from (5) we have

$$\ln(L_j) = \left\{ \ln[BT] - \frac{(T+1)m}{2} \right\} - \frac{T+1}{2} y_j + \varepsilon_j \quad (6)$$

In the above, ε_j captures the 'errors' due to the following annual changes: (i) Increase in membership of USS; (ii) Increase in accrued pensions as a result of wage growth; and (iii) Inflation. Assume these errors add an average of α to the log of liability each year, then the model would become

$$\ln(L_j) = j\alpha + \left\{ \ln[BT] - \frac{(T+1)m}{2} \right\} - \frac{T+1}{2} y_j + \varepsilon_j, \quad (7)$$

and its first difference will have a constant term α as shown below.

$$\Delta \ln(L_j) = \alpha - \frac{T+1}{2} \Delta y_j + \Delta \varepsilon_j \quad (8)$$

Regression results

To estimate the models (6) to (8), the liabilities in Table 5 are transformed into March 2017 prices according to the CPI inflation reported in the same table. Taking log of the liabilities at March 2017 price gives us the dependent variable $\ln(L_j)$. Yields on conventional and index-linked gilts of various terms are used as regressor. It is found that the 20-year index-linked gilt yield provides the best 'fit' of the liabilities and Table 6 below reports the estimated regression models.

It can be seen from the regression results that the gilt yields explain as much as 99.3% variation of liabilities of USS between 2011 and 2017. It will be useful to check the validity of the model by comparing the theoretical value of intercept and slope coefficients with their estimated counterparts. To calculate the theoretical values, $T = 50$, $m = 0.017$ and $B = 1.47$ are used.⁸ Since the yields are

⁸ The value of T is taken as the number of years of discount rates provided in Table 7 of USS 2017 valuation report dated 8 December 2017. Available <http://ucu.group.shef.ac.uk/wp-content/uploads/Technical-provisions-December-2017.pdf> [Accessed 1 May 2018]. The value of m is from a USS letter dated 18 December sent to University of Warwick, which is available at <https://warwick.ac.uk/fac/sci/statistics/staff/academic->

expressed in percentage in the regressions, the theoretical value of slope is $-0.01 \times (T + 1)/2 = -0.255$. For the intercept of (6), the theoretical value is 3.86. It can be seen that both theoretical values are within all the 95% confidence bounds of the estimation.

Table 6

Dependent variable	$\ln(L_j)$	$\ln(L_j)$	$\Delta \ln(L_j)$
Intercept	3.856**	3.844**	0.007
<i>t</i> -statistic	[587.96]	[148.48]	[0.53]
95% confidence bounds	(3.84, 3.88)	(3.75, 3.94)	(-0.040, 0.054)
Slope	-0.258**	-0.247**	-0.242**
<i>t</i> -statistic	[-33.68]	[-10.12]	[-9.87]
95% confidence bounds	(-0.281, -0.234)	(-0.336, -0.157)	(-0.325, -0.158)
Trend		0.004	
<i>t</i> -statistic		[0.49]	
95% confidence bounds		(-0.028, 0.037)	
Adj. R-square	0.993	0.991	0.927

The OLS regression results reported in 2nd, 3rd and 4th column correspond to equations (6), (7) and (8) respectively. Seven observations are used in the first two regressions and six in the last. ** denotes significance at 1% level.

The regression results find that α is insignificantly different from zero, which may be explained as follow. As mentioned above, there are three factors affecting α . First, the increase to liability is considerably smaller than the rise in membership may suggest, as most new members start with zero accrued benefit. Second, wage growth does not affect benefits of deferred and pension members. Finally, adjusting the liabilities to 2017 price actually has a negative impact on α , for the inflation-linked benefit increase applies mainly to members on pension. It is likely that the negative impact of the last factor offsets the effect of the other two components, giving rise to a zero or very small α .

Large and volatile deficits

UUK recently remarked in the Employers Pension Forum that ‘as well as being sizeable, the deficit is volatile and this volatility poses additional risks to the security of the USS.’⁹ However, the reason for the large and volatile deficits can be understood based on the preceding analysis. Essentially, since the liability is valued in a similar way to bonds with gilt yield as the discount rate, the slope of the relationship between the value of liability and interest rate steepens as the latter declines. Since there is no closed form formula for the measure of the nonlinear relationship known as convexity, we can differentiate the expectation of (6) to obtain the following derivative.

$$\frac{\partial L}{\partial y} = -\tau \cdot e^{\ln(BT) - \tau m - \tau y} = -\frac{(T + 1)}{2} L(y) \quad (9)$$

where $\tau = (T + 1)/2$. As can be seen from the derivative in (9), the sensitivity of the value of liability to changes in the interest rate depends on the level of liability, which becomes large as yield falls. For example, $\partial L/\partial y = -10.2$ when the yield in March 2011 was 0.71%. This means that a 10 basis point

[research/hutton/uss/ussreplysssj.pdf](https://www2.le.ac.uk/offices/finance/documents/pensions/uss/epf-ganda-march-2016) [Accessed 12 March 2018]. The value of B is taken as the pension payment from the USS 2011 Annual Report, converted to March 2017 price.

⁹ The remark can be found in <https://www2.le.ac.uk/offices/finance/documents/pensions/uss/epf-ganda-march-2016> [Accessed 2 May 2018]

fall in yield would increase the liability by £1.02bn. On the other hand, when the yield is as low as -1.68% in 2017, $\partial L/\partial y = -18.8$ implying that the same 10 basis point fall in yield would result in £1.88bn rise in the value of liability.

2017 Valuation

There is further evidence that supports the validity of the model. In the 2017 valuation, 50 years of varying discount rates are used, which average to 3.27%. The index-linked gilt yields in the estimated models assume an inflation rate of 3%, which implies the nominal yield in 2017 is $3\% - 1.68\% = 1.32\%$. Adding a margin of 1.7% gives us a discount rate of 3.02%. Now the 2017 valuation reduces the value of liability by £5.2bn, which can be divided by $\partial L/\partial y$ to obtain the associated rise in yield that is consistent with model (6). Therefore, the discount rate of 2017 valuation as implied by model (6) is $3.02 + 5.2/18.8 = 3.296\%$, which is close to the average of discount rates used by USS.

5.2 Is USS in surplus?

The analyses in Section 3 and 4 show that gilt yield is no longer representative of equity returns. Since the portfolio of USS is internationally well diversified, the well-established capital asset pricing theory by Sharpe (1964), Lintner (1965) and Mossin (1966) suggests that the world equity index can be the basis upon which an appropriate discount rate is constructed. To illustrate this empirically, returns on USS assets are regressed on various sets of regressors which include return on the MSCI World Equity Index denominated in pound sterling (WE_t), lagged long-dated index-linked gilt yields (Y_t) and changes in the yields ($dY_t = Y_t - Y_{t-1}$).

Table 7

	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5
Intercept	0.033 [2.510]	0.105* [2.818]	0.072 [1.752]	0.033 [3.017]	0.027 [2.072]
WE_t	0.601** [7.930]			0.640** [9.422]	0.559** [6.946]
Y_{t-1}		-0.023 [-0.376]		0.022 [1.638]	
dY_t			-0.096 [-1.316]		-0.027 [-1.179]
Adj Rsq	0.940	-0.207	0.128	0.947	0.932

*In the regressions, dependent variable is the rate of changes in USS assets from 2011 to 2017. WE_t , Y_{t-1} and dY_t are annual returns in pound sterling on MSCI World Equity Index, lagged long-dated index-linked gilt yields and annual changes of gilt yields respectively. The required yearly asset values are obtained annual reports of USS whereas the other data are sourced from Bloomberg. * and ** indicate significance at 5% and 1% levels respectively.*

The regression results in Table 7 clearly show returns on USS assets are well explained by returns on world equities, with an adjusted R-square of over 94%. On the other hand, the other two regressors based on gilt yield are insignificant in the regressions, thereby confirming the inappropriateness of the gilts plus approach. One application of the results in Table 7 is to use expected long term equity return to construct the required discount rate as presented below.

Discount rates predicated on interest rates

The assets held by USS may be classified into three categories, namely 60% equities, 20% alternate investments and 20% bonds. The analysis in Section 4 suggests the expected rate of return on equities can be taken as 7.5%. Assuming the expected rate of return on alternate investments and bonds are 4% and 2% respectively, the expected rate of long term return on USS portfolio is $0.6 \times 7.5 + 0.2 \times 4 + 0.2 \times 2 = 5.7\%$. For prudence, 1.2% is taken away from the expected return and we have a discount rate of 4.5%. Using model (6), a discount rate of 4.5% translates into a yield of $4.5\% - 3\% - 1.7\% = -0.2\%$ and a technical provision of £49.9bn, giving a surplus of £10.1bn for USS.

The finding of a surplus is primarily the result of a higher discount rate of 4.5% being used, as compared with 3.27% of USS. The USS approach to discount rate is predicated on interest rates. This is evidenced from the first ten years of discount rates used in the 2017 valuation, which average only 0.93%; see Figure 2 below. The reason for the low discount rates can be found in the September 2017 consultation document which reckon the current low gilt yields would take ten years to revert back to the 2014 level. Also, after 2014 actuarial valuation, subsequent valuations on monitoring basis assume that all assets continue to provide the same level of outperformance above gilts. As the USS Chief Risk Officer explained, *'there is a reasonable empirical and theoretical basis for using this metric.'*¹⁰

< Figure 2 >

Finally, the views of USS on future returns track gilt yields closely. For the reported liabilities between 2011 and 2017, model (6) can be used to obtain the corresponding discount rates. Figure 3 plots the thus constructed discount rates (USS) along with the average return realised by USS assets over the period and the average discount rate of the state employees' defined benefit schemes (NASRA) in the US.¹¹ The fall in the NASRA discount rates is gentle and small, possibly due to the small weighting of government bonds in the portfolio. In contrast, USS discount rates decline by 2.40% during the past seven years. The difference between the two discount rates should not be large since portfolios nowadays are internationally well diversified. More importantly, the rapid decline in the USS discount rates reflects the view held by USS: riskless interest rate plus a fixed margin *on the whole* represents returns on other asset classes. Although adjustment is made in each triennial valuation, the revision is small; the change is only 0.276% in 2017 valuation. Between NASRA and USS, which one has a better approach to discount rate? The answer is obvious judging from the realised past returns.

< Figure 3 >

6. Summary and discussion

Because of high inflations, the returns on riskless assets and equities are comparable during 1970s and 1980s. Hence the former were used as the basis to value the liabilities of defined benefit pensions. Successful monetary policies and other economic developments, however, have brought stability to prices, resulting in long term decline of riskless interest rates. With zero lower bound on policy rates,

¹⁰ The article is available at: <https://www.uss.co.uk/how-uss-is-run/views-from-uss/discussing-deficits> [Accessed 1 March 2018].

¹¹ See Public Pension Plan Investment Return Assumptions. NASRA Issue Brief February 2018. Available at: <https://www.nasra.org/files/Issue%20Briefs/NASRAInvReturnAssumptBrief.pdf> [Accessed 25 Feb 2018].

the long-dated interest rates fall further due to quantitative easing as central banks try to stimulate the economies. Other factors such as the savings glut and liability-driven investment of pension funds also contributed to the decline, rendering the riskless yield depressed relative to the economic fundamentals. As Krishnamurthy and Vissing-Jorgensen (2012) points out, the low yield due to their safety and liquidity suggests that risk-free assets in important respects are similar to money.

The returns on equities are driven by entirely different factors. In particular, both theory and empirical evidence indicate that long term stock market returns are the result of the productivity of firms in the real economy. As Mishkin (2008) concludes, price stability and economic growth are mutually reinforcing, long term nominal stock market returns have stabilized at about 7% to 8% in the past three decades. Also, high valuations are not predictor of low future returns but are underpinned by high growths. Otherwise, arbitrageurs will short sell high valuation stocks and buy value stocks if both have similar growth prospect.

In short, gilts are inappropriate to value the liability of a defined benefit since they are now driven by factors that are entirely different from those that determine the equity returns. Evidence indicates that the valuation of USS is predicated on gilts and hence its liabilities have been large and volatile in recent years. A simple model of liability and gilt yield finds the scheme is in surplus instead of deficit.

Finally, in view of the findings presented in this article, many actuarial practices should be reviewed. In particular, there is a need to examine the economics of risk and return from a long term perspective, for pension funds have long horizon investment horizons. For example, given current low interest rates, de-risking can be suboptimal and extremely expensive.

Reference

- Blanchard, O.J., Shiller, R., Siegel, J.J., 1993. Movements in the equity premium. *Brookings Papers on Economic Activity* 2, 75—138.
- Caballero, R.J., Farhi, E., Gourinchas, P., 2017. Rents, technical change, and risk premia. Accounting for secular trends in interest rates, returns on capital, earning yields, and factor shares. *American Economic Review* 107, 614—620.
- Campa, J.M., Goldberg, L.S., 2005. Exchange Rate Pass-Through into Import Prices. *Review of Economics and Statistics* 87, 679—690.
- Carlstrom, C.T., Fuerst, T.S., Paustian, M., 2009. Inflation persistence, monetary policy, and the great moderation. *Journal of Money, Credit and Banking* 41, 767—786.
- Choudhria, E.U., Hakurab, D.S., 2006. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? *Journal of International Money and Finance* 25, 614—639.
- Clare, A.D., Thomas, S.H., Wickens, M.R., 1994. Is the gilt-equity yield ratio useful for predicting UK stock returns? *Economic Journal* 104, 303—315.
- Day, T., 2003. Financial economics and actuarial practice. *North American Actuarial Journal* 8, 90—102.

- Dupor, B., Han, J., Tsai, Y., 2009. What do technology shocks tell us about the New Keynesian paradigm? *Journal of Monetary Economics* 56, 560—569.
- Estrella, A., 2005. Why Does the Yield Curve Predict Output and Inflation? *Economic Journal* 115, 722—744.
- Estrella, A., Mishkin, F.S., 1996. The Yield Curve as a Predictor of U.S. Recessions. *Current Issues in Economics and Finance* 2, 1-6.
- Fama, E.F., French, K.R., 2002. The equity premium. *Journal of Finance* 57, 637—659.
- Faugere, C., Erlach, J.V., 2006. The Equity Premium: Consistent with GDP Growth and Portfolio Insurance. *Financial Review* 41, 547—564.
- Gagnon, J., Raskin, M., Remache, J., Sack, B., 2010. Large scale asset purchases by the Federal Reserve: Did they work? *Federal Reserve of New York Staff Report No. 441*.
- Gordon, M., 1962. *The Investment, Financing, and Valuation of the Corporation*. Homewood, IL: Irwin.
- Greenwood, R., Vayanos, D., 2010, Price pressure in the government bond market. *American Economic Review* 100, 585—590.
- Harvey, C.R., 1988. The real term structure and consumption growth. *Journal of Financial Economics* 22, 305—334.
- Hassapis, C., Kalyvitis, S., 2002. Investigating the links between growth and real stock price changes with empirical evidence from the G-7 economies. *The Quarterly Review of Economics and Finance* 42, 543—575.
- Hördahl, P., Tristani, O., 2012. Inflation Risk Premia in the Term Structure of Interest Rates. *Journal of the European Economic Association* 10, 634—657.
- Ibbotson, R.G., Chen, P., 2003. Long-Run Stock Returns: Participating in the Real Economy. *Financial Analysts Journal* 59, 88-98.
- Jagannathan, R., McGrattan, E.R., Scherbina, A., 2000. The decline of U.S. equity premium. *Federal Reserve Bank of Minneapolis Quarterly Review* 24, 3—19.
- Joyce, M., Lasaosa, A., Stevens, I., Tong, M., 2011. The financial market impact of quantitative easing, *International Journal of Central Banking* 7, 113—161.
- Joyce, M., Lildholdt, P., Sorensen, S., 2009. Extracting inflation expectations and inflation risk premia from the term structure: a joint model of the UK nominal and real yield curves. *Unpublished working paper 360*. Bank of England, London, UK.
- King, R.G., Watson, M.W., 1996. Money, Prices, Interest Rates and the Business Cycle. *The Review of Economics and Statistics* 78, 35—53.
- Krishnamurthy, A., Vissing-Jorgensen, A., 2012. The aggregate demand for treasury debt. *Journal of Political Economy* 120, 233—367.
- Lintner, J., 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics* 47, 13—37.
- Mauro, P., 2003, Stock returns and output growth in emerging and advanced economies. *Journal of Development Economics* 71, 129—153.

- Miller, M.H., Modigliani, F., 1961. Dividend Policy, Growth, and the Valuation of Shares. *Journal of Business* 34, 411-433.
- Mishkin, F.S., 2008. Does Stabilizing Inflation Contribute To Stabilizing Economic Activity? *NBER Working Papers No. 13970*. Cambridge: National Bureau of Economic Research.
- Mossin, J., 1966. Equilibrium in a capital asset market. *Econometrica* 35, 768—783.
- Novy-Marx, R., Rauh, J., 2009. The Liabilities and Risks of State- Sponsored Pension Plans. *Journal of Economic Perspectives* 23, 191-210.
- Novy-Marx, R., Rauh, J., 2011. Public Pension Promises: How Big Are They and What Are They Worth? *The Journal of Finance* 66, 1211-1249.
- Novy-Marx, R., 2015. Economic and Financial Approaches to Valuing Pension Liabilities. *Journal of Pension Economics and Finance* 14, 144—150.
- Piotroski, J.D., So, E.C., 2012. Identifying Expectation Errors in Value/Glamour Strategies: A Fundamental Analysis Approach. *Review of Financial Studies* 25, 2841—2875.
- Sharpe, W.F., 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance* 19, 425—442.
- Siegel, J.J., 1999. The shrinking equity premium: Historical facts and future forecasts. *Journal of Portfolio Management* 26, 10—17.
- Wadhvani, S.B., 1999. The U.S. stock market and the global economic crisis. *National Institute of Economic Review* (January): 86—105.
- Wong, W., Biefang-Frisancho Mariscal, I., Yao, W., Howells, P., 2016, Liquidity and Credit Risks in the UK's Financial Crisis: How 'Quantitative Easing' changed the relationship. *Cardiff Economics Working Papers E2016/9*.
- Wright, J.H., 2011. Term premia and inflation uncertainty: empirical evidence from an international panel dataset. *American Economic Review* 101, 1514—34.
- Zhang, L., 2005. The value premium. *Journal of Finance* 60, 67—103.

Figure 1

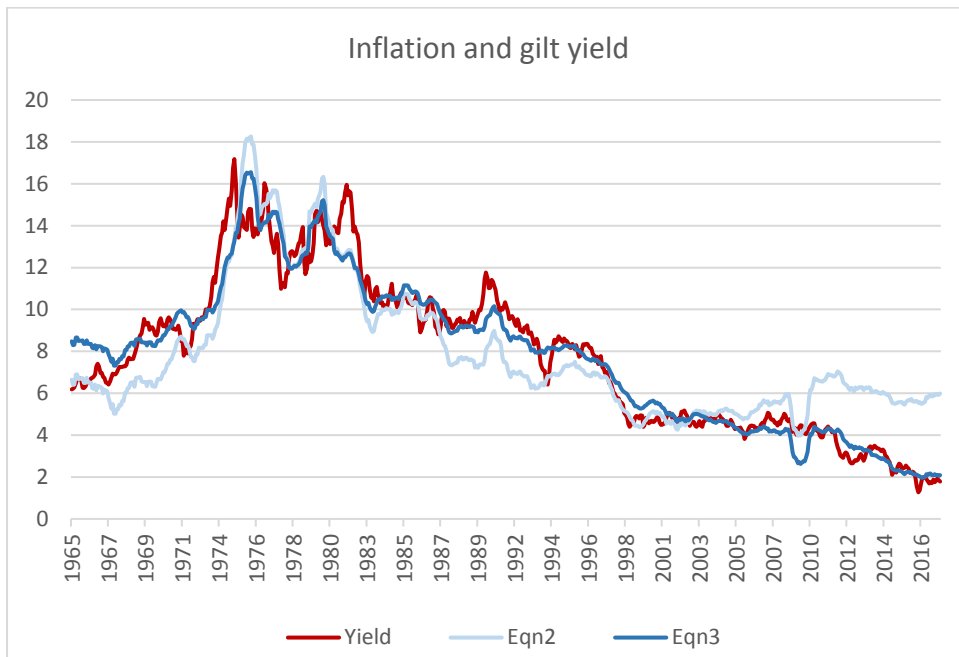


Figure 2

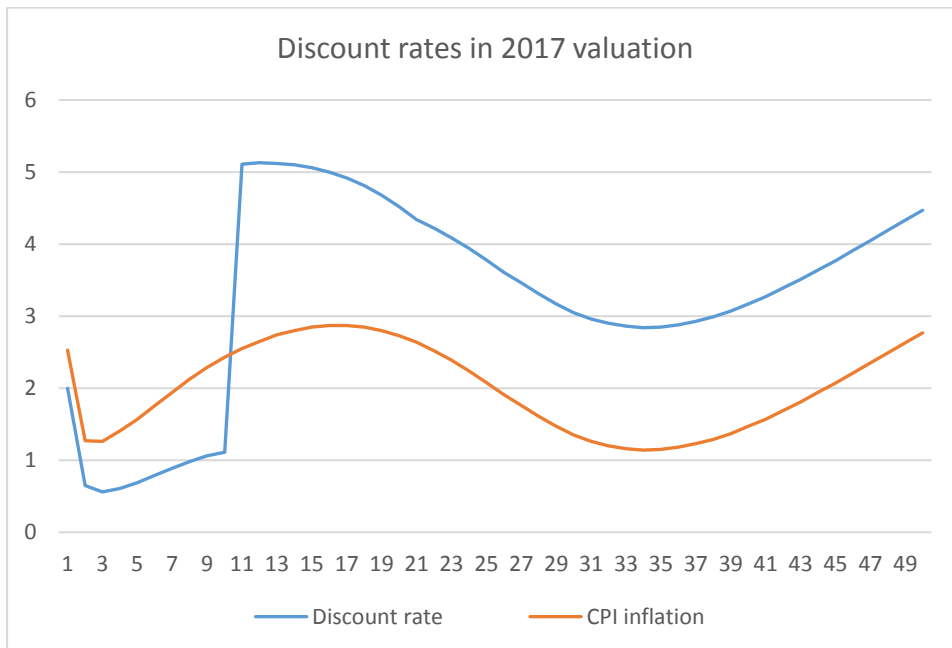


Figure 3

