Portfolio Balance Effects and the Federal Reserve's Large-Scale Asset Purchases

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Abstract

Whereas much of previous literature focuses upon the impact on yields from the Federal Reserve's large-scale asset purchases (LSAPs), we study the changes to expected returns. Our empirical investigation offers support for changes to risk premia coincident with LSAPs. For both equity and bonds, we find evidence for supply/demand LSAPs effects; the equity effects are consistent with a substitution effect from bonds to equities, whereas the bond effects appear to be an anomaly. Such findings represent new insight for weighing the efficacy and identifying the scope of LSAPs.

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The Federal Reserve's large-scale asset purchase programs (LSAPs) have been widely characterized by many, including itself, as an effort to bring down long-term yields in fixed income markets in order to spur long term investment and to improve economic conditions. Indeed, Figure 1 clearly illustrates a downward trend for the yield of the 10-year Treasury bond beginning in 2008 with a recent rebound coinciding with a tapering of the third LSAPs program or Quantitative Easing 3 (QE3). A primary channel through which large-scale asset purchases is thought to facilitate changes in yields is via changes in the market price of risk. By purchasing long maturity fixed income such as Treasuries or mortgage backed securities, the Federal Reserve changes the aggregate supply for these assets which, in turn, causes a shift in these markets' equilibria. Risk premia then must adjust to reduce aggregate demand to meet the decreased supply of these assets. This behavior is often described[1] as the "portfolio balance effect" since the mechanism by which these purchases generate impact relies upon portfolio switches between assets with different risks. In order for LSAPs to be effective, these assets cannot be perfect substitutes. Initial works describing this phenomenon historically begin with Culbertson (1957), Tobin (1961), Tobin (1963), Modigliani and Sutch (1966), Tobin (1969), Brunner and Meltzer (1973).

An analysis into the portfolio balance channel for LSAPs presupposes that the Federal Reserve was a significant trader in fixed income security markets. This is supported by the evidence. Calculations from Hancock and Passmore (2012) indicate that, from 2009-2011, the Federal Reserve's holdings of Treasuries averaged approximately 16% of the whole Treasury market. In fact, by the end of QE2 on June 20, 2011, the Federal Reserve's holdings of Treasury bonds amounted close to 25% of all outstanding Treasury securities. Similarly, its holdings of mortgage-backed securities averaged approximately 19% of the whole MBS market and eventually averaged to about 25% of all outstanding fixed-rate agency MBS. With regard to information about recent flows of Treasuries and MBS, since the announcement of QE3 in late 2012 until at least mid-2013, the Federal Reserve was the single largest buyer

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[1] see e.g., Gagnon et al. (2011), Woodford (2012).

of duration across fixed-income markets.[2] Table 1 arranged by JP Morgan summarizes the Federal Reserve's participation in buying new issuances of fixed income securities over the entire LSAPs program before tapering: 2008-2013. As shown, the Federal Reserve absorbed approximately 35% of the net issuance of fixed income products across major sectors since the LSAPs began. Moreover, the Federal Reserve purchased 65% of the net issuance of Treasuries and MBS in 2009 and nearly all ($\approx 94\%$) in 2013.[3]

The substantial reductions in the aggregate demand for fixed income, required to meet the reductions in the aggregate supply, create the potential for risk premia changes across asset classes. Indeed, portfolio switches induced by changes in the amount of duration risk held in the economy are not limited to fixed income markets. Affected asset classes include imperfect substitutes such as short duration bonds, equities, real estate investments, etc. In this regard, we consider the possible influence LSAPs contributed to the extraordinary performance of equity markets since the recession. Figure 2 depicts the S&P 500 index during the most recent 10-year window. A common explanation for such large gains is that they represent realized compensation for large risk premia assumed during the height of the crisis. In other words, those willing to invest when volatility of future consumption and risk aversion moved very high were rewarded with large expected returns. Here, we ask to what extent LSAPs contributed to this phenomenon through risk premium changes and/or price changes in equity markets? Did fixed income investors displaced by LSAPs require higher compensation from equity markets in order for markets to clear? Or, did LSAPs contribute to higher equity prices (and thus realized returns) while reducing future expected returns for equity investors?

Stock-bond correlation has received considerable attention in the literature. Many works including Christiansen and Ranaldo (2007), Guidolin and Timmermann (2007), Burkhardt and Hasseltoft (2012), Viceira (2012), Campbell, Sunderam and Viceira (2013), and David and Veronesi (2013) have documented the time variation of the correlation and study the

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[2] JP Morgan US Fixed Income Strategy, NY, Aug. 29, 2013.

[3] JP Morgan forecast for full-year 2013 net issuance on August 29, 2013.

safe haven characteristics of US Treasuries. From these sources and others, over a long time horizon, the average correlation between equities and bonds has been slightly positive. However, since the millennium began, the correlation has been considerably negative suggesting a substantial flight-to-quality between bonds and equities. Moreover, Ilmanen (2003) argues that this negative correlation is likely during financial crises and in a world of low and stable inflation.

The investigation we propose is related to the stock-bond correlation literature. In our work, we study the mechanism by which bond supply reductions affect the equity risk premium. While the relationship between bonds and equity is complicated, relying upon market beliefs, preferences, and quantities of assets, we focus our attention on the latter since it is the chosen instrument of influence targeted by LSAPs.

Much of the literature on LSAPs focuses on yields rather than risk premia. Williams (2014) reviews a large collection of this research and highlights LSAPs overall impact on interest rates. While various studies differ in the magnitude of an impact, this research finds sizable effects on the long end of the yield curve. Williams (2014) reports that from this literature, one might expect a 15bp $-$ 25bp decrease in the 10-year Treasury yield for each \$600 million of Federal Reserve purchases–roughly equivalent to a drop of $0.75\% - 1\%$ in the federal funds rate. Event studies leading to such implications include Bernanke, Reinhart and Sack (2004), Gagnon et al. (2011), Joyce, Tong and Woods (2011), DAmico et al. (2012), Christensen and Rudebusch (2012), DAmico and King (2013), and Bauer and Rudebusch (2014). Time series/Model based empirical methods on LSAPs yield effects include Modigliani and Sutch (1966), Krishnamurthy and Vissing-Jorgensen (2011), Hancock and Passmore (2012), Hamilton and Wu (2012), Li and Wei (2013), Greenwood and Vayanos (2014), and Jarrow and Li (2014).

Beyond yields, it is particularly important to estimate the impact of LSAPs on bond risk premia.[4] In fact, expected returns are of primary concern to investors in financial markets.

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[4] see e.g., Ilmanen (2011) and Diebold and Rudebusch (2013) for comprehensive reviews of bond risk premia literature.

However, an analysis of the impact on bond yields tells only a partial story about investor expectations for bond returns. To see this one can appeal to an approximate (first-order) relationship between the yield of a T-maturity zero-coupon bond $y_t^{(T)}$ and its bond risk premium $\mathrm{BRP}_t^{(T)}$:

$$y_t^{(T)} \approx y_t^{(1)} \ + \mathrm{BRP}_t^{(T)} + \mathrm{Dur}_t^{(T)} \times \mathbb{E}_t\left(y^{(T)}(t+1) - y^{(T)}(t)\right),$$

where Dur_t^T denotes the modified duration for the bond with maturity T at time t, and $\mathbb{E}_t[\cdot]$ indicates conditional expectation at time t. Here, we see how yields reflect both an embedded risk premia along with market expectations of yield changes. Separation of these two components of yields is a difficult task which has received wide attention in the literature, see e.g., Kim and Wright (2005), Cochrane and Piazzesi (2005), Cochrane and Piazzesi (2008), and Wright (2011).

Our study builds upon recent research into the supply effects of LSAPs on risk premia. This literature is motivated by earlier work related to the portfolio balance effect which posits that many investors have preferences for specific investments (i.e., preferred habitats) that LSAPs target. Actions by these investors, to accommodate decreases or increases in the amount of available Treasury securities, induce changes to prices and expected returns. Recent work exploring the preferred habitat approach within bond markets include e.g., Vayanos and Vila (2009), Pflueger and Viceira (2013), Hanson (2014), Malkhozov et al. (2014), and Greenwood and Vayanos (2014). In Greenwood and Vayanos (2014), the authors empirically test and confirm a positive relationship between bond supply and expected returns; with augmented effects for longer-maturity bonds and higher investor risk aversion. We contribute to this literature by extending the analysis beyond fixed income to equities.

In a general equilibrium model with rational expectations, an exogenous decrease in bond supply induces changes in the economy through three unique channels: changing market beliefs (e.g., return expectations, volatility), changing market preferences (e.g., risk aversion, impatience), and changing supply/demand effects (e.g., portfolio rebalances). In this work, we empirically investigate which of these channels account for much of the changes in bond and equity risk premiums during LSAPs. Specifically, we examine the expected excess returns for equity (ERP) and risky bonds (BRP) using common proxies and investigate the dominant sources of influence during the LSAPs period.

Our study presents evidence supporting supply/demand effects coincident with LSAPs for both equities and bonds. However, these supply/demand influences behave differently within each market. For equities, our empirical investigation shows that after controlling for endogenous changes to market beliefs and preferences, a bond supply reduction has the effect of decreasing the expected equity return by increasing the price of equity. Thus, a sustained effort in lowering the bond supply has the effect (all else equal) of incrementally increasing equity prices while continuing to reduce the expected return for equity investment over future periods. In contrast, bonds appear to be offer higher risk premia coincident with LSAPs. Such a finding may indicate confounding supply/demand effects resulting from competing actions taken by both the Federal Reserve and the US Treasury during this time period.[5]

The analysis to follow is simple. In Section 1, we empirically test how risk premiums of both bonds and equities were affected by LSAPs. We find evidence that supply/demand effects led to a lower equity premium and a larger bond premium. While the equity impact is consistent with a substitution effect from bonds to equities, the bond impact appears to be an anomaly. For the latter, we offer a possible explanation in light of recent work by Greenwood et al. (2014). Section 2 concludes our discussion and Section A Appendix contains some extra details pertaining to the analysis.

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[5] Greenwood et al. (2014) document competing objectives of the Federal Reserve and the US Treasury regarding debt management policy during LSAPs.

1 The Empirical Analysis

We undertake an empirical investigation into how risk premia in both equity and bonds markets adjusted due to the Federal Reserve's LSAPs program. In our analysis, we estimate the impact of the LSAPs by regressing estimates of the equity and bond risk premia on an indicator variable coincident with significant LSAPs dates, while controlling for market beliefs and preferences using three proxies: volatility index (VIX), variance risk premia (VRP), relative wealth (RelWlth).

As a measure of the implied volatility of 30-day call and put options prices on the S&P 500, the VIX represents the most common proxy for gauging future market volatility and assessing aggregate investor risk aversion. Given the one-to-one mapping between volatility and price (as VIX increases, call and put options become more valuable and vice versa), the level of the VIX corresponds directly to the price of insurance against market downturns. With regard to put options, as their prices increase, the cost of purchasing insurance on the S&P 500 index increases. Such price increases for insurance are consistent with an increase in the market's risk aversion or changing expectations. We use historical closing prices at the beginning of each month from Jan 1990-Dec 2013 for our study.

Carr and Wu (2009) identify the VRP as the difference between the ex-post realized variance and the synthetic variance swap rate determined at swap initiation. Bekaert and Engstrom (2009) and Bekaert, Hoerova and Duca (2013) argue that the VRP may be interpreted as a proxy for aggregate risk-aversion. Additionally, Bollerslev and Todorov (2011) emphasize that the VRP captures both continuous and discontinuous price fluctuation risk. In light of these findings, we include the historical VRP on the S&P 500 index as a proxy for market preferences. Similar to VRP, we use historical closing prices at the beginning of each month from Jan 1990-Dec 2013.

Decreasing relative risk aversion captures the intuitive idea that investors are more risk averse when current wealth is low relative to past wealth. To incorporate this wealth dependent risk aversion notion, we adopt a simple relative value approach using equity returns found in previous literature (e.g., Ilmanen (1997)): From the CRSP value-weighted return (AMEX, NASDAQ, NYSE) monthly series, we calculate the ratio of an exponentially weighted past market level to the current market level to identify market risk aversion, i.e.,

$$\text{RelWlth}_t = \frac{(1-a)\sum_{i=1}^{\infty} a^{i-1} W_{t-i}}{W_t},$$

for some weighting constant $0 < a < 1$.[6]

Table 4 displays the sample correlations between VIX, VRP, and RelWlth over different sample periods: Jan 1990-Dec 2013 and Jan 2008-Dec 2013. Jan 1990 represents the earliest date available in the VIX, VRP time series. In both matrices, we observe strong correlation between VIX and RelWlth. The correlation between VIX and VRP appears to weaken (-0.031) during Jan 2008-Dec 2013 relative to the prior dates from Jan 1990-Dec 2013 (0.326). Across both time periods, the correlation between VRP and RelWlth remains moderate (0.151 and 0.185 resp.).

The Federal Reserve's LSAPs programs can be characterized by intermittent announcements of future purchases along with steady implementation of bond buying. Due to an inability to capture exactly when markets incorporate information into prices, we examine how market return expectations evolved throughout the full implementation phase of LSAPs (Jan 2008-Dec 2013). Specifically, we study how the size of actual Federal Reserve purchases impacted market expectations which already reflect their announced and existing acquisitions. As such, significant movements in risk premia coinciding with particularly (large or small) purchases might reveal the unanticipated impacts of these actions. Moreover, we can separate out different channels of the LSAPs impact by controlling for various proxies for market beliefs and preferences in the regressions.

Let RP_t denote a risk premia proxy, X_t a vector of market beliefs and preferences proxies,

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[6] Following Ilmanen (1997), we take $a = 0.9$.

and $\mathbb{1}_{\{t\in\text{LSAPs}\}}$ an indicator variable of significant LSAPs dates at time t. We consider

$$\text{RP}_t = \beta_0 + \beta_1 \mathbb{1}_{\{t\in\text{LSAPs}\}} + \beta_2 X_t + \varepsilon_t. \tag{1}$$

For our empirical analysis, we first obtain estimates for RP_t. These estimates may result in serially correlation/heteroskedastic errors when subsequently running (1).[7] We adjust t-statistics using Newey and West (1987) standard errors with lags to account for this possibility.[8]

When considering which dates to include in the LSAPs event, we use: the computed change in the Federal Reserve holdings of US Treasuries over each month during the LSAPs period.[9] We define the LSAPs dates as follows: Over the full-scale implementation period of LSAPs (Jan 2008-Dec 2013), we compute the weekly changes in the Federal Reserve holdings of US Treasuries. After aggregating all of these weekly changes, we group months together into an x-percentile group for which the weekly change in their holdings of US Treasuries represented at or above the x-percentile of all changes during Jan 2008-Dec 2013. An example shows how the data for the regression lines up with the LSAPs event dates $\{t \in \text{LSAPs}\}$. Suppose that April 2009 represents a month for which US Treasury purchases were at or above the x-percentile of all purchases during Jan 2008-Dec 2013. Given this observation, April 2009 is included in the x-percentile associated event $\{t \in \text{LSAPs}\}$ for $t =$ May 2009. As such, for $t =$ May 2009, the regression (1) is equal to

$$\text{RP}_t = (\beta_0 + \beta_1) + \beta_2 X_t + \varepsilon_t.$$

Hence, the regression picks up any changes in RP directly after (i.e., next month) the x-percentile purchases by the Federal Reserve. Table 3 displays the dates between Jan 2008-

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[7] See Section A Appendix for a discussion of this point.

[8] We report t-statistics using 12 lags throughout. Additional tests using more lags does not appear to affect the results.

[9] Federal Reserve holdings information is available through `http://www.federalreserve.gov/datadownload`.

Dec 2013 corresponding to x-percentile purchases.

1.1 Equity Risk Premia and LSAPs

To assess the reward from stock investing, academics and practitioners estimate the expected return of a broad-equity index in excess over the risk-less (e.g., 90-day T-Bill) return. As a measure of the performance of the broad US market, we use the monthly returns for the CRSP value-weighted index return series across three exchanges (NYSE, AMEX, NASDAQ). We express equity returns as logarithms. Let r_{t+1} denote the log return of the equity index during the year following t. Excess returns rx_{t+1} result from subtracting off the log return for short-maturity 90-day T-Bill returns, also obtained using CRSP. Summary statistics for CRSP value-weighted returns and T-Bill returns appear in Table 2.

Cochrane (2011) reviews the evidence for the forecastability of returns. For estimating the equity risk premium, there are many well-known forecasting variables, particularly the dividend price ratio, dp $:= \log(D/P)$ (see e.g., Fama and French (1988), Cochrane (2008)) and the consumption-to-wealth ratio, cay (Lettau and Ludvigson (2001)). Using these empirical observations, we run a regression of excess returns on the dividend-price ratio and the consumption-to-wealth ratio to estimate the time-varying equity risk premium, i.e.,

$$rx_{t+1} = \beta_0 + \beta_1 \mathrm{dp}_t + \beta_2 \mathrm{cay}_t + \varepsilon_{t+1}.$$

The results of this regression for data spanning Jan 1952-Dec 2013 appear in Table 5. The t-statistics are computed using the Hansen and Hodrick (1980) correction to adjust for overlapping excess returns. We approximate equity risk premia (ERP) using the fitted part of this forecasting regression, i.e., the ERP (1-yr)

$$\mathrm{ERP}_t := \mathbb{E}_t(rx_{t+1}) = \hat{\beta}_0 + \hat{\beta}_1 \mathrm{dp}_t + \hat{\beta}_2 \mathrm{cay}_t.$$

As previously mentioned, an exogenous shift in the bond supply may affect expected returns through market beliefs, market preferences, and market supply/demand. With regard to LSAPs, improving future return characteristics for equity investment and lowering investor risk aversion appear to have been important goals for undertaking such programs. For example, the Federal Reserve stated that large asset purchases of long-term fixed income hoped to "lower their term premiums, putting downward pressure on longer-term interest rates and easing financial conditions more broadly."[10] Nevertheless, the chosen mechanism of influence underlying the LSAPs operations primarily targets market supply/demand balance. To test for a supply/demand effects coincident with LSAPs, we run regressions which control for market beliefs/preferences.

For analyzing the impact of LSAPs on equities, we specialize (1) for the equity risk premium

$$\mathrm{ERP}_t = \beta_0 + \beta_1 \mathbb{1}_{\{t \in \mathrm{LSAPs}\}} + \beta_2 X_t + \varepsilon_t. \tag{2}$$

Table 6 displays the results of running (2) across different sets of LSAPs dates (i.e., percentile purchases) and different collections of market proxies. The t-statistics are based on Newey and West (1987) standard errors allowing for serial correlated/heteroskedastic errors with 12 lags. Due to the significant correlation between VIX and RelWlth, shown in Table 4, we do not include these variables together in the regressions to avoid multicollinearity. Overall, column (5) appears to produce the strongest statistical significance and gives the most ERP explanatory power. Across LSAPs percentiles, it appears that large percentile purchases (90th, 97th percentiles) yield the most statistical significance. This phenomenon conforms with intuition suggesting that large purchases provide investors with greater opportunities to reassess market expectations about future returns.

Over the largest percentile LSAPs dates, we observe a negative impact ($\approx -1\%$ to -2%)

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[10] "Long Term Interest Rates" Federal Reserve speech to the Annual Monetary/Macroeconomics Conference by former Chairman Ben Bernanke, March, 1, 2013.

to ERP, holding proxies for market beliefs and preferences fixed. Thus, ERP appears to adjust downward in the wake of large percentile US Treasury purchases made by the Federal Reserve. All else equal, exogenous bond supply reductions induce a larger equity price at the expense of lowering future expected returns. Hence, without endogenous changes to either market beliefs or market preferences, the net result of a sustained purchasing program is a higher equity valuation coupled with lower expected future returns.

1.2 Bond Risk Premia and LSAPs

As stated by the Federal Reserve, a primary goal behind LSAPs was to lower bond risk premia (BRP) for long maturities. In this section, we study the empirical evidence of the effect of LSAPs on BRP.

BRP is quantified in several ways in the literature; see e.g., Campbell and Shiller (1991), Jarrow (2009), Chapter 5 Jarrow (2002), Chapter 19.2 Cochrane (2005), etc. Consistent with our equity analysis, we define BRP as the expected difference between a holding period return for a given maturity and the return earned on a short-maturity Treasury.

We express bond yields and returns as logarithms and utilize the following common notations. We define $p_t^{(T)}$ as the log price of a T-year zero-coupon bond at time t. Let $y_t^{(T)}$ denote the log yield of a T-year zero-coupon bond at time t. We write the log forward rate at time t for loans between $t+T-1$ and $t+T$ as $f_t^{(T)} := p_t^{(T-1)} - p_t^{(T)}$. Further, we set $r_{t+1}^{(T)}$ to be the log return of the T-year zero-coupon bond during the year following t. The excess return $rx_{t+1}^{(T)}$ results from subtracting off the log return for short-maturity 90-day T-Bills. We denote BRP of maturity T over 1 year following t as

$$\mathrm{BRP}_t^{(T)} := \mathbb{E}_t\left(rx_{t+1}^{(T)}\right).$$

In our analysis below, we consider two popular estimation procedures for BRP: (1) the Cochrane-Piazzesi forward curve methodology, and (2) the Kim-Wright term structure model. First, we define how to obtain $\mathrm{BRP}_t^{(T)}$ for both methods and second, we discuss the LSAPs impact analysis.

1.2.1 BRP Estimation

Cochrane and Piazzesi (2005) and Cochrane and Piazzesi (2008) identify a single forecasting factor x_t (computed as a linear combination of forward rates) which explains expected returns across all maturities. To adapt this methodology for our analysis, we collect data on end-of-month historical bond yields from Jan 1972-Dec 2013 via three sources: Fama and Bliss (1987) data on $1-5$ year zero coupon bond prices; Gürkaynak, Sack and Wright (2007) zero-coupon Treasury yields for $1-15$ year maturities; and CRSP 90-day T-Bill returns. Summary statistics for collected data appears in Table 2.

To identify the bond-forecasting factor x_t, we regress the average excess return across maturities $T = 2, \dots 15$ on the five Fama-Bliss forward rates. More specifically,

$$\frac{1}{14}\sum_{T=2}^{15} rx_{t+1}^{(T)} = \gamma_0 + \gamma_1 y_t^{(1)} + \ldots + \gamma_5 f_t^{(5)} + \bar{\varepsilon}_{t+1}.$$

Then, we use the estimate $\hat{\gamma}_t, i = 0, 1, \ldots, 5$ to define the bond-return forecasting factor as

$$\hat{x}_t := \hat{\gamma}_0 + \hat{\gamma}_1 y_t^{(1)} + \ldots + \hat{\gamma}_5 f_t^{(5)}.$$

Table 7 displays the regression results for identifying the coefficients for the forward rates. We note that the estimates display the expected tent shape identified in Cochrane and Piazzesi (2005). After identifying $\hat{x}_t$, we then run regressions across maturities of one-year excess returns on $\hat{x}_t$

$$rx_{t+1}^{(T)} = \beta^{(T)}\hat{x}_t + \varepsilon_{t+1}^{(T)},$$

after which we approximate the Cochrane-Piazzesi BRP (CP-BRP) as

$$\mathrm{BRP}_t^{(T)} = \hat{\beta}^{(T)} \hat{x}_t. \tag{3}$$

Table 8 displays the results from this regression.

Kim and Wright (2005) estimate the term premia using a three-factor no-arbitrage term structure model supplemented with survey data. At the Federal Reserve's website[11], the author's estimate both the term premia and the instantaneous forward term premia through time. We use a variation of their estimated term premia in order to back out an estimate of a holding period bond risk premia. More specifically, Kim and Wright (2005) report an estimate of the average expected return of the bond with maturity T over its life in excess of a series of 1-year investments, i.e.,

$$\mathrm{TP}_t^{(T)} = y_t^{(T)} - \frac{1}{T}\mathbb{E}_t\left(y_t^{(1)} + y_{t+1}^{(1)} + \ldots + y_{t+T-1}^{(1)}\right), \tag{4}$$

Using this representation, we define the Kim-Wright BRP (KW-BRP) as[12]

$$\mathrm{BRP}_t^{(T)} = T \times \mathrm{TP}_t^{(T)} - (T-1) \times \mathrm{TP}_{t+1}^{(T)}, \tag{5}$$

where $(t, t+1)$ represents a 1-year time interval.

1.2.2 LSAPs Impact on BRP

With historical time series estimates for BRP along with our market beliefs and preferences proxies, we study the effect of LSAPs through the regression

$$\mathrm{BRP}_t^{(T)} = \beta_0 + \beta_1 \mathbb{1}_{\{t \in \mathrm{LSAPs}\}} + \beta_2 X_t + \varepsilon_t. \tag{6}$$

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[11] `http://www.federalreserve.gov/pubs/feds/2005/200533/200533abs.html.`

[12] see Section A Appendix for motivation of this definition.

Table 9 and Table 10 displays the results over Jan 2008-Dec 2013 for a 10-year maturity Treasury bond using both CP-BRP and KW-BRP. The reported t-statistics are based on Newey and West (1987) standard errors allowing for serial correlated/heteroskedastic errors with 12 lags. Similar to the equity analysis, it appears that the large percentile purchases yield the most statistical significance. For CP-BRP, it appears that stronger significance occurs within the 90-th percentile purchase dates. Within the 90th percentile, all regressions produce statistically significant coefficients for the LSAPs indicator variable along with largely insignificant market beliefs and preferences proxy variables. The 97-th percentile purchases yields similar results but with smaller t-statistics (between $1.13 - 1.88$) for the LSAPs indicator variable. Regressions using KW-BRP yield similar observations with stronger statistical significance. Within both the 90th and 97th percentile purchases, large positive t-statistics for the LSAPs indicator variable are paired with insignificant proxy variables.

In summary, there appears to be evidence of a positive increase in BRP after larger LSAPs dates unattributable to changes in market beliefs and preferences. However, due to the possibility of noisy proxies which confound market beliefs and preferences, this insignificance may be in error. For example, VIX may be a noisy combination of market risk aversion and volatility. To further explore the possibility of misidentification, we add an additional proxy, breakeven inflation (BEI), to our tests to explore inflation risk.

Inflation risk is well known to be an important consideration in the economy. Through LSAPs, the Federal Reserve intended to cause changes to market expectations that would result in increased investment and spending to increase economic growth and lift the inflation rate. However, the impact of these changes on BRP is ambiguous; easing financial conditions helps to promote a lower BRP while increased spending and growth spurs inflation risk which increases BRP. The literature cites several main drivers of BRP. Pflueger and Viceira (2013) provide evidence that both time-varying inflation risk premia and time-varying real interest rate risk premia are important in explaining the time variation of BRP. With regard to inflation risk, Section 9.5 in Ilmanen (2011) documents that inflation risk premium (IRP) represents one of the most important drivers of BRP; contributing $3\% - 4\%$ of nominal US bond yields during the early 1980's.

Due to the IRP's influence on the BRP, we test for a BRP increase attributable to an increase in the inflation risk premium to bondholders. We consider the historical (Jan 2008-Dec 2013) break-even inflation rate (BEI), defined as the difference between the nominal yield and the real yield implied by Treasury Inflation Protected Securities (TIPS) with the same maturity, and use it as a control for our test. Table 11 shows the results from running the regression

$$\mathrm{TP}_t^{(T)} = \beta_0 + \beta_1 \mathbb{1}_{\{t \in \mathrm{LSAPs}\}} + \beta_2 X_t + \beta_3 \mathrm{BEI}_t^{(T)} + \varepsilon_t, \tag{7}$$

for $\mathrm{TP}_t^{(T)}$ defined in (4). We used the term premia for our test since it matches better with breakeven inflation. Recall that the term premia is defined as the excess yield of a T-maturity bond over the expected future short rate over T years. Break-even inflation consists of two pieces: market expectations for inflation over T years, and inflation risk premia over T years. Similar to our previous discussion, we see that the larger percentile purchases yield the most statistical significance.[13] Moreover, we observe that BEI does not eliminate the significance of the LSAPs indicator variable. For example, in the 97th percentile case, BEI has a coefficient 0.0054 (t-stat 2.76) whereas $\mathbb{1}_{\{t \in \mathrm{LSAPs}\}}$ has a coefficient 0.0058 (t-stat 2.11). As such, the evidence in Table 11 suggests that rising inflation expectations and/or inflation risk premia cannot explain the significant rise in bond risk premia coincident with LSAPs.

The evidence appears to show supply/demand effects coincident with LSAPs. One possible explanation for this effect may be found in the recent work by Greenwood et al. (2014). There, the authors illustrate how the US Treasury's implementation of a campaign to lengthen the average maturity of debt over 2008-2014 partially offsetted the Federal Re-

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[13] As with the previous risk premia regressions, we report Newey and West (1987) standard errors using 12 lags.

serve's LSAPs program to reduce the supply of bonds in the private sector. In their analysis, they estimate that the Kim-Wright term premium (KW-TP) for 10-year Treasuries rose by approximately 25bp cumulatively from 2009-2010 in lieu of US Treasury announcements of its intention to extend the average maturity of debt. Further, they estimate that the US Treasury's maturity extension program offset 35% of the "duration supply impact" of LSAPs over 2008-2014. This suggests the potential for a market supply/demand response to the competing objectives of the Federal Reserve and US Treasury during LSAPs. Indeed, market adjustments to the US Treasury's actions may help explain a supply/demand induced rise (as opposed to an LSAPs induced decrease) in the BRP observed in the data.

2 Conclusion

Many papers in the literature attempt to document the effects on yields from the Federal Reserve's LSAPs programs beginning in 2008. These works find evidence for sizable movements in yields, particularly in long maturity bonds. Fewer works attempt to quantify the impact on expected returns for bonds across the term structure. Substantially less work has been done on the indirect effect of LSAPs outside of fixed income. This is surprising given the substantial attention investors pay to the Federal Reserve's actions in the fixed income market when assessing outside investment opportunities. In this work, we address these significant omissions.

For our analysis, we estimate the impact of LSAPs on expected returns in both bond and equity markets. To begin, we note three main channels by which LSAPs may influence expected returns: changing market beliefs, changing market preferences, and changing supply/demand effects. In order to assess the relative impact each channel has upon expected returns, we empirically investigate both equity and bond risk premium coincident with influential LSAPs dates. After estimating these quantities using common methodologies, we document evidence in favor of significant supply/demand effects coincident with LSAPs for both equities and bonds. These effects, however, are different across markets.

For equities, we find evidence for a decrease in risk premium coincident with. In contrast, bonds appear to offer higher risk premia in lieu of LSAPs. Such an effect on bond risk premia may result from a market adjustment of bond supply expectations due to competing objectives undertaken by the Federal Reserve and the US Treasury during LSAPs; a recent study by Greenwood et al. (2014) documents this possibility. In summary, our investigation offers new insights into how equity and bond risk premia adjust as a result of the LSAPs programs recently completed by the Federal Reserve.

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A Appendix

KIM-WRIGHT HOLDING PERIOD TERM PREMIA:

We begin with the definition of the Kim-Wright term premium:

$$\mathrm{TP}_t^{(T)} = y_t^{(T)} - \frac{1}{T}\mathbb{E}_t\left(y_t^{(1)} + y_{t+1}^{(1)} + \ldots + y_{t+T-1}^{(1)}\right),$$

where, again, $(t, t+1)$ here represents a 1-year time interval. Using this representation and letting $p_t^{(T-1)}$ denote log price of a T zero-coupon bond at time t, we have

$$\begin{aligned} -(T-1) \times \mathrm{TP}_{t+1}^{(T)} &= p_{t+1}^{(T-1)} + \mathbb{E}_{t+1}\left(y_{t+1}^{(1)} + \ldots + y_{t+T-1}^{(1)}\right), \\ -T \times \mathrm{TP}_t^{(T)} &= p_t^{(T)} + \mathbb{E}_t\left(y_t^{(1)} + \ldots + y_{t+T-1}^{(1)}\right). \end{aligned}$$

Noting that $\mathbb{E}_t\left(r_t^{(T)}\right) = \mathbb{E}\left(p_{t+1}^{(T-1)} - p_t^{(T)}\right)$, the holding period return (using one-year yield to obtain excess returns) is

$$\mathbb{E}_t\left(rx_t^{(T)}\right) = \mathbb{E}_t\left(r_t^{(T)}\right) - y_t^{(1)} = T \times \mathrm{TP}_t^{(T)} - (T-1) \times \mathbb{E}_t\left(\mathrm{TP}_{t+1}^{(T)}\right).$$

Thus, we define our Kim-Wright holding period return estimate of the bond risk premia (KW-BRP) as

$$\mathrm{BRP}_t^{(T)} = T \times \mathrm{TP}_t^{(T)} - (T-1) \times \mathrm{TP}_{t+1}^{(T)}, \tag{8}$$

where we replace $\mathbb{E}_t\left(\mathrm{TP}_{t+1}^{(T)}\right)$ with the available $\mathrm{TP}_{t+1}^{(T)}$ value.

SERIAL CORRELATION/HETEROSKEDASTICITY IN REGRESSION (2):

We wish to estimate

$$\mathrm{RP}_t = \beta_0 + \beta_1 \mathbb{1}_{\{t \in \mathrm{LSAPs}\}} + \beta_2 X_t + \varepsilon_t, \tag{9}$$

while using estimates for the risk premium $\widehat{\mathrm{RP}}_t$. For instance, we estimate BRP_t via the regression model

$$rx_{t+1} = \alpha_0 + \alpha_1 z_t + \epsilon_t,$$

where z_t is the Cochrane and Piazzesi (2005) factor which also must be estimated ($\hat{z}_t$). Then, we take $\widehat{\mathrm{RP}}_t = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{z}_t$. Afterwards, the regression model (9) becomes

$$\widehat{\mathrm{RP}}_t = [\beta_0 - (\alpha_0 - \hat{\alpha}_0)] + \beta_1 \mathbb{1}_{\{t \in \mathrm{LSAPs}\}} + \beta_2 X_t + [\varepsilon_t - \alpha_1 z_t + \hat{\alpha}_1 \hat{z}_t]. \tag{10}$$

Thus, the empirical regression (10) will need standard error adjustments if $-\alpha_1 z_t + \hat{\alpha}_1 \hat{z}_t$ is serially correlated/heteroskedastic. To account for this possibility when running our empirical regressions, we adjust t-statistics using Newey and West (1987) standard errors with lags.

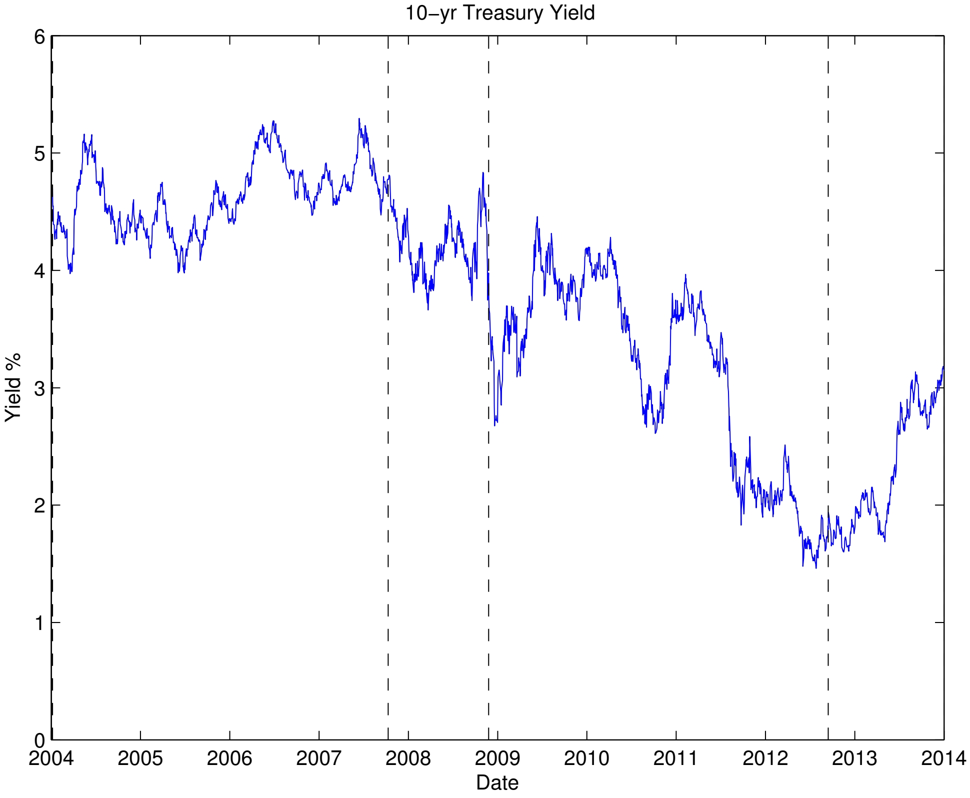

Figure 1. Historical 10-yr US Treasury Yield from Jan 2004-Dec 2013. Yields calculated using Federal Reserve data from Gürkaynak, Sack and Wright (2007). Vertical dashed lines indicate: October 9, 2007 (S&P500 highest close prior to crash), November 24, 2008 (QE1 begins), September 13, 2012 (QE3 begins).

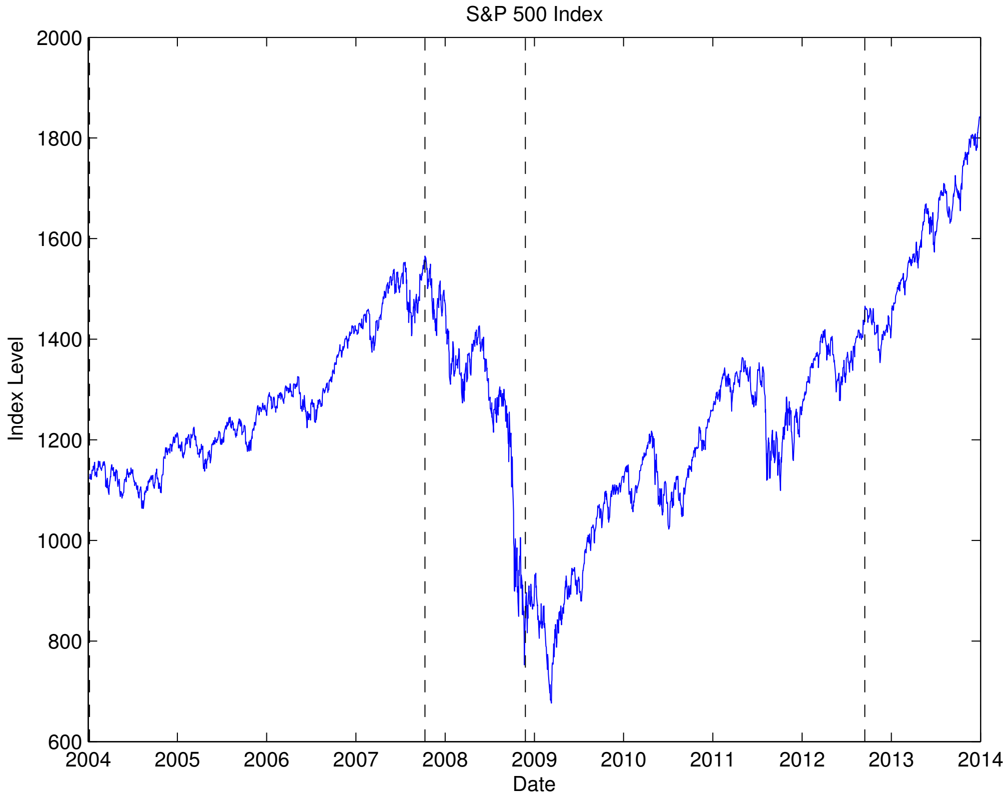

Figure 2. Historical S&P 500 Index from Jan 2004-Dec 2013. Vertical dashed lines indicate: October 9, 2007 (S&P500 highest close prior to crash), November 24, 2008 (QE1 begins), September 13, 2012 (QE3 begins).

Table 1. Net Issuance of fixed-income absorbed by Federal Reserve (in \$ billions)

Sector	2008	2009	2010	2011	2012	2013*
IG corporates	98	83	266	375	516	394
HY corporates	-34	77	103	36	124	150
EM corporates	36	99	157	135	244	233
EM sovereign	2	40	32	35	51	4
Municipals	85	112	111	-28	-11	5
Non-agency MBS	-334	-364	-266	-202	-201	-151
Agency MBS	519	524	-72	20	70	200
CMBS	-40	-46	-58	-55	-44	-10
Consumer ABS	-67	-35	-107	-58	-3	5
CLOs	5	-17	-18	-30	20	12
Agency debt	-39	-19	-119	-164	-188	-150
Treasuries	396	1549	1611	1325	1009	839
Total	627	2003	1640	1389	1587	1520
Fed purchases	0	1349	311	458	47	975
as % of total	0%	67%	19%	33%	3%	64%
as % of MBS/Treas	0%	65%	20%	34%	4%	94%

Notes: * JP Morgan Forecast for full-year 2013 net issuance. Source: JP Morgan US Fixed Income Strategy, New York, August 29, 2013. Additional Sources: FRBNY, Thomson SDC, S&P, Bloomberg, CMA, JP Morgan.

Table 2. Summary Statistics

Data	Period	Type	Compounding	Mean (%)	Std (%)	Min (%)	Max (%)
GSW	1972.1-2013.12	10-yr Yld	Cont. Annlzd	6.92	2.73	1.55	14.89
Breakeven	1999.1-2013.12	10-yr Yld	Cont. Annlzd	2.26	0.37	0.39	2.87
3mo T-Bill	1972.1-2013.12	Ret	Effective Annlzd	5.03	3.42	-1.48	28.79
CRSP-vw monthly	1952.1-2013.12	Ret w Div	Effective Annlzd	11.99	51.79	-95.33	528.82
CRSP-vw monthly	1952.1-2013.12	Ret No Div	Effective Annlzd	8.49	51.69	-95.47	508.89
VIX	1990.1-2013.12	Std Dev	Annual	20.20	7.69	10.42	59.89
VRP	1990.1-2013.12	Variance RP	Annual	17.97	20.07	-180.68	116.52

Notes: US 10 year nominal yields (GSW) and breakeven inflation (Breakeven) from Gürkaynak, Sack and Wright (2007) and Gürkaynak, Sack and Wright (2010). The 3-month maturity US Treasury Bill monthly return is obtained from CRSP. CRSP-vw monthly is the value-weighted monthly return across three indices: AMEX, NASDAQ, NYSE with/out dividends. VIX is the monthly level of the volatility index on S&P 500 call and put options. VRP is the variance risk premium of Carr and Wu (2009) written on the S&P 500. Cont. Annlzd refers to a continuously compounded annual yield. Effective Annlzd is the effective annualized return for the monthly returns.

Table 3. LSAPs Dates

		Percentiles			
50	75	85	90	95	97
Apr-09	Apr-09	Apr-09	Apr-09	Aug-09	Nov-10
May-09	May-09	May-09	May-09	Nov-10	Dec-10
Jun-09	Jun-09	Jun-09	Jun-09	Dec-10	Jan-11
Jul-09	Jul-09	Aug-09	Aug-09	Jan-11	Feb-11
Aug-09	Aug-09	Nov-10	Nov-10	Feb-11	Mar-11
Sep-09	Sep-10	Dec-10	Dec-10	Mar-11	Apr-11
Oct-09	Oct-10	Jan-11	Jan-11	Apr-11	May-11
Aug-10	Nov-10	Feb-11	Feb-11	May-11	-
Sep-10	Dec-10	Mar-11	Mar-11	Jun-11	-
Oct-10	Jan-11	Apr-11	Apr-11	-	-
Nov-10	Feb-11	May-11	May-11	-	-
Dec-10	Mar-11	Jun-11	Jun-11	-	-
Jan-11	Apr-11	Nov-11	Dec-13	-	-
Feb-11	May-11	Jan-13	-	-	-
Mar-11	Jun-11	Feb-13	-	-	-
Apr-11	Nov-11	Mar-13	-	-	-
May-11	Dec-11	May-13	-	-	-
Jun-11	Jan-12	Jun-13	-	-	-
Jul-11	Apr-12	Jul-13	-	-	-
Aug-11	Jan-13	Oct-13	-	-	-
Sep-11	Feb-13	Nov-13	-	-	-
Oct-11	Mar-13	Dec-13	-	-	-
Nov-11	Apr-13	-	-	-	-
Dec-11	May-13	-	-	-	-
Jan-12	Jun-13	-	-	-	-
Feb-12	Jul-13	-	-	-	-
Mar-12	Aug-13	-	-	-	-
Apr-12	Sep-13	-	-	-	-
Jun-12	Oct-13	-	-	-	-
Sep-12	Nov-13	-	-	-	-
Oct-12	Dec-13	-	-	-	-
Nov-12	-	-	-	-	-
Dec-12	-	-	-	-	-
Jan-13	-	-	-	-	-
Feb-13	-	-	-	-	-
Mar-13	-	-	-	-	-
Apr-13	-	-	-	-	-
May-13	-	-	-	-	-
Jun-13	-	-	-	-	-
Jul-13	-	-	-	-	-
Aug-13	-	-	-	-	-
Sep-13	-	-	-	-	-
Oct-13	-	-	-	-	-
Nov-13	-	-	-	-	-
Dec-13	-	-	-	-	-

Notes: LSAPs dates between Jan 2008-Dec 2013 corresponding to x-percentile. Weekly changes in the Federal Reserve holdings of US Treasuries between Jan 2008-Dec2013 are computed. After collecting all of the weekly changes, we then group months together into an x-percentile group (column) for which the weekly change in the Federal Reserve's holdings of US Treasuries represented at or above the x-percentile of all changes during Jan 2008-Dec 2013.

Table 4. Correlations of Market Proxies

(a) 1990.1-2013.12

1990.1-2013.12	VIX	VRP	RelWlth
VIX	1	0.326	0.590
VRP	0.326	1	0.151
RelWlth	0.590	0.151	1

(b) 2008.1-2013.12

2008.1-2013.12	VIX	VRP	RelWlth
VIX	1	-0.031	0.762
VRP	-0.031	1	0.185
RelWlth	0.762	0.185	1

Notes: Sample correlations for market proxies VIX, VRP, and RelWlth. Sample periods for estimation are Jan 1990-Dec 2013 and Jan 2008-Dec 2013. See Section **??** for descriptions of VIX, VRP and RelWlth.

Table 5. Equity Forecasting Regression.

Panel A: 1yr	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$
coeff	0.374	0.092	0.030
t-stat	1.87	1.57	1.38
R^2	0.083		

Notes: Forecasting regression over Jan 1952-Dec 2013 using monthly CRSP value-weighted returns (AMEX, NASDAQ, NYSE) and quarterly available consumption-to-wealth ratio (cay) data of Lettau and Ludvigson (2001). We assume cay is fixed over a given month during each quarter. Dividend price ratio (dp) is calculated using CRSP value-weighted returns with/out dividends.

$$rx_{t+1} = \beta_0 + \beta_1 \mathrm{dp}_t + \beta_2 \mathrm{cay}_t + \varepsilon_{t+1}.$$

Due to the overlapping one-year returns, we adjust the standard errors using the Hansen and Hodrick (1980) correction with 12 lags.

Table 6. ERP (1-yr) and LSAPs (2008.1-2013.12)

(a) 50th percentile

ERP	(1)	(2)	(3)	(4)	(5)
VIX	0.0007**			0.0007**	
	(2.94)			(3.07)	
VRP		-0.0001		-0.0001	-0.0001**
		(-1.06)		(-0.96)	(-3.18)
RelWlth			0.0589**		0.0651**
			(4.71)		(5.46)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	-0.0039	-0.0101	-0.0010	-0.0039	0.0002
	(-0.72)	(-1.28)	(-0.18)	(-0.72)	(0.04)
R^2	0.228	0.105	0.356	0.242	0.419

(b) 75th percentile

ERP	(1)	(2)	(3)	(4)	(5)
VIX	0.0008**			0.0008**	
	(3.58)			(3.74)	
VRP		-0.0001		-0.0001	-0.0001**
		(-1.09)		(-0.97)	(-3.41)
RelWlth			0.0614**		0.0668**
			(6.34)		(7.05)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	0.0002	-0.0065	0.0011	0.0001	0.0017
	(0.03)	(-0.82)	(0.17)	(0.01)	(0.28)
R^2	0.218	0.055	0.356	0.232	0.419

(c) 90th percentile

ERP	(1)	(2)	(3)	(4)	(5)
VIX	0.0007*			0.0007*	
	(2.46)			(2.57)	
VRP		-0.0001		-0.0001	-0.0001**
		(-0.93)		(-0.89)	(-3.19)
RelWlth			0.0558**		0.0604**
			(5.95)		(6.86)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	-0.0133**	-0.0161**	-0.0128**	-0.0131**	-0.0121**
	(-2.84)	(-2.84)	(-3.75)	(-2.81)	(-3.80)
R^2	0.310	0.156	0.441	0.322	0.493

(d) 97th percentile

ERP	(1)	(2)	(3)	(4)	(5)
VIX	0.0007*			0.0006*	
	(2.16)			(2.29)	
VRP		-0.0001		-0.0001	-0.0001**
		(-1.32)		(-1.11)	(-3.57)
RelWlth			0.0519**		0.0566**
			(5.14)		(6.32)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	-0.0200**	-0.0253**	-0.0170**	-0.0204**	-0.0170**
	(-5.41)	(-6.11)	(-4.26)	(-5.91)	(-4.67)
R^2	0.338	0.220	0.441	0.357	0.501

Notes: ERP LSAPs impact regression over Jan 2008- Dec 2013. Using monthly data, we regress the estimated ERP (1-yr) onto market beliefs and preferences proxies (see Section **??** for definitions of proxies) and the LSAPs indicator variable under different percentile choices which define the purchases dates. Newey and West (1987) t-statistics with 12 lags in parentheses. * and ** denote significance at the 5% and 1% level, respectively.

Table 7. CP-BRP Factor Regression.

Param	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5
Coeffs	-3.06	-3.43	-1.14	3.60	3.39	-2.14
t-stat	-0.87	-2.98	-0.76	1.81	2.57	-1.83
R^2	0.243					

Notes: Cochrane and Piazzesi (2005) factor estimation over Jan 1972-Dec 2013. Here, we run

$$\frac{1}{14}\sum_{T=2}^{15} rx_{t+1}^{(T)} = \gamma_0 + \gamma_1 y_t^{(1)} + \ldots + \gamma_5 f_t^{(5)} + \bar{\varepsilon}_{t+1},$$

using monthly returns, yields and forward rates. The right-hand side variables are calculated using Fama and Bliss (1987) data on $1-5$ year zero coupon bonds. Excess returns (1-yr) on the left-hand side are calculated using Gürkaynak, Sack and Wright (2007) yields and CRSP 90-day T-Bill returns. Due to the overlapping one-year returns, we adjust the standard errors using the Hansen and Hodrick (1980) correction with 12 lags. Coefficient values reflect returns taken in % for the regression.

Table 8. CP-BRP Restricted Bond Regression.

T(yrs)	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Coeffs	0.17	0.33	0.48	0.62	0.75	0.87	0.99	1.10	1.20	1.30	1.40	1.50	1.60	1.69
t-stat	4.46	4.51	4.64	4.76	4.85	4.91	4.93	4.92	4.88	4.83	4.76	4.66	4.59	4.50
R^2	0.131	0.159	0.182	0.200	0.214	0.225	0.232	0.238	0.242	0.245	0.247	0.244	0.251	0.253

Notes: Cochrane and Piazzesi (2005) restricted bond forecasting regressions using monthly returns over Jan 1972-Dec 2013. Here, we run

$$rx_{t+1}^{(T)} = \beta^{(T)} x_t + \varepsilon_{t+1}^{(T)},\ T = 2, \ldots, 15.$$

The right-hand side variable (x_t) is the estimated Cochrane and Piazzesi (2005) factor. Excess returns (1-yr) on the left-hand side are calculated using Gürkaynak, Sack and Wright (2007) yields and CRSP 90-day T-Bill returns. Due to the overlapping one-year returns, we adjust the standard errors using the Hansen and Hodrick (1980) correction with 12 lags. Coefficient values reflect returns taken in % for the regression.

Table 9. CP-BRP and LSAPs (2008.1-2013.12): 10-yr Maturity

(a) 50th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	-0.0004			-0.0004	
	(-0.63)			(-0.63)	
VRP		0.0001		0.0001	0.0001
		(0.52)		(0.44)	(0.97)
RelWlth			-0.0599		-0.0662
			(-1.54)		(-1.81)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	-0.0140	-0.0106	-0.0199	-0.0140	-0.0210
	(-1.08)	(-0.78)	(-1.42)	(-1.08)	(-1.55)
R^2	0.032	0.026	0.087	0.036	0.101

(b) 75th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0001			0.0001	
	(0.08)			(0.10)	
VRP		0.0001		0.0001	0.0001
		(0.47)		(0.47)	(0.64)
RelWlth			-0.0299		-0.0338
			(-0.80)		(-0.92)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	0.0066	0.01	0.0025	0.0068	0.0021
	(0.51)	(0.55)	(0.18)	(0.53)	(0.15)
R^2	0.034	0.012	0.025	0.012	0.033

(c) 90th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0001			0.0001	
	(0.21)			(0.23)	
VRP		0.0001		0.0001	0.0001
		(0.36)		(0.38)	(0.50)
RelWlth			-0.0229		-0.0257
			(-0.84)		(-0.94)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	0.0306**	0.0300**	0.0287*	0.0305*	0.0283*
	(2.65)	(2.71)	(2.31)	(2.64)	(2.25)
R^2	0.114	0.115	0.125	0.116	0.129

(d) 97th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0001			0.0001	
	(0.10)			(0.12)	
VRP		0.0001		0.0001	0.0001
		(0.52)		(0.53)	(0.66)
RelWlth			-0.0239		-0.0275
			(-0.74)		(-0.88)
$\mathbb{1}_{\{t\in \text{LSAPs}\}}$	0.0220	0.0218	0.0179	0.0224	0.0178
	(1.57)	(1.88)	(1.13)	(1.63)	(1.13)
R^2	0.034	0.039	0.046	0.039	0.054

Notes: Cochrane-Piazzesi BRP LSAPs impact regression over Jan 2008- Dec 2013. Using monthly data, we regress the estimated CP-BRP (1-yr) for 10-yr maturity onto market beliefs and preferences proxies (see Section **??** for definitions of proxies) and the LSAPs indicator variable under different percentile choices which define the purchases dates. Newey and West (1987) t-statistics with 12 lags in parentheses. * and ** denote significance at the 5% and 1% level, respectively.

Table 10. KW-BRP and LSAPs (2008.1-2013.12): 10-yr Maturity

(a) 50th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0009			0.0009	
	(0.83)			(0.83)	
VRP		0.0000		0.0000	0.0001
		(0.09)		(0.14)	(0.33)
RelWlth			-0.0578		-0.0617
			-1.16		-1.26
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0347	0.0263	0.0173	0.0346	0.0166
	(1.95)	(1.16)	(0.98)	(1.95)	(0.92)
R^2	0.070	0.050	0.071	0.070	0.073

(b) 75th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0012			0.0012	
	(0.92)			(0.92)	
VRP		0.0000		0.0000	0.0001
		(0.14)		(0.23)	(0.32)
RelWlth			-0.0472		-0.0504
			(-0.85)		(-0.92)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0468^{*}	0.0370	0.0312	0.0469^{*}	0.0309
	(2.38)	(1.77)	(1.62)	(2.41)	(1.60)
R^2	0.133	0.100	0.116	0.133	0.118

(c) 90th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0008			0.0008	
	(0.78)			(0.77)	
VRP		0.0000		0.0000	0.0000
		(-0.09)		(-0.08)	(0.14)
RelWlth			-0.0505		-0.0517
			(-1.11)		(-1.12)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0976^{**}	0.0942^{**}	0.0910^{**}	0.0976^{**}	0.0908^{**}
	(4.46)	(4.98)	(4.48)	(4.46)	(4.44)
R^2	0.412	0.394	0.414	0.412	0.414

(d) 97th percentile

BRP	(1)	(2)	(3)	(4)	(5)
VIX	0.0010			0.0010	
	(0.83)			(0.85)	
VRP		0.0001		0.0001	0.0001
		(0.30)		(0.44)	(0.42)
RelWlth			-0.0302		-0.0340
			(-0.59)		(-0.69)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.1167^{**}	0.1097^{**}	0.1048^{**}	0.1172^{**}	0.1047^{**}
	(5.81)	(7.09)	(4.55)	(5.85)	(4.60)
R^2	0.341	0.317	0.322	0.344	0.325

Notes: Kim-Wright BRP LSAPs impact regression over Jan 2008- Dec 2013. Using monthly data, we regress the estimated KW-BRP (1-yr) for 10-yr maturity onto market beliefs and preferences proxies (see Section **??** for definitions of proxies) and the LSAPs indicator variable under different percentile choices which define the purchases dates. Newey and West (1987) t-statistics with 12 lags in parentheses. * and ** denote significance at the 5% and 1% level, respectively.

Table 11. KW-TP, BEI, and LSAPs (2008.1-2013.12): 10-yr Maturity

(a) 50th percentile

KW-TP	(1)	(2)	(3)	(4)	(5)
VIX	0.0003*			0.0003*	
	(2.03)			(2.07)	
VRP		0.0000		0.00	0.0000
		(0.56)		(1.37)	(0.41)
RelWlth			0.01294		0.0127
			(1.67)		(1.63)
BEI	0.0034*	0.0004	0.0037	0.0040**	0.0038
	(2.60)	(0.23)	(1.77)	(2.79)	(1.82)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	-0.0029	-0.0047**	-0.0033	-0.0029	-0.0033
	(-1.75)	(-3.42)	(-1.71)	(-1.72)	(-1.75)
R^2	0.246	0.151	0.183	0.263	0.186

(b) 75th percentile

KW-TP	(1)	(2)	(3)	(4)	(5)
VIX	0.0004**			0.0004**	
	(2.93)			(3.07)	
VRP		0.0000		0.0000	0.0000
		(0.33)		(1.40)	(0.18)
RelWlth			0.0228*		0.0227*
			(2.63)		(2.57)
BEI	0.0040**	-0.0006	0.0057*	0.0047**	0.0058**
	(2.76)	(-0.28)	(2.59)	(2.87)	(2.65)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0017	-0.0007	0.0011	0.0018	0.0011
	(0.85)	(-0.35)	(0.48)	(0.98)	(0.47)
R^2	0.216	0.010	0.137	0.237	0.138

(c) 90th percentile

KW-TP	(1)	(2)	(3)	(4)	(5)
VIX	0.0004**			0.0004**	
	(3.75)			(3.62)	
VRP		0.0000		0.0000	0.0000
		(0.15)		(1.17)	(0.03)
RelWlth			0.0225**		0.0225**
			(3.43)		(3.34)
BEI	0.0035*	-0.0013	0.0052**	0.0041*	0.0053**
	(2.17)	(-0.66)	(2.69)	(2.03)	(2.71)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0060**	0.0050*	0.0056*	0.0059**	0.0056*
	(3.15)	(2.15)	(2.48)	(3.17)	(2.43)
R^2	0.348	0.115	0.262	0.362	0.262

(d) 97th percentile

KW-TP	(1)	(2)	(3)	(4)	(5)
VIX	0.0004**			0.0004**	
	(3.48)			(3.53)	
VRP		0.0000		0.0000	0.0000
		(0.30)		(1.48)	(0.20)
RelWlth			0.0236**		0.0236**
			(3.50)		(3.42)
BEI	0.0032*	-0.0014	0.0053**	0.0039*	0.0054**
	(2.16)	(-0.66)	(2.74)	(2.17)	(2.76)
$\mathbb{1}_{\{t\in\text{LSAPs}\}}$	0.0056*	0.0044	0.0058*	0.0056*	0.0058*
	(2.31)	(1.57)	(2.10)	(2.46)	(2.11)
R^2	0.273	0.053	0.210	0.294	0.211

Notes: Kim-Wright Term Premia (KW-TP) LSAPs impact regression over Jan 2008- Dec 2013. Using monthly data, we regress the estimated KW-TP (1-yr) for 10-yr maturity ($\text{TP}_t^{(10)}$ from equation (4)), for a 10-yr maturity onto break-even inflation (BEI), the market beliefs and preferences proxies (see Section **??** for definitions of proxies), and the LSAPs indicator variable under different percentile choices which define the purchases dates. Newey and West (1987) t-statistics with 12 lags in parentheses. * and ** denote significance at the 5% and 1% level, respectively.