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Abstract

We undertake a variance decomposition of index-linked bond returns for the US, UK and Iceland. In all cases, news about future excess returns is the key driver though only for Icelandic bonds are returns independent of inflation.

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Keywords: Index-Linked Bonds; Variance Decomposition; Real interest rate

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1 Introduction.

The *ex ante* real rate of interest is central to both micro and macroeconomic analysis. In principle, inflation indexed bonds are likely to be among the most reliable source of such rates since their prices depend most directly on them, thereby minimizing the need to lean heavily on potentially inaccurate pricing models. However, even the yields on these bonds are some way from a pure measure of real interest rates, their prices are contaminated by both technical flaws in their design that means that indexation is imperfect and, more fundamentally, by risk premia relating to the underlying behavior of real interest rates. Although the riskless asset for any investor is an indexed bond that matches her consumption plan, if future real interest rates are uncertain, bonds that do not match the timing and length of that plan precisely will be viewed as risky, as will bonds that have other undesirable characteristics such as low liquidity or perceived credit risk. In this paper we assess the contributions of innovations to three determinants (real rates, imperfect indexation and future excess returns) to the variance of returns of inflation-indexed bonds issued by the governments of Iceland, the United States and the United Kingdom through a variance decomposition over the period from 1996 to 2004 (subsequent to 2004 the Icelandic government's move to nominal issuance and changes in the indexation procedure in the UK make it difficult to undertake our analysis).

1.1 Inflation indexation in Iceland, the US, and UK

Bonds indexed to a measure of consumer prices are issued by many governments, but the efficiency of their indexation, and their consequent exposure to inflation risk, varies across countries. More specifically, inflation risk arises because these bonds are indexed to consumer prices measured some time prior to the indexation date. Here we give a brief description of the indexation lag in place for the three markets we analyze. Full details of the indexation process on which our estimates below are based is described in Deacon, Derry and Mirfendereski (2004).

Iceland's zero-coupon inflation-indexed bonds are arguably the most efficiently indexed. Over the period of this study, the Icelandic Consumer Price Index, as measured on the first day of the month and published on the 12th, is used in the indexation process for the following month. This leaves a maximum indexation lag of about two months. By contrast, UK indexed bonds have the longest lag (over the period of this study). Due to tax regulations - no longer in force - it was necessary for the next coupon payment to be known with certainty. Since coupons are paid every six months this requirement, added to the publication lag of the Retail Price Index, meant that UK indexed bonds were indexed to prices measured up to eight month previously (though since 2005 the UK has been issuing bonds with a three month lag). Finally indexed bonds issued by the US government are an intermediate case with a lag of up to 3 months between measurement and indexation.

2 What moves the price of Inflation Indexed bonds?

We follow Barr and Pesaran (1997) who adapted the methodology of Campbell and Ammer (1993) in using the the present-discounted-value model to account for all changes in the prices of indexed bonds (and to allow for coupon-bearing bonds such as those of the UK

and US). The model is transformed to provide for an equation relating unexpected excess returns to revisions to expected future cash-flows and discount rates.

In order to simplify the empirical analysis the model is based on a log-linear approximation to the true present-discounted-value in which the discount rate is expressed as the sum of the real rate, the rate of inflation, and a risk premium, or excess return. We measure the latter as the asset's one-month return relative to the one-month interbank rate. Inflation has a role to play in the equation due to the lag in the indexation of the bonds described above.

For an m -period bond the unexpected excess return has the form

$$x_{m,t+1} = -(E_{t+1} - E_t) \sum_{i=1}^{m-1} \rho^i r_{t+1+i} - (E_{t+1} - E_t) \sum_{i=1}^{m-1} \rho^i \pi_{t+1+i} - \sum_{i=j}^{m-1} \rho^i \pi_{t+1+i+j} - (E_{t+1} - E_t) \sum_{i=1}^{m-1} \rho^i x_{m-i,t+1+i} \quad (1)$$

where ρ is the linearization coefficient and j is the indexation lag. We decompose its variance as

$$var(x) = var(r) + var(\pi) + var(x) + 2cov(r, \pi) + 2cov(r, x) + 2cov(\pi, x) \quad (2)$$

where r, π, x are the unexpected components of the real interest rate, inflation and the excess return respectively.

2.1 Empirical Method

We assume that agents' expectations can be proxied by forecasts based on a monthly VAR that incorporates three key financial variables - short term real interest rates, inflation and indexed bond yields. The VAR should not be interpreted simply as the model with which agents make forecasts. Its variables are assumed to be determined simultaneously with these forecasts, where the latter may be based on a range of additional variables. The credibility of our results rests on the extent to which the variables in our VAR are themselves determined by agents' expectations of the future.

Unexpected excess returns and revisions to expectations are obtained from projections of the error vector as

$$(E_{t+1} - E_t)w_{t+1+i} = A_j \epsilon_{t+1} \quad (3)$$

The VAR is estimated using GMM to produce a heteroskedasticity-consistent covariance matrix V for the VAR parameters and the decomposition. Standard errors for the latter are calculated as $\sqrt{f'_\gamma V f_\gamma}$ where γ is the full set of estimated parameters, from which we calculate the variance decompositions as non-linear functions $f(\gamma)$.

The VAR provides direct proxies for revisions to expectations of future real rates and inflation, and for unexpected contemporaneous excess returns. Revisions to expectations of future excess returns are found as residuals after substitution of the VAR-generated series.

2.2 Variance Decomposition Results.

Table 1: Variance Decomposition of Indexed Bond Returns
(shares of total variance)

		π	r	x	$2\text{cov}(r,x)$	$2\text{cov}(r,\pi)$	$2\text{cov}(x,\pi)$
Iceland	5-year	0.01 (0.01)	0.04 (0.03)	0.67 (0.12)	0.26 (0.10)	0.01 (0.04)	0.02 (0.12)
	10-year	0.00 (0.00)	0.04 (0.03)	0.54 (0.19)	0.41 (0.22)	0.00 (0.03)	0.00 (0.19)
UK	5-year	0.12 (0.03)	0.16 (0.03)	0.39 (0.11)	0.03 (0.14)	0.07 (0.04)	0.24 (0.11)
	10-year	0.05 (0.03)	0.14 (0.05)	0.70 (0.19)	0.01 (0.24)	0.00 (0.05)	0.10 (0.19)
US	5-year	0.05 (0.02)	0.37 (0.07)	0.27 (0.19)	0.07 (0.25)	0.13 (0.06)	0.11 (0.20)
	10-year	0.02 (0.02)	0.02 (0.02)	0.64 (0.19)	0.28 (0.22)	0.01 (0.03)	0.04 (0.20)

π is news about inflation, r is news about real interest rates, and x is news about excess returns, standard errors in brackets. Sample: 1996-2004. Data: 10 and 5 year Index bond yields/prices interpolated from the conditional yields of the two nearest bonds either side of that date; Price indices are CPI for Iceland, RPI for the UK, and NSA CPI-U for the US. 1 month inter-bank interest rates are used to calculate excess returns and combined with CPI data to create the ex-post real short rate. The decomposition results are based on a monthly VAR using 1 lag of returns, the ex-post real short rate, and inflation.

The impact of inflation news on bond returns is greatest for the UK, and smallest for Iceland, and is directly proportional to their indexation lags. For both the UK and US the contribution of inflation to 5-year bond returns is statistically significant. In general, shocks to bond returns are generated by news about excess returns though for 5 and 10 year bonds in the UK case and 5 year bonds in the US case real interest news makes a significant contribution. In the case of Icelandic bonds, the role of real rates is insignificant though the Icelandic results are complicated by the large and significant impact of the covariance between news about real rates and excess returns. It appears that when real rates are revised upward, so too are excess returns. The UK and US markets do not present statistically significant covariance components.

3 Conclusion.

Overall, our results are disappointing for those who would like to use indexed bonds to measure movements in real interest rates. Not only do we find that most of these bonds are contaminated by inflation risk due to their imperfect indexation, but that in any case the key driver of unexpected returns is in fact changes in future excess returns - which can be thought of as changes in risk premia. This latter result is consistent with other studies such as Pflueger and Viceira (2011).

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