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Richhild Moessner \*

\* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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De Nederlandsche Bank NV  
P.O. Box 98  
1000 AB AMSTERDAM  
The Netherlands

# Effect of the zero lower bound on bond yield sensitivity to news in Canada in comparison with the UK and US\*

Richhild Moessner<sup>a,b</sup>

<sup>a</sup>De Nederlandsche Bank

<sup>b</sup>Cass Business School

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## Abstract

The interest rate channel of monetary policy works both through short- and long-term interest rates. At the zero lower bound of the policy rate, monetary policy can still be effective through unconventional monetary policy measures. We study whether the sensitivity of Canadian government bond yields to domestic and US macroeconomic data surprises changed at the zero lower bound, and compare the results with those for the United Kingdom and the United States. We find that the sensitivity of government bond yields to domestic economic news was reduced only at shorter maturities in Canada than in the United Kingdom and the United States. Moreover, we find that it was reduced less strongly in Canada than in the United Kingdom. This suggests that in Canada monetary policy lost less of its effectiveness than in the United Kingdom, and only up to shorter horizons than in the United Kingdom and the United States.

JEL classification: E52, E58.

Key words: Monetary policy, zero lower bound, economic news, government bond yields.

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# 1 Introduction

The interest rate channel of monetary policy works both through short-term and long-term interest rates (Rajan (2013)). At the effective zero lower bound of the policy rate, monetary policy can still be effective through unconventional monetary policy measures, such as exceptional liquidity provision, large-scale asset purchases and forward policy rate guidance, which can affect market interest rates of different maturities, including medium- and longer-term maturities, and which major central banks have employed at the zero lower bound of the policy rate. In this paper we study whether the sensitivity of Canadian government bond yields to domestic and US macroeconomic data surprises was changed while the effective zero lower bound on the policy rate was reached in Canada, and compare the results for Canada with those for the United Kingdom and the United States. We interpret the sensitivity of longer-term yields to economic news as a measure of the effectiveness of monetary policy at the zero lower bound, as done in Swanson and Williams (2012, 2013) for the United States, the United Kingdom and Germany.

The Bank of Canada, as well as the Bank of England and the Federal Reserve, applied unconventional monetary policy measures which could affect market interest rates while the policy rate was at the zero lower bound. The Bank of Canada introduced explicit policy rate guidance as an unconventional monetary policy tool when the zero lower bound of the policy rate was reached in Canada, on 21 April 2009, committing to holding the policy rate at that level through the second quarter of 2010, conditional on the outlook for inflation (Carney (2012)). Moreover, it extended its exceptional liquidity programs already in place for the duration of the conditional commitment (Carney (2012)). The Bank of England already engaged in large-scale asset purchases when the effective zero lower bound was reached in March 2009, but only introduced explicit policy rate guidance several years later, in August 2013. The Federal Reserve had announced large-scale asset purchases (Hofmann and Zhu (2013)) and introduced explicit policy rate guidance when the zero lower bound was reached in December 2008 (Yellen (2012)).

Woodford (2012) gives an overview of unconventional monetary policy employed by central banks at the zero lower bound of the policy rate. An overview of studies of the effects of large-scale asset purchases is provided in Rosa (2012). Bank of England (2013) provides an overview of forward policy rate guidance internationally. Rudebusch and Williams (2008) and Jones and Kulish (2013) present models for the effect of policy rate guidance. Curdia and Ferrero (2013)'s model analysis suggests that forward policy rate guidance is essential for quantitative easing to be effective. Del Negro et al. (2012) find that policy rate guidance has implausibly large effects

on the economy in standard medium-scale DSGE models. The impact of explicit policy rate guidance in Canada is analysed in Chang and Feunou (2013), Chehal and Trehan (2009) and He (2010). Wright (2012) studies the effects of monetary policy shocks at the zero lower bound in the United States. Krishnamurthy and Vissing-Jorgensen (2011) consider different channels for the effects of quantitative easing on interest rates, Bauer and Rudebusch (2012) focus on the signalling channel of asset purchases, and Krishnamurthy and Vissing-Jorgensen (2013) focus on the portfolio balance channel. Neely (2010) studies the international effects of quantitative easing in the United States. Joyce et al. (2011) study the effect of quantitative easing in the United Kingdom.

Swanson and Williams (2012) analysed changes in the sensitivity of US government bond yields to domestic macroeconomic data surprises at the zero lower bound of the policy rate, focussing on rolling regressions. They found that yields on US Treasury securities with maturities greater or equal to one year remained responsive to news from 2008 to 2010, suggesting that monetary policy maintained its usual effectiveness during this period, but that the sensitivity of US Treasury yields to news fell closer to zero from late 2011. They conclude that the Federal Reserve's unconventional policy actions seem to have helped to offset the effects of the zero lower bound of the policy rate on medium- and longer-term interest rates. Swanson and Williams (2013) apply this analysis also to the United Kingdom and Germany. They conclude that yields on German government bonds were essentially unconstrained by the zero lower bound until late 2012, and yields on UK government bonds were substantially constrained by the zero lower bound in 2009 and 2012, but were surprisingly responsive to news in 2010 to 2011. Raskin (2013) also studied changes in the sensitivity of short-term US interest rate expectations to economic news, but using probability distributions of interest rate expectations derived from interest rate options, and finds that the introduction of the FOMC's date-based policy rate guidance in August 2011 led to a significant reduction in the sensitivity of the risk-neutral percentiles to economic surprises.

We compare the results for the sensitivity of government bond yields to economic news in Canada with those for the United Kingdom and the United States. In addition to domestic economic news, we consider the impact of US macroeconomic news on Canadian and UK government bond yields, since they have been shown to have a significant influence in the past; indeed, over an earlier period, before the Bank of Canada announced the dates of its policy meetings in advance, US macroeconomic news tended to move Canadian bond yields more than domestic

macroeconomic news (Gravelle and Moessner (2002)). We adopt the approach of Moessner and Nelson (2008) to study changes in the sensitivity of market interest rates to economic news, by introducing a dummy variable in a regression of changes in bond yields on economic data surprises, which takes on the value of 1 during the period of the zero lower bound, and zero otherwise. Moessner and Nelson (2008) used this approach to study changes in the sensitivity of market interest rates during a period of explicit policy rate guidance by the Federal Reserve prior to the global financial crisis. Swanson and Williams (2012) use a similar approach, introducing dummy variables for each year in a regression of changes in bond yields on economic data surprises.

The outline of the paper is as follows. Section 2 presents the data, section 3 presents the method and results, and section 4 concludes.

## 2 Data

For Canada and the United Kingdom, we use daily data for benchmark government bond yields from Bloomberg. For the United States, we use constant-maturity US Treasury yields from the Federal Reserve’s website (Figures 1, 2 and 3). The sample period is from 1 June 1998 to 15 February 2013.

[Figures 1 to 3 around here]

The surprises of the real-time macroeconomic data releases are calculated relative to Bloomberg median survey expectations and are normalized by their standard deviation. We choose the following macroeconomic indicators for Canada, CPI inflation, PPI inflation, the unemployment rate, net changes in labour force employment, retail sales, GDP, raw materials prices, the current account, the merchandise trade balance, a survey of manufacturing sales, mortgage and housing starts, and the Ivey Purchasing Managers’ index. For the United Kingdom we use macroeconomic indicators based on those used in Gravelle et al. (2005). They are RPIX inflation, average earnings, monthly changes in unemployment, retail sales, PPI inflation, GDP, industrial production, the current account balance, the trade balance in goods, and the public sector net cash requirement. For the United States we use the same macroeconomic indicators that were considered in Moessner and Nelson (2008), namely CPI inflation, GDP (advance), hourly earnings, housing starts, industrial production, the ISM manufacturing index, changes in nonfarm payrolls, PPI inflation, retail sales, the trade balance, and the unemployment rate.

The effective zero lower bound of the policy rate was reached from 21 April 2009 until 31 May 2010 in Canada, from 5 March 2009 in the United Kingdom, and from 16 December 2008 in the United States, in the latter two countries until the end of our sample period of 15 February 2013.

### 3 Method and results

We adopt the approach of Moessner and Nelson (2008) to study changes in the sensitivity of market interest rates to economic news, by introducing a dummy variable in a regression of changes in bond yields on economic data surprises, which takes on the value of 1 during the period of the zero lower bound, and zero otherwise. We denote government bond yields in country  $i = CA, UK$  or  $US$  for Canada, the United Kingdom and the United States of maturity  $m$  by  $y_i^m(t)$ . We regress daily changes in government bond yields in percentage points,  $y_i^m(t) - y_i^m(t-1)$ , in country  $i$  at maturities of  $m = 1, 2, 5$  or  $10$  years, on the surprise components of US and domestic economic data releases,  $surprise_j^i(t)$ , where for each indicator  $j$  in country  $i$  the variable  $surprise_j^i(t)$  takes on the value of the normalised surprises on the dates of the release of the macroeconomic indicator, and zero on other days. The regression equation takes the form

$$y_i^m(t) - y_i^m(t-1) = c + c_{ZLB,i} * dum_{ZLB,i}(t) + \sum_{j=1}^{n^{US}} (a_j * surprise_j^{US}(t)) * (1 + f_{ZLB,i} * dum_{ZLB,i}(t)) + \sum_{j=1}^{n^i} (b_j * surprise_j^i(t)) * (1 + g_{ZLB,i} * dum_{ZLB,i}(t)) + \varepsilon_t \quad (1)$$

where  $i = CA, UK$  refers to the country and domestic (ie Canadian or UK) data, where  $n^i$  is the number of domestic macroeconomic indicators, and where  $n^{US}$  is the number of US macroeconomic indicators included in the regression. The dummy variable  $dum_{ZLB,i}(t)$  takes the value of one while the country was at the effective zero lower bound of interest rates, and zero otherwise. The equation is estimated via nonlinear least squares, using Newey-West adjusted standard errors. For the United States, only US economic news is included, and the regression takes the form

$$y_{US}^m(t) - y_{US}^m(t-1) = c + c_{ZLB,US} * dum_{ZLB,US}(t) + \sum_{j=1}^{n^{US}} (a_j * surprise_j^{US}(t)) * (1 + f_{ZLB,US} * dum_{ZLB,US}(t)) + \varepsilon_t \quad (2)$$

Results for Canada are presented in Table 1. We can see that international economic news is relevant for Canadian government bond yields. The surprises of 6 to 7 US macroeconomic indicators are significant at the 10% level for Canadian government bond yields at each of the maturities of 1, 2, 5 and 10 years. Moreover, all of the coefficients of the US macroeconomic data surprises, as well as of the Canadian macroeconomic data surprises, have the expected sign if they are significant at the 10% level. We can also see from Table 1 that the sensitivity of Canadian government bond yields to domestic macroeconomic news was reduced by 77% at the 1% significance level during the period of the zero lower bound of the policy rate in Canada for the 1-year maturity, but was not reduced significantly for the longer maturities of 2, 5 and 10 years. The sensitivity of Canadian government bond yields to US macroeconomic news was also significantly lower during the period of the zero lower bound of the policy rate in Canada, by 47% for the 1-year maturity at the 5% significance level, and by 38% for the 10-year maturity at the 10% level, but not for the maturities of 2 and 5 years. Interpreting the sensitivity to domestic economic news as a measure of monetary policy effectiveness as discussed above, these results suggest that monetary policy in Canada remained effective at the zero lower bound for maturities of 2 years and above, with somewhat less of a focus on international (US) macroeconomic news at the longer maturity of 10 years.

[Table 1 about here]

Results for the United Kingdom are presented in Table 2. We can see that international economic news is also relevant for UK government bond yields. The surprises of 5 to 7 US macroeconomic indicators are significant at the 10% level for UK government bond yields at each of the maturities of 1, 2, 5 and 10 years. Moreover, all of the coefficients of the US macroeconomic data surprises, as well as of the UK macroeconomic data surprises, have the expected sign if they are significant at the 10% level. We can also see from Table 1 that the sensitivity of UK government bond yields to domestic macroeconomic news was significantly reduced at the 1% level during the period of the zero lower bound of the policy rate in the United Kingdom, by 98% for the 1-year maturity, by 97% for 2-year maturity, and by 72% for the 5-year maturity, but not for the longest maturity 10 years. The sensitivity of UK government bond yields to US macroeconomic news was also significantly reduced during the period of the zero lower bound of the policy rate in the United Kingdom, by 50% for the 1-year maturity at the 10% significance level, and by 46% for the 2-year maturity at the 5% level, but not for the

maturities of 5 and 10 years. These results suggest that monetary policy in the United Kingdom was less effective at the zero lower bound for maturities up to 5 years, but remained effective at the longer maturity of 10 years.

[Table 2 about here]

Results for the United States are presented in Table 3. The sensitivity of US government bond yields to domestic macroeconomic news was also significantly reduced during the period of the zero lower bound of the policy rate in the United States, by 64% for the 1-year maturity at the 1% significance level, and by 46% for the 2-year maturity at the 5% level, but not for the maturities of 5 and 10 years. These results suggest that monetary policy in the United States was less effective at the zero lower bound for maturities up to 2 years, but remained effective at the longer maturities of 5 and 10 years.

[Table 3 about here]

A summary of the results from Tables 1 to 3 for the coefficients for a country's government bond yields on the dummy variable for the zero lower bound in that country interacted with domestic and US macro news surprises is presented in Table 4. Comparing the results for Canada and the United Kingdom, we find that the sensitivity of government bond yields to domestic economic news was reduced less strongly, and only at shorter maturities, in Canada than in the United Kingdom. Comparing the results for Canada and the United States, we find that the sensitivity of government bond yields to domestic economic news was again reduced only at shorter maturities in Canada than in the United States. At the 1-year maturity, the sensitivity of government bond yields to domestic macroeconomic news was reduced somewhat more strongly in Canada than in the United States, by 77% compared with 64%; but at that maturity the sensitivity of government bond yields to US data surprises was reduced less strongly in Canada than in the United States, by 47% compared with 64%. The effective zero lower bound of the policy rate lasted for a shorter period in Canada than in both the United Kingdom and the United States. A shorter duration of the zero lower bound and smaller severity of the effect of the global financial crisis in Canada may have contributed to the fact that the sensitivity of government bond yields to macro news was not affected at medium- and long-term maturities in Canada. This is also consistent with the prompt use of unconventional monetary policy upon reaching the zero lower bound in Canada.

The interpretation that a shorter duration of the zero lower bound in Canada is partly responsible for the result that the sensitivity of government bond yields to macro news was reduced only at shorter maturities in Canada is consistent with the findings of Swanson and Williams (2012) that the sensitivity of US Treasury yields remained higher earlier in the zero lower bound period (from 2008 to 2010), but fell closer to zero later in the zero lower bound period, from late 2011. It is also consistent with the findings of Swanson and Williams (2012) that yields on UK government bonds were surprisingly responsive to news in 2010 to 2011, but were substantially constrained by the zero lower bound later in 2012; their finding that UK government bond yield movements in response to economic news were also substantially constrained by the zero lower bound already in 2009 does not fit with this interpretation, however.

Comparing the results for the United Kingdom and the United States, we find that the sensitivity of government bond yields to domestic economic news was reduced more strongly, and up to longer maturities, in the United Kingdom than in the United States. This occurred even though the size of the Bank of England's balance sheet quintupled between June 2007 and early 2013, while the size of the Federal Reserve's balance sheet approximately tripled. These results might reflect the severity and persistence of the effect of the global financial crisis on the United Kingdom. They may also reflect the fact that the Bank of England did not introduce the unconventional monetary policy of forward policy rate guidance when reaching the zero lower bound, but only several years later in 2013.

[Table 4 about here]

## 4 Conclusions

We find that the sensitivity of government bond yields to domestic economic news was reduced only at shorter maturities in Canada than in the United Kingdom and the United States, during the periods of the effective zero lower bound of the policy rate in each country. Moreover, we find that the sensitivity of government bond yields to domestic economic news was reduced less strongly in Canada than in the United Kingdom. This suggests that in Canada monetary policy lost less of its effectiveness than in the United Kingdom, and only up to shorter horizons than in the United Kingdom and the United States at the zero lower bound. This is likely to partly reflect a shorter period of the zero lower bound and smaller severity of the effect of the global financial crisis in Canada.

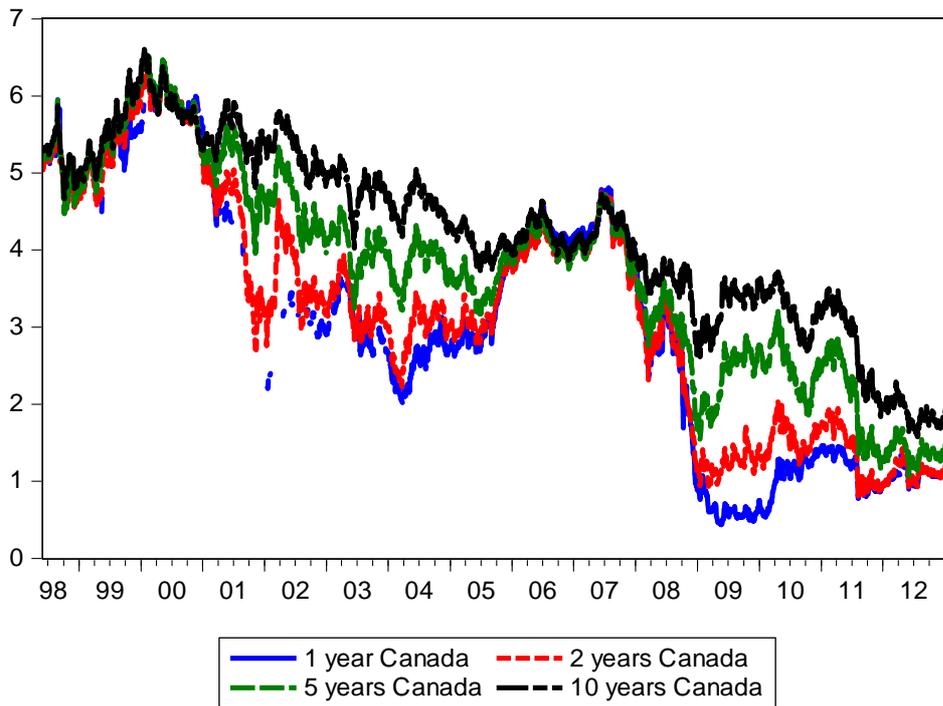
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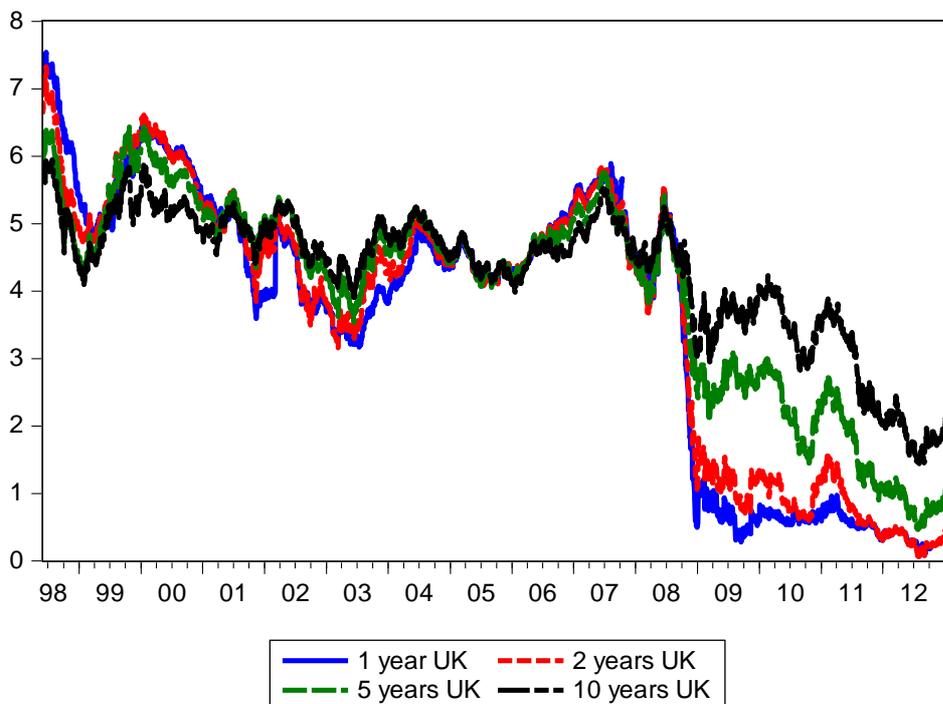
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Figure 1: Canadian government bond yields, benchmark bonds (in percent).



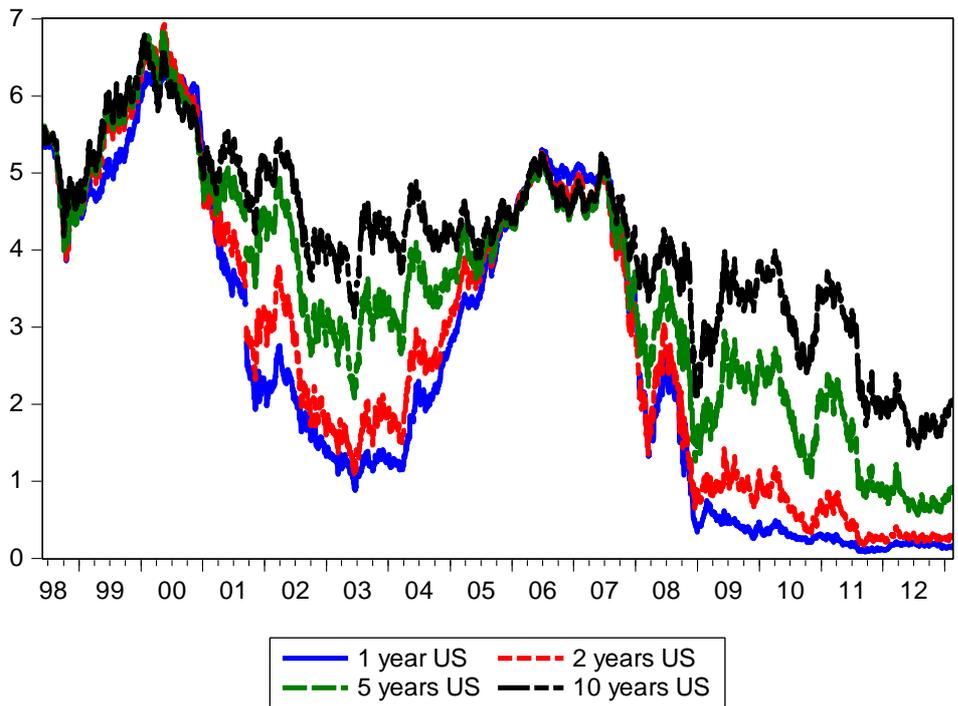
Source: Bloomberg.

Figure 2: UK government bond yields, benchmark bonds (in percent).



Source: Bloomberg.

Figure 3: US government bond yields, constant-maturity (in percent).



Source: Federal Reserve Board, Table H.15 (<http://www.federalreserve.gov/releases/h15/current/h15.pdf>).

**Table 1: Reactions of Canadian government bond yields to macroeconomic news**

	1 year	2 years	5 years	10 years
<i>c</i>	-0.0008	-0.0010	-0.0009	-0.0008
<i>c</i> <sub>ZLB,CA</sub>	0.0020	0.0011	0.0024	0.0013
US non-farm payrolls	0.0336***	0.0384***	0.0381***	0.0292***
US ISM	0.0140**	0.0191***	0.0155***	0.0167***
US unemployment rate	-0.0092***	-0.0109***	-0.0102***	-0.0082**
US retail sales	0.0082*	0.0230***	0.0228***	0.0209***
US industrial production	0.0088**	0.0112**	0.0087**	0.0056
US housing starts	0.0050	0.0031	0.0006	0.0002
US CPI	0.0065	0.0071	0.0066	0.0044
US PPI	-0.0007	0.0000	0.0003	0.0005
US hourly earnings	0.0155***	0.0150***	0.0178***	0.0154***
US trade	0.0026	0.0004	0.0021	0.0026
US GDP	0.0125	0.0300***	0.0272**	0.0215**
<i>f</i> <sub>ZLB,CA</sub> (on US data surprises)	-0.47**	-0.25	-0.27	-0.38*
CA CPI	0.0204***	0.0258***	0.0188***	0.0091**
CA PPI	-0.0036	0.0033	0.0008	0.0004
CA unemployment rate	-0.0043	-0.0178**	-0.0116**	-0.0073
CA employment change	0.0236***	0.0275***	0.0227***	0.0145***
CA retail sales	0.0101**	0.0152***	0.0120***	0.0080**
CA GDP	0.0191**	0.0219***	0.0074	0.0031
CA raw materials prices	0.0029	-0.0021	-0.0042	-0.0044
CA current account balance	0.0082	0.0134	-0.0076	-0.0074
CA trade balance	-0.0034	0.0014	0.0008	0.0020
CA manufacturing sales	-0.0025	0.0014	-0.0028	-0.0030
CA housing starts	-0.0015	-0.0015	-0.0033	-0.0033
CA Ivey index	0.0016	0.0067	0.0061	0.0040
<i>g</i> <sub>ZLB,CA</sub> (on CA data surprises)	-0.77***	0.21	-0.02	0.05
Adjusted R-squared	0.057	0.085	0.063	0.043

\*\*\*, \*\*, and \* represent significance at the 1%, 5% and 10% level, respectively. Newey-West adjusted standard errors. Sample period: 6/01/1998-2/15/2013.

**Table 2: Reactions of UK gilt yields to macroeconomic news**

	1 year	2 years	5 years	10 years
<i>c</i>	-0.0018*	-0.0017	-0.0010	-0.0005
<i>c</i> <sub>ZLB,UK</sub>	0.0013	0.0007	-0.0006	-0.0015
US non-farm payrolls	0.0150***	0.0203***	0.0227***	0.0235***
US ISM	0.0119***	0.0166***	0.0169***	0.0166***
US unemployment rate	-0.0030	-0.0040	-0.0064*	-0.0075**
US retail sales	0.0059	0.0113*	0.0114**	0.0104**
US industrial production	0.0116**	0.0103**	0.0059	0.0000
US housing starts	0.0016	0.0014	0.0008	0.0015
US CPI	0.0108***	0.0100**	0.0074*	0.0055
US PPI	-0.0026	-0.0030	-0.0021	-0.0006
US hourly earnings	0.0055	0.0080*	0.0116***	0.0099***
US trade balance	0.0032	0.0050	0.0074*	0.0062*
US GDP	0.0073	0.0101	0.0117	0.0073
<i>f</i> <sub>ZLB,UK</sub> (on US data surprises)	-0.50*	-0.46**	-0.02	0.40
UK average earnings	0.0168**	0.0193***	0.0079	-0.0059*
UK RPIX	0.0204***	0.0236***	0.0186***	0.0119***
UK unemployment changes	0.0033	0.0038	0.0016	-0.0020
UK retail sales	0.0173***	0.0205***	0.0163***	0.0102**
UK PPI	0.0125	0.0133	0.0141*	0.0087*
UK GDP	0.0118	0.0120	0.0101	-0.0006
UK industrial production	0.0163***	0.0186***	0.0155***	0.0074**
UK current account balance	0.0010	0.0027	0.0032	-0.0005
UK trade balance	-0.0029	-0.0008	-0.0030	-0.0020
UK PSNCR	-0.0078	-0.0069	-0.0068	0.0012
<i>g</i> <sub>ZLB,UK</sub> (on UK data surprises)	-0.98***	-0.97***	-0.72***	0.42
Adjusted R-squared	0.027	0.032	0.030	0.027

\*\*\*, \*\*, and \* represent significance at the 1%, 5% and 10% level, respectively. Newey-West adjusted standard errors. Sample period: 6/01/1998-2/15/2013.

**Table 3: Reactions of US government bond yields to macroeconomic news**

	1 year	2 years	5 years	10 years
<i>c</i>	-0.0022**	-0.0017	-0.0016	-0.0014
<i>c</i> <sub>ZLB,US</sub>	0.0019*	0.0014	0.0016	0.0012
US non-farm payrolls	0.0340***	0.0483***	0.0465***	0.0343***
US ISM	0.0172***	0.0230***	0.0213***	0.0186***
US unemployment rate	-0.0129***	-0.0181***	-0.0088	-0.0068
US retail sales	0.0135***	0.0249***	0.0256***	0.0223***
US industrial production	0.0068	0.0179**	0.0114**	0.0038
US housing starts	-0.0001	0.0003	0.0009	-0.0005
US CPI	0.0076	0.0094	0.0093	0.0056
US PPI	0.0001	-0.0004	-0.0003	0.0040
US hourly earnings	0.0114**	0.0171***	0.0180***	0.0140***
US trade	0.0010	0.0055	0.0089**	0.0087**
US GDP	0.0207*	0.0349**	0.0307**	0.0283**
<i>f</i> <sub>ZLB,US</sub> (on US data surprises)	-0.64***	-0.46**	0.03	0.36
Adjusted R-squared	0.037	0.050	0.041	0.032

\*\*\*, \*\*, and \* represent significance at the 1%, 5% and 10% level, respectively. Newey-West adjusted standard errors. Sample period: 6/01/1998-2/15/2013.

**Table 4: Coefficients for government bond yields on dummy variable for zero lower bound in that country interacted with domestic and US macro news surprises**

	1 year	2 years	5 years	10 years
<b>A. Canadian government bond yields</b>				
<i>g</i> <sub>ZLB,CA</sub> (on CA data surprises)	-0.77***	0.21	-0.02	0.05
<i>f</i> <sub>ZLB,CA</sub> (on US data surprises)	-0.47**	-0.25	-0.27	-0.38*
<b>B. UK government bond yields</b>				
<i>g</i> <sub>ZLB,UK</sub> (on UK data surprises)	-0.98***	-0.97***	-0.72***	0.42
<i>f</i> <sub>ZLB,UK</sub> (on US data surprises)	-0.50*	-0.46**	-0.02	0.40
<b>C. US government bond yields</b>				
<i>f</i> <sub>ZLB,US</sub> (on US data surprises)	-0.64***	-0.46**	0.03	0.36

\*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Newey-West adjusted standard errors. Sample period: 6/01/1998-2/15/2013.

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