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U.S. Macroeconomic News and Low-Frequency Changes in Small Open Economies' Bond Yields

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Abstract

This paper investigates the importance of U.S. macroeconomic news in driving low-frequency fluctuations in the term structure of interest rates in Canada, Sweden and the United Kingdom. We follow two complementary approaches: First, we apply a regression-based framework that aggregates the impact of daily macroeconomic news on bond yields to a lower quarterly frequency. Next, we estimate a macro-finance affine term structure model linking the daily news to lower-frequency changes in bond yields and their expectations and term premia. Both approaches show that U.S. macroeconomic news is an important source of lower-frequency quarterly fluctuations in bond yields in these small open economies—even more important than the respective countries' domestic macroeconomic news. Furthermore, the macro-finance model shows that U.S. macroeconomic news is particularly important to explain low-frequency changes in the expectation components of the nominal, real and break-even inflation rates.

Topics: Central bank research; Econometric and statistical methods
JEL codes: E43, E44, E47, G14

Résumé

Dans cette étude, nous nous intéressons à l'influence des nouvelles macroéconomiques américaines sur les fluctuations à basse fréquence dans la structure par terme des taux d'intérêt au Canada, en Suède et au Royaume-Uni. Nous suivons deux approches complémentaires. D'abord, nous appliquons un modèle de régression qui cumule les effets des nouvelles macroéconomiques quotidiennes sur les rendements obligataires pour les organiser selon une plus faible fréquence, soit sur une base trimestrielle. Puis, nous estimons un modèle macrofinancier affine fondé sur la structure par terme des taux d'intérêt qui relie les nouvelles quotidiennes aux variations à plus basse fréquence des rendements obligataires ainsi qu'aux anticipations et aux primes de terme relatives à ces variations. Les deux approches montrent que les nouvelles macroéconomiques des États-Unis sont une source importante de fluctuations trimestrielles des rendements obligataires dans ces petites économies ouvertes – encore plus importante que les nouvelles macroéconomiques propres à ces économies. De plus, le modèle macrofinancier indique que les nouvelles macroéconomiques américaines jouent un rôle particulièrement déterminant dans les variations à faible fréquence de la composante d'anticipation des taux courts nominaux, des taux courts réels et du taux d'inflation.

Sujets : Recherches menées par les banques centrales; Méthodes économétriques et statistiques
Codes JEL : E43, E44, E47, G14

1 Introduction

Market participants closely monitor monetary policy and macroeconomic announcements, such as consumer price inflation (CPI), nonfarm payrolls and gross domestic product (GDP). Bond yields of different maturities react to these announcements as market participants adjust their perceptions of the economy and the monetary policy stance. Several studies (e.g., Gurkaynak et al., 2005, Faust et al., 2007, and Andersen et al., 2007) have examined this relationship. Despite the attention market participants devote to these macroeconomic announcements, the existing literature generally indicates that macroeconomic news accounts for only a minor portion of the daily fluctuations in bond yields. For instance, Altavilla et al. (2017) report that U.S. macroeconomic news explains less than 10% of the daily variations in the yield curve of U.S. Treasury bonds. However, these daily changes cumulatively contribute significantly (up to 35%) to monthly or quarterly variations. This contribution demonstrates that macroeconomic news exerts a persistent influence on bond yields. It helps reconcile the findings of event studies using daily data, which suggest a limited role for macroeconomic news in shaping long-term rates, with studies utilizing lower-frequency monthly and quarterly data, which tend to identify a more substantial impact of macroeconomic news (Ang and Piazzesi, 2003).

This paper examines how macroeconomic news in the U.S. moves the yield curve in a set of small (and developed) open economies: Canada, Sweden and the U.K. We start by expanding the approach of Altavilla et al. (2017) to an international setting. We link the daily changes in bond yields in these countries to U.S. and their own macroeconomic news. We then aggregate the daily predicted variation of bond yields using U.S. and domestic macroeconomic news to a quarterly frequency using their regression approach. This allows us to study the share of variance of bond yields at a lower frequency, namely quarterly, that can be explained by either U.S. or their own macroeconomic news. We complement this regression-based approach with a second one that estimates a macro-finance dynamic term structure of interest rate model, similar to Rudebusch and Wu (2008) for these three countries. We then link the U.S. and domestic macroeconomic surprises to the model, following the approach of Hördahl et al. (2020). One of the advantages of this second approach is that it allows us to investigate whether U.S. macroeconomic news moves the yield curve in these countries through its effects on expectations or the term premium. We investigate the role of U.S. macroeconomic news in driving low-frequency movements in nominal yield, the real yield, and the break-even inflation rate (BEIR) curves in the three countries of our sample.

The regression-based analysis reveals that combined U.S. and domestic macroeconomic news account for less than 15% of daily yield curve variations in domestic bonds. However, they contribute significantly—up to 35%—for short-maturity bonds (two- or three-year) on a quarterly basis and between 15% and 20% for other, longer, maturities. When comparing the impact of domestic versus U.S. macroeconomic news, we find that domestic news contributes to approximately 10% of the quarterly yield curve variation, while U.S. news explains up to 25%. In our macro-finance model, we observe that much of the influence of U.S. news on bond yields in these countries is attributable to its impact on the term premium. Furthermore, we investigate the effects of these news on the BEIR, most commonly referred to as inflation compensation. Once again, our analysis highlights that a significant portion of the influence of U.S. macroeconomic news on BEIR originates from its role as a driver of the inflation risk premium.

Our paper contributes to the existing literature investigating the relationships between the macroeconomy, yield curves, and the global transmission of macroeconomic news. First, our paper relates to the strand of literature linking macro news and asset prices. As previously discussed, seminal contributions by Gurkaynak et al. (2005), Andersen et al. (2007) and Faust et al. (2007) have shown that macroeconomic surprises are economically important and have statistically significant impact on daily changes in bond yields. Bauer (2015) shows that the effect of macroeconomic news on yields of different maturities is one-dimensional. Similarly, Gurkaynak et al. (2020) also find a strong common response of interest rates to macro data releases. The paper that is the closest to ours is Altavilla et al. (2017), where a simple regression-based procedure is developed to analyze the effect of macroeconomic news on yields at lower frequencies (monthly and quarterly). We extend Altavilla et al. (2017) to analyse the persistence of U.S. macro news spillovers into the yield curves of other small open economies (SOEs) and complement our analysis with a macro-finance term structure model.

This paper also contributes to the extensive literature examining the transmission of U.S. monetary policy and macro news to SOEs. Goldberg and Leonard (2003) analyze how U.S., German, and euro-area news impact changes in sovereign debt yields for the U.S. and Germany. Their findings reveal a strong influence of U.S. news on German yields, while euro-area news has limited effects on U.S. Treasury yields. Similarly, Ehrmann and Fratzscher (2005) find stronger spillover effects from the U.S. to the euro area compared to the reverse direction. Bekaert et al. (2023) studies how monetary policy and risk shocks transmit between the U.S., the euro area and Japan. They show that monetary policy is not the main driver of a global component of risk shocks. Finally, Boehm and Kroner (2020) establish that U.S. macroeconomic news releases exert substantial and significant effects on global risky asset prices. These findings align with our results, although our primary focus centers on the lower-frequency impact of U.S. and domestic macroeconomic news on the term structure of interest rates in these three SOEs.

The paper is organized as follows. Section 2 presents the data used in the first part of our analysis. The next section shows how U.S. and domestic news drive the high-frequency daily variation in bond yields. Section 4 shows how the approach of Altavilla et al. (2017) can be applied to an international setting and examines the low-frequency quarterly changes in bond yields due to the influence of U.S. and domestic news. Section 5 then develops a macro-finance term structure model that provides further evidence of the channels (i.e., expectations or risk premia) through which U.S. macro-news impacts bond yields in these countries. Section 6 discusses the results and Section 7 concludes the paper.

2 Data

We use two primary sets of data: zero-coupon yield curves and macroeconomic news. Alongside U.S. data, we collect data for three SOEs: Canada, Sweden, and the U.K. Our sample period spans from January 3, 2000, to March 31, 2020.

2.1 Yield curve data

We gather end-of-day zero-coupon nominal yield curves spanning 2 to 10 years. For the U.S., we employ zero-coupon yields created by Liu and Wu (2021) using a non-parametric kernel-smoothing method.[1] Canada's zero-coupon curves are generated by the Bank of Canada, applying an estimation method based on the Merrill Lynch Exponential Spline (MLES) model.[2] In the United Kingdom (U.K.), real and nominal yield curves are estimated using a spline-based technique adapted from Waggoner (1997) and Anderson and Sleath (1999).[3] Lastly, Swedish bond yields are constructed using a smooth discount function based on the parametrization method proposed by Svensson (1994) and provided by Riksbank staff.

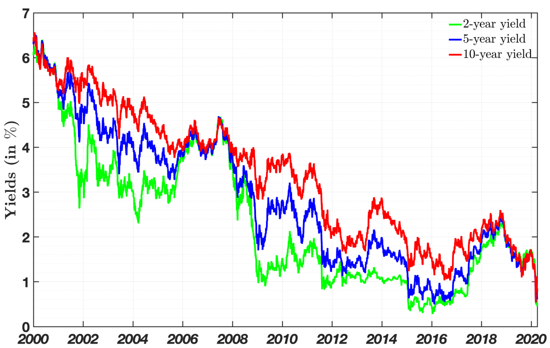
Figure 1 displays the 2-, 5-, and 10-year yields for the three SOEs in our dataset. These yields exhibit a consistent pattern of declining interest rates since the start of our sample in early 2000. Periodically, this declining trend is interrupted by episodes of interest rate increases, such as those of the early 2000s. The most significant and rapid yield movements occurred during the onset of the Global Financial Crisis (GFC), marked by sharp declines in both short- and long-term yields in late 2018 and early 2019.

[1]This dataset is accessible on Cynthia Wu's website: https://sites.google.com/view/jingcynthiawu/yield-data.

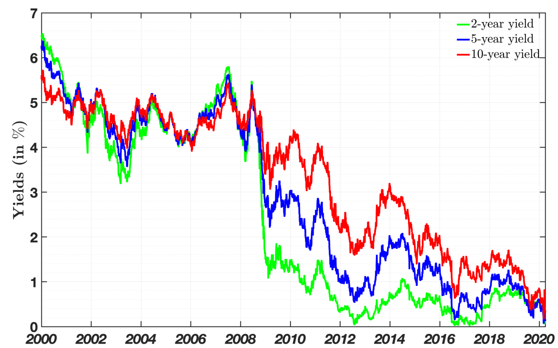
[2]For more details, see Bolder et al. (2004).

[3]Daily UK zero-coupon yield data is available at the Bank of England's website: https://www.bankofengland.co.uk/statistics/yield-curves.

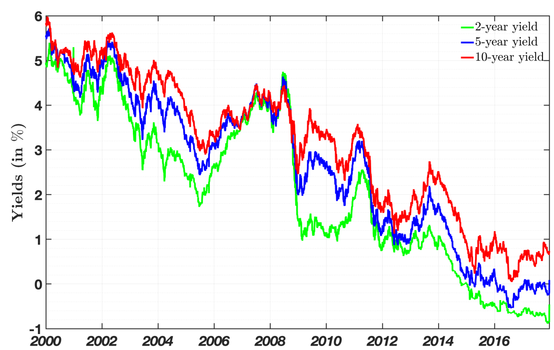
Figure 1: 2-, 5- and 10-year yields



(a) Canada



(b) UK



(c) Sweden

Note: This figure shows daily observations for the 2-, 5-, and 10-year zero-coupon yields for Canada and the U.K. from January 4, 2000, to March 31, 2020, and for Sweden from January 3, 2000, to December 15, 2017.

2.2 U.S. and SOE macroeconomic news

We follow Altavilla et al. (2017) and use data from Bloomberg's Economic Calendars (ECO) to replicate the real-time information flow available to market participants. This dataset includes the actual values of macroeconomic announcements and the predictions made by a panel of market experts for each release. Typically, ECO survey forecasts commence one to two weeks prior to the release and are continuously updated until the official macroeconomic data becomes available. In our empirical analysis, we use the median (consensus) forecast from the survey data. To construct macroeconomic news, we calculate the difference between the official first release at time t represented as x_t, and the survey forecast $E[x_t|I_{t-\epsilon}]$.

$$News_t^x = \frac{x_t - E[x_t|I_{t-\epsilon}]}{\hat{\sigma}^x} \tag{1}$$

To ensure comparability across macroeconomic variables and countries, we standardize the differences between macro-releases and their forecasts by dividing them by their sample standard deviation ($\hat{\sigma}^x$). Table 1 shows the list of U.S. macroeconomic releases considered. Tables A.1 to A.4 in the online appendix reports the list of macroeconomic announcements for each country. The number of releases varies: 10 for the U.S., 16 for Canada, 9 for Sweden, and 12 for the U.K. The tables also include the mean, standard deviation, and persistence of these macroeconomic news for each country. Notably, macroeconomic news exhibits no evidence of persistence and, on average, does not significantly differ from zero, statistically speaking.

Additionally, we provide correlation matrices (Tables B.1 to B.6) in the online appendix, detailing the correlation among domestic macroeconomic news within each country, along with their correlations with U.S. macroeconomic news. Across both sets of tables, the correlations among macroeconomic news are predominantly close to zero in most cases.

3 The high-frequency effects of U.S. macroeconomic news on SOEs' yield curves

We start by conducting an event study to estimate the impact of U.S. macroeconomic news on daily yield curve changes in the three SOEs of our sample. For each country—Canada, Sweden and the U.K.—we estimate the following regressions.

$$\Delta y_{i,t}^{\tau} = \alpha + \sum_{j=1}^{n} \beta_j^{\tau} News_{j,t}^{US} + \epsilon_t \tag{2}$$

where $\Delta y_{i,t}^{\tau}$ represents the daily change in bond yields of maturity τ for country i on day t. $News_{j,t}^{US}$ corresponds to the news surprises related to the announcements of macroeconomic variable j on day t in the U.S. If there are no releases for variable j on day t, then $News_{j,t} = 0$. The impact of an increase of one standard-deviation in *News* on bond yields of maturity τ is given by β_j^{τ}. We estimate Equation 2 individually for each country.

Table 1 presents the estimates of β_i for U.S. macro news on two-year bond yields in each country. Tables A.5 and A.6 in the online appendix show the regression results for the 5- and 10-year bond yields. Numerous releases significantly impact daily yield changes across all maturities in these countries. In line with the findings of Altavilla et al. (2017), qualitative surveys like the Conference Board Consumer Confidence index and ISM manufacturing surveys exhibit significant effects on daily yield changes in all countries. These soft data indicators are particularly valuable due to their timeliness in providing market participants an early read on broad economic conditions.

Additionally, hard data indicators closely linked to economic fundamentals, such as GDP and retail sales, are also statistically significant in explaining yield fluctuations. Variables summarizing labor market dynamics, such as changes in nonfarm payrolls, are highly timely and have the highest impact on daily bond yield changes. Furthermore, surprises related to monetary policy have a positive effect on bond yields, although the impact varies across the three countries.

In comparing the effects of U.S. macroeconomic news across the three countries, it is notable that they are usually stronger on Canadian yields. This is not surprising, given the close commercial and financial links between the two countries. Gravelle and Moessner (2001) and Hayo and Neuenkirch (2012) document the impact of U.S. macroeconomic news on Canadian financial indicators and also find evidence that U.S. macroeconomic news exert a stronger impact on the Canadian stock market and bond yields. Moreover, U.S. macroeconomic news appears to have a relatively similar impact on both U.K. and Swedish daily bond yield changes.

Finally, as discussed earlier in the introduction, our findings align with extensive research on the high-frequency impact of macroeconomic news on asset prices. Specifically, our results indicate that U.S. macroeconomic news accounts for only a modest portion of the daily fluctuations in bond yields in these countries, consistent with the limited influence of U.S. macroeconomic news on U.S. yields, as documented by Altavilla et al. (2017).

Table 1: Impact of U.S. macroeconomic news on two-year domestic bond yields at high frequency

Coefficients of Releases (in %)	Canada	UK	Sweden
Change in nonfarm payrolls	**2.70***	**1.51***	**1.37***
Consumer confidence	**0.66**	0.05	**0.47*
Consumer price index (MoM)	0.06	0.41	0.02
Industrial production	0.67	0.44	0.63
ISM manufacturing	**1.59***	**1.27***	**1.42***
Monetary policy surprise	**1.67***	0.04	**0.39*
Producer price index (MoM)	0.11	−0.28	−0.51
Retail sales less autos	**2.58***	0.97	**2.59***
Trade balance	0.09	0.29	**0.66**
GDP annualized QoQ A	**1.95***	**0.85**	0.48
R^2	0.040	0.016	0.016

Note: Boldface denotes coefficients that differ significantly from zero at different confidence levels. *, **, and *** indicate statistical significance at 10, 5, and 1%, respectively (all the t-stat values are based on Newey-West standard errors).

3.1 The relative strength of U.S. and SOEs' macroeconomic news

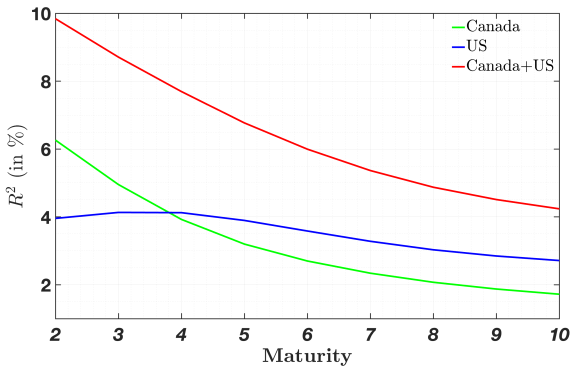
We also investigate how the influence of U.S. macroeconomic news contrasts with the reaction of yields to their respective domestic macroeconomic news. We expand equation 2 by incorporating the term $\sum_{j=1}^{m} \gamma_j^{\tau} News_{j,t}^{SOE_i}$, which accounts for domestic macroeconomic news across the countries in our dataset.

$$\Delta y_{i,t}^{\tau} = \alpha + \sum_{j=1}^{n} \beta_j^{\tau} News_{j,t}^{US} + \sum_{j=1}^{m} \gamma_j^{\tau} News_{j,t}^{SOE_i} + \epsilon_{i,t} \tag{3}$$

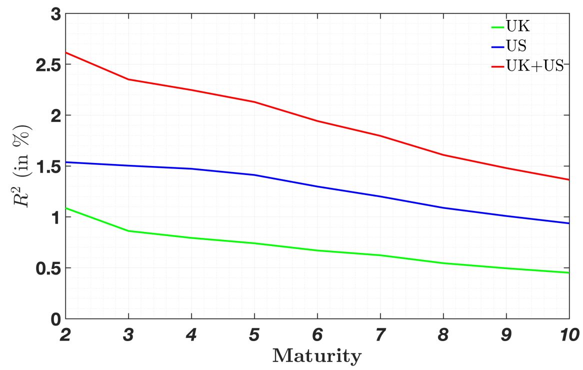
We estimate the R^2 for three variations of the regression. First, we estimate equation 3 with all β_j set to zero, focusing solely on domestic macro surprises. Next, we estimate equation 3 with all γ_j set to zero, emphasizing only U.S. macro surprises, as in the previous section. Finally, we estimate the unrestricted version of equation 3. These regressions are conducted for each SOE_i across bond maturities ranging from 2 to 10 years. The results can be found in Figure 2. Tables A.5 to A.9 in the online appendix show the coefficient of these regressions for the 5- and 10-year bond yields.

Local domestic macroeconomic news usually have a stronger influence on the shorter end of the yield curve (two- to three-year yields). This is the case for both Canada and Sweden. For instance, Canadian macroeconomic news accounts for approximately 6% of the two-year yield (green line), while U.S. macroeconomic news explains just over 4% of the same maturity yield (blue line). In contrast, for longer maturity yields, U.S. macroeconomic news plays a more significant role in explaining daily yield changes compared to local domestic macroeconomic news in all countries. For example, U.S. macroeconomic news explains approximately 3% of 10-year Canadian yields (blue line), whereas Canadian macroeconomic news contributes very little to the same variation (green line). This is once more consistent with the results of Gravelle and Moessner (2001) and Hayo and Neuenkirch (2012) showing that U.S. macroeconomic news has a larger impact on Canadian bond yields than Canadian news.

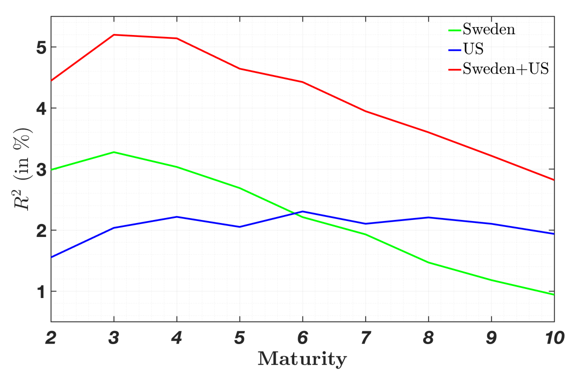
Figure 2: R^2 of regressions of daily yield changes on U.S. and domestic macroeconomic news



(a) Canada



(b) U.K.



(c) Sweden

Note: The figures plot the R^2s of three different version of equation 3 for zero-coupon yields with maturities ranging from 2 to 10 years. The green lines plot the R^2s when equation 3 is estimated only with domestic macroeconomic news; the blue line with only U.S. news; and, finally, the red line when both U.S. and domestic news enter equation 3. The R^2s (in %) are reported in the vertical axis, whereas the horizontal axis refers to different maturities, from 2 to 10 years.

4 The low-frequency effects of U.S. macroeconomic news on SOEs' yield curves

In this section, we investigate the persistence of the impact of U.S. and domestic macroeconomic news on the yield curves of the three countries. Following Altavilla et al. (2017), we define a daily news fitted index, denoted as nix_t^{τ}, which represents the fitted values of equation 2. We aggregate this news fitted index over a specific time horizon h, resulting in $nix_t^{h,\tau} = \sum_{j=0}^{h-1} nix_{t-j}^{\tau}$. Our focus will be on h=*66* days, equivalent to a quarter. Subsequently, we estimate the following regression:

$$\Delta^h y_{i,t}^{\tau} = \gamma^{h,\tau} nix_t^{h,\tau} + \varepsilon_{i,t}^{h,\tau}. \tag{4}$$

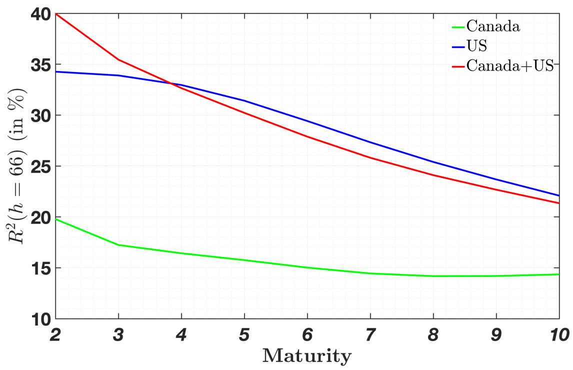
The R^2 in this regression gauges the significance of macroeconomic news releases in explaining bond yield fluctuations at the h horizon. Similar to the previous section, we estimate regressions (3) and (4) using three sets of data: with only U.S. macroeconomic news, with only domestic macroeconomic news, and with both U.S. and domestic macroeconomic news. Figure 3 presents several interesting findings.

First, as originally shown by Altavilla et al. (2017), macroeconomic news demonstrates significantly greater explanatory power when examined at lower quarterly frequencies, as opposed to the higher daily frequency. For instance, in the case of two-year bond yields, U.S. and domestic macroeconomic news can account for up to 40% of Canada's, 37% of the U.K.'s, and 40% of Sweden's quarterly yield changes, which is notably higher than the daily regressions in 3. For 10-year bond yields, the R^2 values drop to approximately 23%, 12%, and 21%, respectively. Nevertheless, these figures remain considerably higher than the daily frequency results.

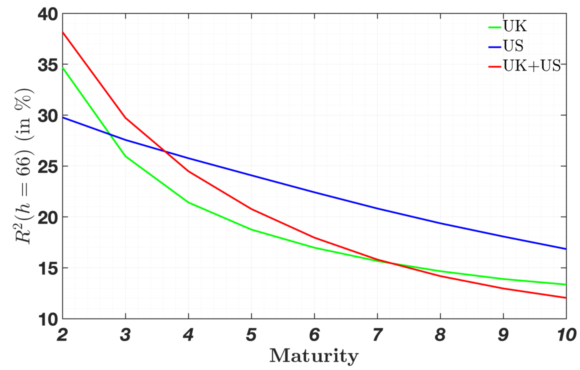
These findings again mask a substantial difference in the relative contribution of U.S. and domestic macroeconomic news to low-frequency bond yield changes in these countries. This contrast is particularly pronounced in Canada. While U.S. macroeconomic news alone can explain up to 35% of the quarterly changes in 2-year bond yields and 22% in 10-year bond yields, domestic Canadian macroeconomic news alone can account for just 20% and

15% of the quarterly changes in 2- and 10-year bond yields, respectively. Consequently, not only do U.S. macroeconomic surprises exert a more substantial impact on Canadian bond yields at higher frequencies as shown in the previous section, but this influence is also more persistent than the effects of Canadian macroeconomic news. Similar trends are observed in the U.K. and Sweden, albeit to a lesser extent. These relative results are not surprising in light of Canada's close trade and financial linkages with the U.S.

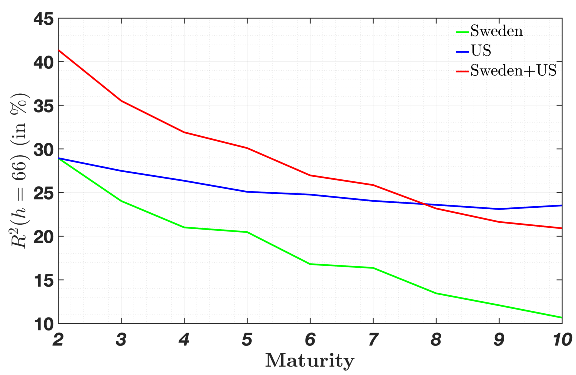
Figure 3: R^2 of quarterly regressions of yield changes on U.S. and domestic macroeconomic news



(a) Canada



(b) UK



(c) Sweden

Note: The figures show the R^2s of three different version of equation 4 for zero-coupon yields ranging from 2 to 10 years. The green lines plot the R^2s when equation 4 is estimated with only domestic macro news; the blue line with only US news; and finally, the red line when both US and domestic news enter equation 4. The R^2s (in percentage (%)) are reported in the vertical axis, whereas the horizontal axis refers to different maturities, from 2 to 10 years.

5 A macro-finance dynamic term structure model

The simple regression analysis mentioned earlier, while attractive and straightforward to implement, leaves us with important unanswered questions. Firstly, it does not readily allow us to explore the impact of news at frequencies beyond the quarter. Given that many macroeconomic models often operate at these lower frequencies, we want to understand the extent to which news can account for movements in asset prices at such frequencies. Secondly, this regression analysis is primarily suited for analyzing observed yield movements. However, in many cases, our interest lies in comprehending how macroeconomic news influences unobservable components, such as expectations of monetary policies and investor demand for bearing risks like interest rate risk and inflation risk. These crucial questions can be effectively investigated only through the lens of a dynamic model, as it enables us to uncover the dynamics of both observed and unobserved variables at any desired frequency.

To complement the above regression analysis, we develop and estimate an affine term structure model that incorporates macroeconomic factors, such as inflation and GDP growth, similar to Rudebusch and Wu (2008). This model essentially comprises a three-equation new Keynesian model encompassing an IS curve, a Phillips curve, and a monetary policy rule. It shares similarities with other well-known dynamic term structure models of interest rates that incorporate macroeconomic factors, as Ang and Piazzesi (2003), Ang et al. (2006), Ang et al. (2008), and Joslin et al. (2014).[4]

5.1 Overview of the structural model proposed in Rudebusch and Wu (2008)

We develop a reduced-form macro-finance model, in contrast to the structural model proposed by Rudebusch and Wu (2008). However, both models share the same implications for the dynamics of the state vector examined in this paper: the state vector follows a VAR(2) under the physical dynamics. The distinction between our reduced form and the

[4]We abstract in this analysis from considerations about the zero lower bound on nominal interest rates (Wu and Xia, 2016). Swanson and Williams (2014) show though that the zero lower bound has not significantly constrained the reaction of long-maturity yields to macroeconomic news.

structural form of Rudebusch and Wu (2008) is straightforward: our reduced form does not impose constraints on the parameters of the VAR(2), whereas the structural form imposes constraints that align with a theoretical framework (a three-equations new Keynesian model). Therefore, we provide a brief description of this model because it motivates our reduced-form model.

The one-month short rate is defined as the sum of two latent-term structure factors

$$i_t = \delta_0 + L_t + S_t$$

The dynamics of the macro-finance latent factors are specified as:

$$\begin{aligned} L_t &= \rho_L L_{t-1} + (1-\rho_L)\,\pi_t + \varepsilon_{Lt} \\ S_t &= \rho_S S_{t-1} + (1-\rho_S)\left[g_y y_t + g_\pi\left(\pi_t - L_t\right)\right] + u_{St} \\ u_{St} &= \rho_u u_{St-1} + \varepsilon_{St}. \end{aligned}$$

Here, π_t represents the annual inflation rate, and y_t is a measure of the output gap. To describe the dynamics of inflation and the output gap, we employ a standard theoretical representation. We begin with the representation for inflation:

$$\pi_t = c_\pi + \mu_\pi L_t + (1-\mu_\pi)\left(\alpha_{\pi 1}\pi_{t-1} + \alpha_{\pi 2}\pi_{t-2}\right) + \alpha_y y_{t-1} + \varepsilon_{\pi t}.$$

In this setup, current-month inflation is a weighted average of the public's medium-term inflation target expectation (L_t) and two lags of inflation. Additionally, we incorporate a one-month lag on the output gap to account for typical adjustment costs.

Aggregate demand is represented by an intertemporal Euler equation in the form of:

$$y_t = c_y + \mu_y E_t y_{t+1} + (1-\mu_y)\left(\beta_{y1} y_{t-1} + \beta_{y2} y_{t-2}\right) - \beta_r S_{t-1} + \varepsilon_{yt}.$$

This equation introduces an extra lag for the output, but the crucial difference lies in the specification of the *ex ante* real interest rate, proxied by S_{t-1}. This means that individuals assess nominal rates in relation to their expectation of underlying future inflation, not solely the inflation rate for the next month. Moreover, since our interest rate data are observed at the end of each month, the timing of the real rate at $t-1$ is appropriate for determining output at time t.

Rudebusch and Wu (2008) show that

$$\Gamma_0 Y_t = C_Y + \Gamma_1 Y_{t-1} + \Psi \varepsilon_t + e_{8,8}\eta_t,$$

where

$$Y_t = \left[\begin{array}{cccccccc} \pi_t & \pi_{t-1} & y_t & y_{t-1} & L_t & S_t & u_{St} & E_t y_{t+1} \end{array} \right]'$$

Γ_0, Γ_1 and C_Y are functions of the structural parameters of the model, $e_{8,8}$ is an 8×1 vector with 1 at the 8^{th} row and 0 elsewhere and $\eta_t \equiv y_t - E_{t-1} y_t$. We use the algorithm of Sims (2002) to solve the system, and the solution is in the form of

$$Y_t = C + \Gamma Y_{t-1} + \Omega \varepsilon_t.$$

Focussing on the first seven component and denoting

$$F_t \equiv \left[\begin{array}{ccccccc} \pi_t & \pi_{t-1} & y_t & y_{t-1} & L_t & S_t & u_{St} \end{array} \right]',$$

the dynamic of F_t is as follows

$$F_t = C_F + \rho F_{t-1} + \Sigma \varepsilon_t \tag{5}$$

where

$$\rho \equiv \Gamma\left(1:7, 1:7\right) \quad \Sigma \equiv \Omega(1:7, :).$$

We show in section D of our online appendix that our state variable Z_t defined as

$$Z_t \equiv \begin{bmatrix} \pi_t & y_t & L_t & S_t \end{bmatrix}'$$

follows a VAR(2), that is

$$Z_t = C_z + \rho_z \psi_{f_1} Z_{t-1} + \rho_z \psi_{f_2} Z_{t-2} + \Sigma_z \varepsilon_t$$

where

$$\begin{aligned} \psi_{f_1} &= \begin{bmatrix} e_{4,1} & 0_{4\times1} & e_{4,2} & 0_{4\times1} & e_{4,3} & e_{4,4} & \psi_u \end{bmatrix}' \\ \psi_{f_2} &= \begin{bmatrix} 0_{4\times1} & e_{4,1} & 0_{4\times1} & e_{4,2} & 0_{4\times1} & 0_{4\times1} & -\rho_S e_{4,4} \end{bmatrix}' \end{aligned}$$

and

$$\begin{aligned} C_z &= \begin{bmatrix} e_{7,1} & e_{7,3} & e_{7,5} & e_{7,6} \end{bmatrix}' C_F \\ \rho_z &= \begin{bmatrix} e_{7,1} & e_{7,3} & e_{7,5} & e_{7,6} \end{bmatrix}' \rho \\ \Sigma_z &= \begin{bmatrix} e_{7,1} & e_{7,3} & e_{7,5} & e_{7,6} \end{bmatrix} \Sigma. \end{aligned}$$

5.2 Our reduced-form model

There are four components in the state vector Z_t:

1. CPI inflation (yoy): π_t
2. unemployment rate: y_t
3. the level of the nominal yield curve: L_t
4. the slope of the nominal yield curve: S_t

.

$$Z_t = \begin{pmatrix} \pi_t \\ y_t \\ L_t \\ S_t \end{pmatrix}.$$

We assume that Z_t follows a VAR(2) process, that is:

$$Z_{t+1} = \omega + \phi_1 Z_t + \phi_2 Z_{t-1} + \Sigma \varepsilon_{t+1} \tag{6}$$

We show in Section D of our online appendix that this assumption is consistent with the three-equations new Keynesian model outlined in Rudebusch and Wu (2008). Our model serves as the reduced-form counterpart to theirs, which can be derived by imposing constraints on the matrices ϕ_1 and ϕ_2. We opt for the reduced-form approach due to its ease of estimation using ordinary least squares (OLS), while the constrained version in Rudebusch and Wu (2008) necessitates maximum likelihood estimation (MLE), which tends to be less stable. This model allows us to forecast each of the four components of Z_t at any given time horizon.

5.3 Pricing

The affine term structure of interest rate theory tells us that we can relate the nominal interest rate and the break-even inflation rate to the state vector Z_t linearly, that is

$$\begin{aligned} y_t^{(n)} &= a_n + b_n^\top Z_t \\ \pi_{t,e}^{(n)} &= a_{n\pi} + b_{n\pi}^\top Z_t \end{aligned}$$

where $y_t^{(n)}$ and $\pi_{t,e}^{(n)}$ represent the nominal interest rate and the break-even inflation rate at maturity n at time t. a_n, $b_n^\top$, $a_{n\pi}$, and $b_{n\pi}^\top$ are functions of the risk-neutral parameters, which can be readily estimated using nonlinear least squares. This estimation involves minimizing the gap between model-predicted rates and observed rates. We have included all the specific details on nominal and real bond pricing in Section D of the online appendix.

Our modeling framework implies a non-Markovian (VAR(2)) dynamic for the state vector under the physical dynamic, and a Markovian dynamic (VAR(1)) for the same state vector in the risk-neutral dynamic. As a result, Z_{t-2} has an impact on the time series dynamics at time t and may aid in forecasting excess returns, but it does not influence pricing. This setup is akin to scenarios involving unspanned factors, where variables at time $t-2$ cannot be backed out from the yield curve at time t. Similar discussions on these issues can be found in previous papers such as Feunou and Fontaine (2014), Feunou and Fontaine (2018), Joslin et al. (2014), Bauer and Rudebusch (2016), and Hanson et al. (2019).

After estimating the model (a detailed description of the estimation process is provided in Section D.3 of the online appendix), we calculate all the following quantities using closed-form expressions: (*i*) nominal rates, break-even inflation, and real interest rates at any given maturity, and (*ii*) inflation forecasts at any given horizon. Hence, we can compute the inflation risk premium[5] and (*iii*) nominal expected short and real rates and the nominal and real-term premia at any given horizon.

5.4 Linking the macro-finance model innovation to macro surprises

Our goal is to investigate how macroeconomic news influences the fluctuations in bond yields and their expectations and risk premium components across different time horizons and maturities. To achieve this, we use the conventional variance decomposition method, which involves connecting the reduced-form innovation in equation (6) to macroeconomic news.

Connecting reduced-form innovations to macroeconomic news mirrors the approach taken in the structural vector autoregressive (SVAR) model literature when examining the dynamic impact of structural shocks. In SVAR analysis, reduced-form innovations are linear functions of certain structural innovations, and various restrictions are applied to

[5] We plot out estimates of the inflation risk premium in the appendix, and find them to be low and relatively smooth for most countries in our sample, similar to the evidence in Bekaert et al. (2023).

identify how reduced-form innovations load onto structural shocks.

We thus assume that reduced-form innovations to each state variable in Z_t are proportional to the announced macroeconomic news:

$$u_t \equiv \Sigma\varepsilon_t = \sum_{j=1}^{n} \alpha_j News_{j,t} + \xi_t. \tag{7}$$

We are not the first to establish this connection; further details can be found in Hördahl et al. (2020). We interpret ξ_t as the residual variation in reduced-form innovation that is not captured by news about macroeconomic variables.

Two approaches can be used for the estimation of the α_j: (i) using a rich cross-section of high-frequency changes of the nominal and real rates around macro-announcement times (see Hördahl et al. (2020) for details) and (ii) a regression-based approach. As previously discussed, due to limited access to a comprehensive cross-section of nominal and real rate data for the countries in our analysis, we opt for the regression-based method. We estimate equation 7 through simple regressions of the reduced-form innovation (u_t), derived from the VAR(2) dynamics (as outlined in equation 6), on the macroeconomic news. This link allows us to estimate the impulse responses and the proportion of variance of each interest rate (including its expectations and term premium components) due to each individual macroeconomic news. These shares of variance can then be aggregated to assess the impact of different groups of macroeconomic surprises (such as domestic, U.S., nominal, real, etc., macro-news) on various segments of the nominal, real, and inflation compensation curves.

The residual ξ_t is orthogonal to macroeconomic news, and it provides a straightforward way to address the following question: to what extent is the variation in bond yields (and their expectation and term premium components) associated with macroeconomic news? Answering this question simply relies on the orthogonality condition between ξ_t and $News_t$.

The regression-based method consists in estimating the α_j, through simple regressions of the reduced-form innovation (u_t) derived from the VAR(2) dynamics (as outlined in equation 6), on the macroeconomic news $News_{j,t}$ since both series are observed. The residual ξ_t is orthogonal to macroeconomic news, and it provides a straightforward way to address the following question: to what extent is the variation in bond yields (and their expectation and term premium components) associated with all of the macroeconomic news? Answering this question simply relies on the orthogonality condition between ξ_t and $News_t$.

However, because of potential correlations between different macro news (that is $News_{j,t}$ might be correlated with $News_{i,t}$ for $i \neq j$), we cannot determine the precise proportion of yields (and their expectation and term premium components) variation that can be attributed to a particular macroeconomic news event j or a group of such events. This correlation between news can arise for many reasons, but perhaps most importantly the same underlying structural forces drive the news. We then first must remove the correlations between macroeconomic news or blocks of macroeconomic news before estimating equation (7). In simpler terms, we require macroeconomic news (or a set of such news) to be contemporaneously uncorrelated. We show on Section B of the online appendix that there is very little, if any, correlation amongst most macroeconomic news, but to remove any correlation amongst the exceptions, we sequentially orthogonalize all the macroeconomic news before conducting the regression in equation (7).

Sequential orthogonalization entails an ordered approach where we initially establish a specific ranking among the macroeconomic news. Starting with the first macroeconomic news ($j = 1$), we regress $News_j$ for $j = 2, ..., n$ against $News_1$ and replace them with the resulting residuals. We then exclude the first macroeconomic news and repeat the same procedure. This process yields a collection of macroeconomic news that are contemporaneously uncorrelated, allowing us to calculate the contribution of individual macroeconomic news or groups of such news to the variations in yields, expectations and risk premia.

It is important to note that the order in which we arrange these macroeconomic news will impact the results of this procedure and our variance decomposition outcomes. This issue is analogous to what we encounter when conducting the Cholesky decomposition of the variance of u_t. In our approach, we use the ordering of the macroeconomic news based on the relevance index, which evaluates the significance of each release from the perspective of market participants.

5.5 Data description

On top of the nominal yield curve and macroeconomic news data described in Section 2, our macro-finance model uses additional macroeconomic data in its estimation. Additionally, we also estimate our model on real yields and break-even inflation rates for a sample starting in May 2008 and ending in December 2021. Prior studies, like that of Abrahams et al. (2016) and Andreasen et al. (2021), have found a notable rise in liquidity premiums on real yields amidst the 2008 financial crisis. To assess the potential influence of these liquidity challenges on our findings, we initiated our model estimation with data from January 2010 onwards. We found no substantial changes in our estimates, and therefore keep the earlier starting sample.

For the U.S., our market-based inflation expectation measures are inflation swaps with maturities of two, five and ten years. Our measure of inflation is the annualized month over month change in the Personal Consumption Expenditures, and our measure of the level of real activity is the Capacity Utilization index. We made these choices to be consistent with Rudebusch and Wu (2008). We plot these variables in Figure 1 of the accompanying online appendix.

For Canada, our market-based inflation expectation measures are break-even inflation rates with maturities of five and ten years. Our measure of inflation is the annualized month over month change in the consumer price index, and our measure of the level of real activity is the unemployment rate. We plot these variables in Figure 2 of the accompanying online appendix.

For the U.K., our market-based inflation expectation measures are inflation swap rates with maturities of two, five and ten years. Our measure of inflation is the annualized month over month change in the consumer price index, and our measure of the level of real activity is the Industrial Production Index (IPI). We plot these variables in Figure 3 of the accompanying online appendix.

For Sweden, our market-based inflation expectation measures are inflation swap rates with maturities of five, seven and ten years. Our measure of inflation is the annualized month over month change in the consumer price index, and our measure of the level of real activity is the IPI. We plot these variables in Figure 4 of the accompanying online appendix.

5.6 Parameter estimate and model fit

We provide the parameter estimates for the physical dynamic (VAR(2)) in Section D.5 of the online appendix. To assess the model's performance, we calculate the root-mean-squared-error (RMSE) for nominal yields and inflation compensation. The results presented in the appendix demonstrate that both nominal and real bonds are effectively priced within our framework. Specifically, the pricing error for nominal yields remains at approximately 15 basis points, while that for inflation compensation is around 35 basis points. This high level of accuracy allows us to employ the model framework to analyze how macroeconomic news influences interest rate components across various horizons and maturities, which is the focus of our attention moving forward.

6 Results from the macro-finance model

In this section, we leverage the model framework outlined above to examine the significance of U.S. and domestic macroeconomic news in explaining the dynamics of bond yields in these three countries. As discussed previously, one of the primary advantages of employing a macro-finance term structure model is its ability to easily aggregate results to lower frequencies beyond a quarter, thanks to the recursive structure of the model. Therefore, in our baseline results below, we present the proportion of variance explained by macroeconomic news at a six-month horizon. In the appendix, we present results for higher frequencies, such as a 12-month horizon. Additionally, another advantage of the macro-finance model is that it allows us to conduct a more detailed analysis of the channels through which macroeconomic news impacts bond yields, specifically whether it operates through the expectations or the term premium. We present below our results for each of the countries in our sample.

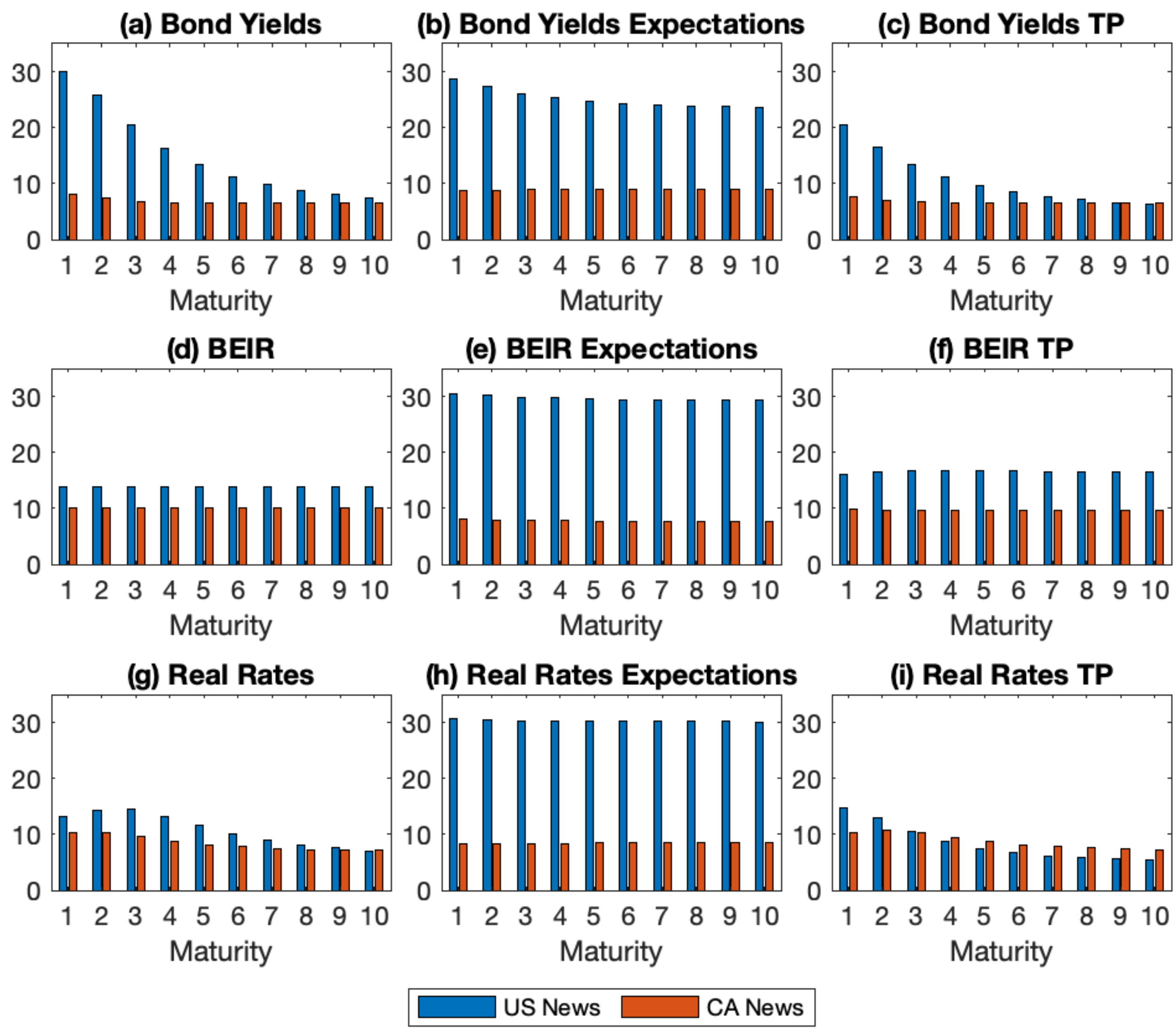
6.1 Canada

Figure 4 (a) shows that U.S. macroeconomic news accounts for nearly 30% of fluctuations in Canadian one-year bond yields, while Canadian macroeconomic news contributes slightly under 10%. For longer-term bonds (maturities exceeding four years), both U.S. and Canadian macroeconomic news each explains approximately 9% of the variance in Canadian bond yields.

Furthermore, Figures 4 (b) and (c) demonstrate that U.S. macroeconomic news plays a more significant role in explaining both the expectation and term premium components of Canadian bond yields. To be specific, U.S. macroeconomic news accounts for nearly 30% of the expectations component, compared to the less than 10% attributed to Canadian macroeconomic news. Additionally, U.S. macroeconomic news explains about 20% of the variability in short-term Canadian yields, while Canadian macroeconomic news contributes only about 9% to the variance of the Canadian bond yield term premia.

Next, we examine how U.S. and Canadian macroeconomic news impacts the term structure of break-even inflation and real rates in Canada. Figure 4 (d) to (i) also demonstrates that U.S. macroeconomic news explains around 10% of Canadian break-even rates, which is approximately twice the impact of Canadian macroeconomic news. While Canadian news has a stronger influence on the expectations component of break-even rates, U.S. macro-news significantly contributes to the inflation risk premium (Figures 4 (e) and (f)).

Figure 4: Share of variance (in %) of Canadian bond yields explained by U.S. and Canadian macroeconomic news after 6 months



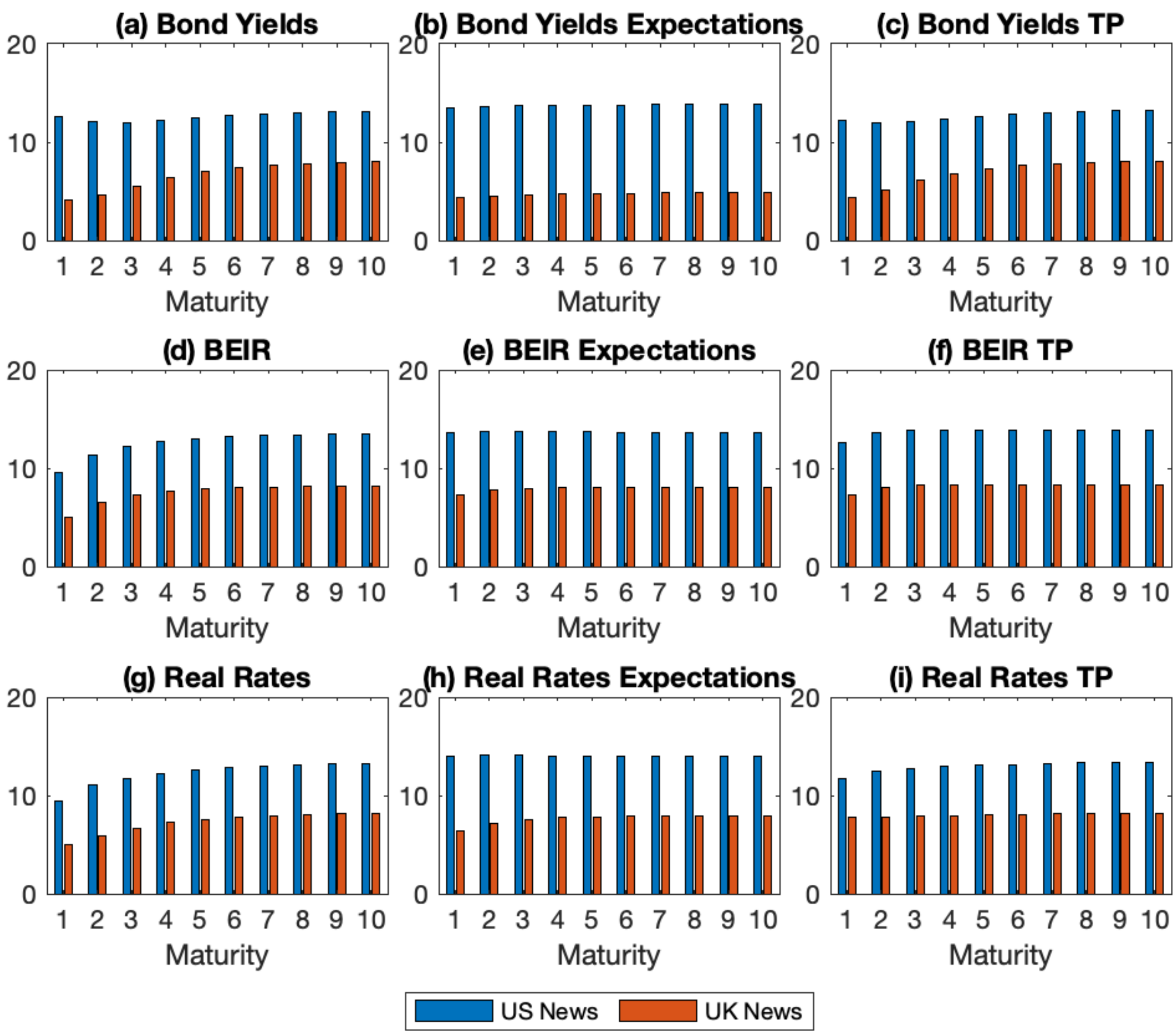
Note: This figure plots the share (in percentage) of variance of Canadian nominal bond yields, break-even inflation rates (inflation compensation) and real bond yields, and their respective expectations and term premium explained by U.S. and Canadian macroeconomic news after 6 months. The horizontal axis refers to different maturities, from 2 to 10 years.

6.2 U.K.

Figure 5 shows that U.S. macroeconomic news contributes slightly more than 10% of the variation in U.K. nominal bond yields across all the maturities, which is approximately twice the impact of U.K. macroeconomic news. Similarly, U.S. macroeconomic news accounts for more of the variance in both the expectations and term premium components of U.K. bond yields, each explaining just over 10%, while U.K. macroeconomic news explains between 5% and 8%.

Additionally, U.S. macroeconomic news has a more significant influence on U.K. breakeven rates compared to U.K. macroeconomic news. As shown in Figure 5 (e) and (f), this increased impact on U.K. inflation compensation arises from their greater effect on both the expectations component and the inflation risk premium. Lastly, in line with the findings for Canada, our model demonstrates that U.S. macroeconomic news plays a more prominent role in explaining fluctuations in U.K. real bond yields, as well as in their expectations and risk premium components.

Figure 5: Share of variance (in %) of U.K. bond yields explained by U.S. and U.K. macroeconomic news after 6 months



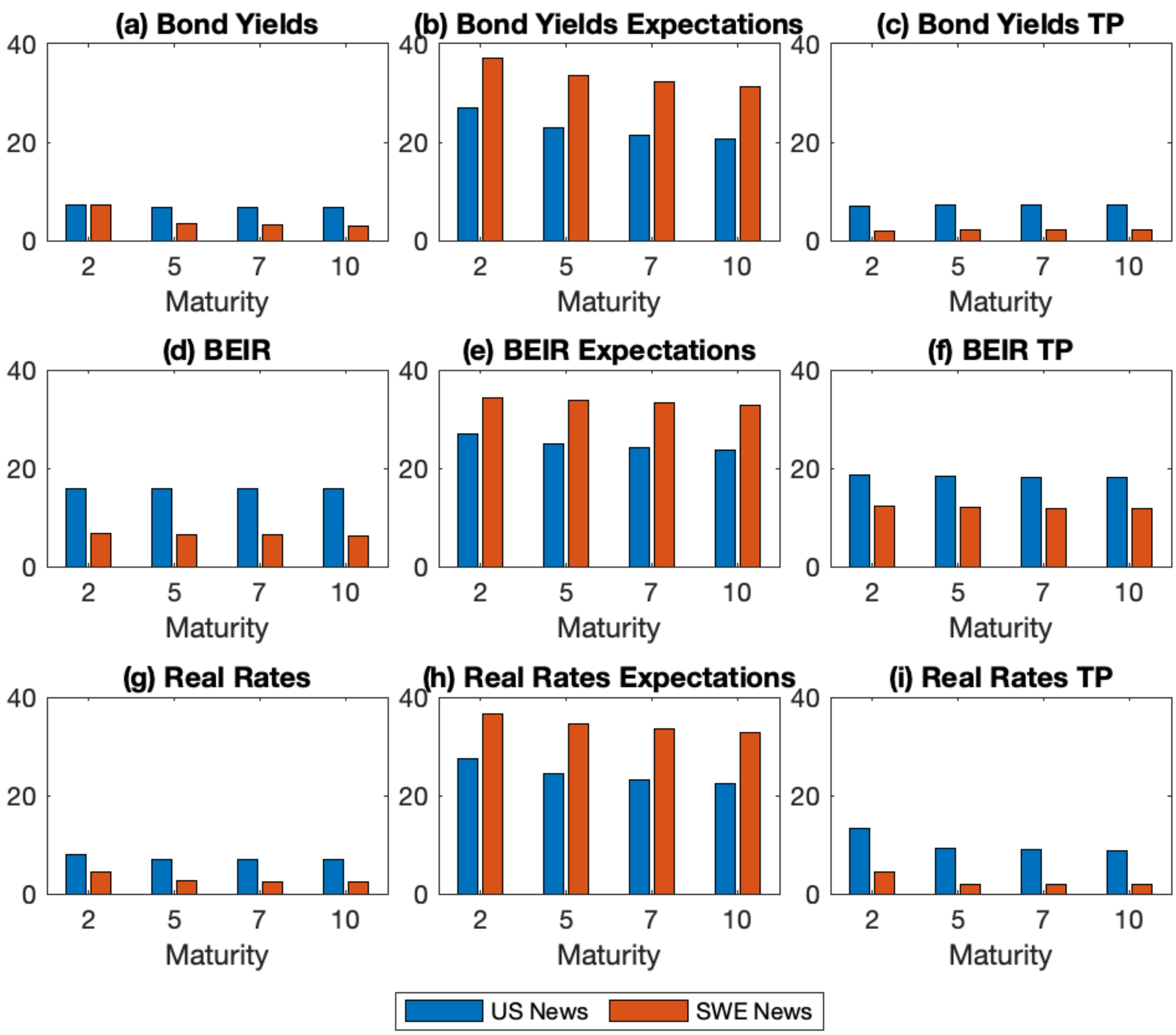
Note: This figure plots the share (in percentage) of variance of U.K. nominal bond yields, break-even inflation rates (inflation compensation) and real bond yields and their respective expectations and term premium explained by U.S. and U.K. macroeconomic news after 6 months. The horizontal axis refers to different maturities, from 2 to 10 years.

6.3 Sweden

Figure 6 shows similar findings for Sweden. U.S. macroeconomic news has a slightly greater impact on nominal Swedish bond yield changes, particularly for maturities exceeding two years, explaining approximately 8% of the 5-, 7-, and 10-year bond yields variation. While Swedish domestic macroeconomic news contributes more to the expectations component of nominal bond yields, U.S. macroeconomic news is more influential in driving fluctuations in the term premium. This contrast with our previous results for Canada and the U.K. may stem from the weaker trade and financial ties between Sweden and the U.S., relative to the U.K. and Canada.

This pattern also extends to Swedish BEIR and real bond yields. In both cases, U.S. macroeconomic news plays a more significant role in explaining their fluctuations, explaining slightly less than 20% and 10% of the variation in BEIRs and real bond yields, respectively. In contrast with the results for Canada and the U.K., but consistent with the findings for nominal bond yields, domestic Swedish macroeconomic news has a more pronounced impact on explaining the expectations components of both the BEIR and the risk premium, while U.S. macroeconomic news continues to play a notably more important role in driving the risk premium in both cases.

Figure 6: Share of variance (in %) of Swedish bond yields explained by U.S. and Swedish macroeconomic news after 6 months



Note: This figure plots the share (in percentage) of variance of Swedish nominal bond yields, break-even inflation rates (inflation compensation) and real bond yields and their respective expectations and term premium explained by U.S. and Swedish macroeconomic news after 6 months. The horizontal axis refers to different maturities, from 2 to 10 years.

7 Conclusion

This paper examines how bond yields in Canada, Sweden, and the U.K. respond to macroeconomic news from both the United States and their own domestic sources, with a focus on low-frequency responses. Using a regression method similar to the one introduced by Altavilla et al. (2017), we find that economic news from the United States plays a more significant role in explaining the dynamics of low-frequency yield curves in these countries, compared to their own domestic news.

To further understand the mechanisms through which U.S. economic news affects bond yields and inflation compensation in these nations, we introduce a macro-finance dynamic term structure model of interest rates similar to Hördahl et al. (2020). The model helps explain how U.S. economic news impacts nominal and real bonds as well as inflation compensation. It shows that the explanatory power of U.S. economic news for changes in bond yields and inflation compensation, the spread between nominal and real yields in these economies, is primarily driven by their influence on term and inflation risk premia.

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