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SHORT NOTE

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An international analysis of the trend five-year government bond rate

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Abstract

Employing an unobserved components stochastic volatility model, we estimate the trend 5-year government bond rate in Canada, Norway, Sweden, Switzerland, the United Kingdom and the United States. Our results suggest that the estimated trend rate has decreased substantially between 2000 and 2020 in all six countries. In Norway, Switzerland and the United Kingdom, the trend rate has increased non-negligibly since 2020; in Canada, Sweden and the United States, the trend rate has not been affected much by the increase in the actual 5-year government bond rate. At the end of the sample, none of the countries has a trend rate higher than 3%. The model hence suggests that the 5-year government bond rate will be fairly low in the medium-to-long run.

KEYWORDS
Bayesian estimation, unobserved components model

JEL CLASSIFICATION
C11, C32, E44, E52

1 | INTRODUCTION

Long-term nominal interest rates in many OECD countries were until fairly recently on a downward trend—a development which had lasted for several decades. For example, in the United States, the 5-year government bond yield averaged 11.4 percent in 1980, 6.2 percent in 2000 and 0.5 percent in 2020. With the return of high inflation in 2021, there has been a reversion though and, in many countries, long-term nominal interest rates have increased by several

percentage points. One important factor behind this increase is higher central bank policy rates. However, opinions differ as to whether policy rates will remain high or whether there will be a return to a low-interest-rate environment; see, for example, Gopinath (2022) and International Monetary Fund (2023a, 2023b). Seeing that the future policy rate is a key determinant for long-term interest rates, this means that there also is uncertainty about where long-term interest rates are heading in the medium-to-long run. In this paper, we analyse this question empirically.

We do this by employing an unobserved components stochastic volatility model to estimate the trend value of the 5-year government bond rate in six countries: Canada, Norway, Sweden, Switzerland, the United Kingdom and the United States. The trend value is the 'local mean' and describes the time-varying level at which the model's forecasts of the 5-year government bond rate will converge. The model—developed by Chan et al. (2018)—has previously been used to estimate trend values of inflation in several countries (Chan et al., 2018; Garcia & Poon, 2022; Österholm & Poon, 2022) and the three-month Treasury bill rate in the United States (Beechey et al., 2023). Here it is for the first time applied to long-term nominal interest rates.

The model is estimated separately for each of the six countries. Estimation relies on data on outcomes for the 5-year government bond rates and survey data on long-run expectations concerning these rates from Consensus Economics' survey *Consensus Forecasts*. Our analysis generates a time series of the trend value in each of the six countries. The last of these values is an estimate of the level at which the 5-year government bond rate is likely to stabilise in the future; it accordingly also provides information regarding to which extent the rise in long-term interest rates that we have observed should be seen as transitory or permanent.

Briefly mentioning our results, we note that the estimated trend rate has decreased substantially between 2000 and 2020 in all six countries. In Norway, Switzerland and the United Kingdom, the trend rate has increased in a non-negligible manner since 2020. In Canada, Sweden and the United States, the trend rate has not been affected much by the increase in the actual 5-year government bond rate. At the end of the sample, none of the countries has a trend rate higher than 3%. The model hence suggests that the 5-year government bond rate will be fairly low in the medium-to-long run.

Regarding our modelling choice, it can be noted that the purpose of the survey data is to improve the estimate of the trend value. The idea is to achieve this by augmenting a model which takes its starting point in a key variable (which here is the 5-year government bond rate) with additional information. Our analysis is hence similar in spirit to the literature where survey expectations are employed in order to improve time series models. For example, survey expectations were used by Kim and Orphanides (2012) in a term structure model for the US Treasury yield curve and by Kozicki and Tinsley (2012) in a model for (the term structure of) US inflation expectations. The fact that our model allows the economy to evolve over time means that our analysis also is related the literature which acknowledges that one should take into account time variation in dynamics and/or the volatility of the disturbances when modelling interest rates; see, for example, Cogley (2005), Carriero et al. (2021) and Fischer et al. (2023) for analysis of US data using vector autoregressions. This is in turn related to a broader literature where models with time variation in dynamics and/or the volatility of the disturbances are used to analyse how interest rates interact with the macroeconomy (e.g. Bianchi et al., 2009; Cogley & Sargent, 2005; Liu et al., 2019; Mumtaz & Surico, 2009; Primiceri, 2005) or to study other macroeconomic questions (e.g. D'Agostino et al., 2013; Guevara & Rodríguez, 2020; Karlsson & Österholm, 2023; Koop & Korobilis, 2019; Stock & Watson, 2007).

The rest of this paper is organised as follows: The model and data are presented in Section 2. We report and discuss the results from our estimations in Section 3. Section 4 concludes.

2 | MODEL AND DATA

We employ the unobserved components stochastic volatility model of Chan et al. (2018) for our empirical analysis and apply it in line with the study of Beechey et al. (2023) on the US three-month Treasury bill rate. The model in given in Equations (1)–(6):

$$i_t - i_t^* = b_t\left(i_{t-1} - i_{t-1}^*\right) + \nu_t,\ \nu_t \sim N\left(0, e^{h_{\nu,t}}\right) \tag{1}$$

$$i_t^* = i_{t-1}^* + \eta_t,\ \eta_t \sim N\left(0, e^{h_{\eta,t}}\right) \tag{2}$$

$$b_t = b_{t-1} + \epsilon_{b,t},\ \epsilon_{b,t} \sim \mathrm{TN}_{(0,1)}\left(0, \sigma_b^2\right) \tag{3}$$

$$z_t = d_{0,t} + d_{1,t} i_t^* + \epsilon_{z,t} + \psi \epsilon_{z,t-1},\ \epsilon_{z,t} \sim N\left(0, \sigma_z^2\right) \tag{4}$$

$$d_{j,t} - \mu_{dj} = \rho_{d_j}\left(d_{j,t-1} - \mu_{dj}\right) + \epsilon_{d_j,t},\ \epsilon_{d_j,t} \sim N\left(0, \sigma_{d_j}^2\right), j = 0, 1 \tag{5}$$

$$h_{k,t} = h_{k,t-1} + \gamma_{h_k,t},\ \gamma_{h_k,t} \sim N\left(0, \sigma_{h_k}^2\right), k = \nu, \eta \tag{6}$$

where ν_t, η_t, $\epsilon_{b,t}$, $\epsilon_{z,t}$, $\epsilon_{d_j,t}$ and $\gamma_{h_k,t}$ are disturbances. We denote the 5-year government bond rate i_t and its trend rate i_t^*. As can be seen from equation (1), the interest-rate gap $(i_t - i_t^*)$ is given by a first-order autoregressive [AR(1)] process; AR(1) processes are commonly used as a simple, yet flexible, modelling choice in macroeconomics in general (e.g. Orphanides & Williams, 2004) and for interest rates in particular (e.g. Hjalmarsson & Österholm, 2017). Equation (2) states that the trend rate is a random walk[1]; having a unit root, the trend rate is accordingly subject to permanent shifts (if the variance of η_t is non-zero). The autoregressive parameter b_t of the interest-rate gap is modelled as a random-walk process where the innovations are truncated in order to ensure that $0 < b_t < 1$; this means that the interest-rate gap has time-varying persistence. Equation (4) relates z_t—that is, the long-run expectation of the 5-year government bond rate—to the trend rate. The coefficients describing this relation—that is, $d_{j,t}$—are time varying around the constant means, μ_{dj}. Finally, $h_{k,t}$—that is, the log volatilities of the interest-rate gap and the trend rate—are random-walk processes. Hence, both the interest-rate gap and the trend rate are subject to heteroskedasticity. This means that the speed with which the trend rate moves can vary over time. Since 'structural change' does not necessarily happen at an even pace, we believe that this is an appealing feature of the model.

We estimate the model using Bayesian methods employing data on 5-year government bond rates for Canada, Norway, Sweden, Switzerland, the United Kingdom and the United States[2]; all six series were sourced from Macrobond. In addition, we use survey data from Consensus Economics' survey *Consensus Forecasts*. These survey data reflect the mean of the six-to-ten years ahead expectations of the respondents in the survey. They should hence provide a fairly good measure of where the respondents think that the 5-year government bond rate will be in the long run.

Due to the availability of the survey data, the samples employed vary somewhat between countries. For Canada, the United Kingdom and the United States, the samples span the period 1990Q2 to 2023Q3. For Sweden, the sample is 1995Q2 to 2023Q3 and for Norway and Switzerland, it is 1998Q4 to 2023Q3.[3] Data are shown in Figure 1.[4]

[1]This assumption is consistent with nominal interest rates being unit-root processes; see, for example, Romero-Ávila (2007).

[2]In line with Beechey et al. (2023), we employ an inverse-gamma prior on the state variances in equations (3) to (6); these are set to $\sigma_z^2 = \sigma_{d_0}^2 = \sigma_{h_\nu}^2 = \sigma_{h_\eta}^2 \sim \mathrm{IG}(5, 0.04)$ and $\sigma_b^2 = \sigma_{d_1}^2 \sim \mathrm{IG}(5, 0.004)$. For further details on priors and estimation, see Chan et al. (2018).

[3]It should be noted that from 1990 to 2013, the survey was conducted two times per year (April and October). In 2014, it was conducted three times (April, July and October) and from 2015 and on, it has been conducted four times per year (January, April, July and October). In order to be able to work on a quarterly frequency, we follow Beechey et al. (2023), Chan et al. (2018) and Österholm and Poon (2022) and replace the missing observations for Q1 and Q3 in the beginning of the sample with values that are arithmetic means of the neighbouring Q2 and Q4 values. This approach has also been employed to address missing values for Norway in 2001Q2, 2011Q2, 2012Q2 and 2016Q3.

[4]Note that we for the survey expectations—due to the proprietary nature of the data—have plotted HP-filtered data rather than the actual series. The filtering was done using a smoothing parameter of 100 in order to make the filtered series follow the actual ones fairly closely. All estimations are based on the actual series.

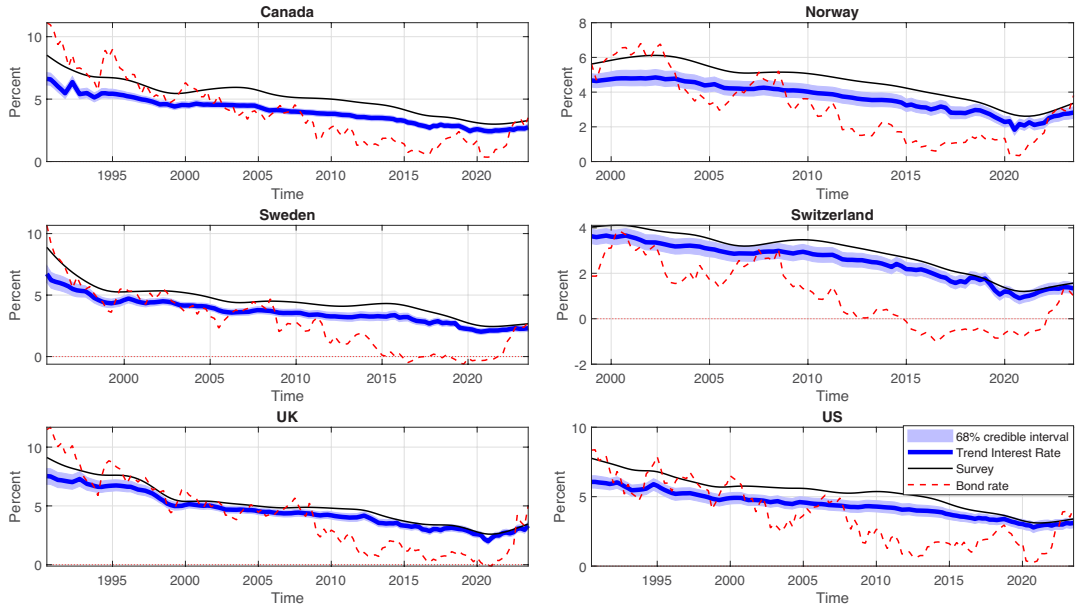

FIGURE 1 Data and estimated trend interest rate. Percent on vertical axis. The black solid line represents the HP-filtered long-run interest-rate expectation (see footnote 4). The red dashed line represents the actual 5-year government bond rate. The blue solid line is the posterior mean of the trend rate and the shaded area is the associated the 68 percent credible interval. *Source*: Consensus Economics, Macrobond and authors' own calculations.

Looking at the data, it is evident that both the actual 5-year government bond rate and the survey expectations have been on a downward trend. The causes behind the downward trend in nominal interest rates internationally are not fully understood. Explanations put forward include lower global growth, increased income inequality, demographic developments, the conduct of monetary policy, deleveraging and shifts in saving and investment preferences; see, for example, Auclert et al. (2021), Caballero et al. (2008), Del Negro et al. (2019), Gourinchas et al. (2016), Marx et al. (2019), Summers (2014), and Teulings and Baldwin (2014).[5] It can also be noted that the interest-rate level in Switzerland is lower in Switzerland than in the other countries.[6]

Turning to the upswing in interest rates at the end of sample, this has been substantial in all six countries. However, differences between the countries are also non-negligible. For example, between 2020Q4 and 2023Q3, the 5-year government bond rate in the United Kingdom increased by approximately five percentage points. In Switzerland, the increase over the corresponding period was only 1.7 percentage points; this is related to the fact that Switzerland—unlike any of the other countries analysed here—experienced a decline in the 5-year government bond rate during the last two quarters of the sample (from 1.3 to 1 percent). The United Kingdom stands out relative to the other countries when it comes to the increase in the survey expectations at the end of the sample; while the other countries have experienced increases in the range of 0.4 to 0.7 percentage points between 2020Q4 and 2023Q3, the increase for the United Kingdom has been 1.7 percentage points.[7]

[5]Several of these explanations are related to the more general suggestion that the natural rate of interest has fallen; see, for example, Benati (2023) and Holston et al. (2017).

[6]Jordan (2022) suggests the following explanation for this: 'Interest rates in Switzerland are generally lower than abroad since the Swiss franc is valued as a safe investment given Switzerland's long-standing political, fiscal and monetary stability'.

[7]These numbers refer to the actual data—not the HP-filtered series.

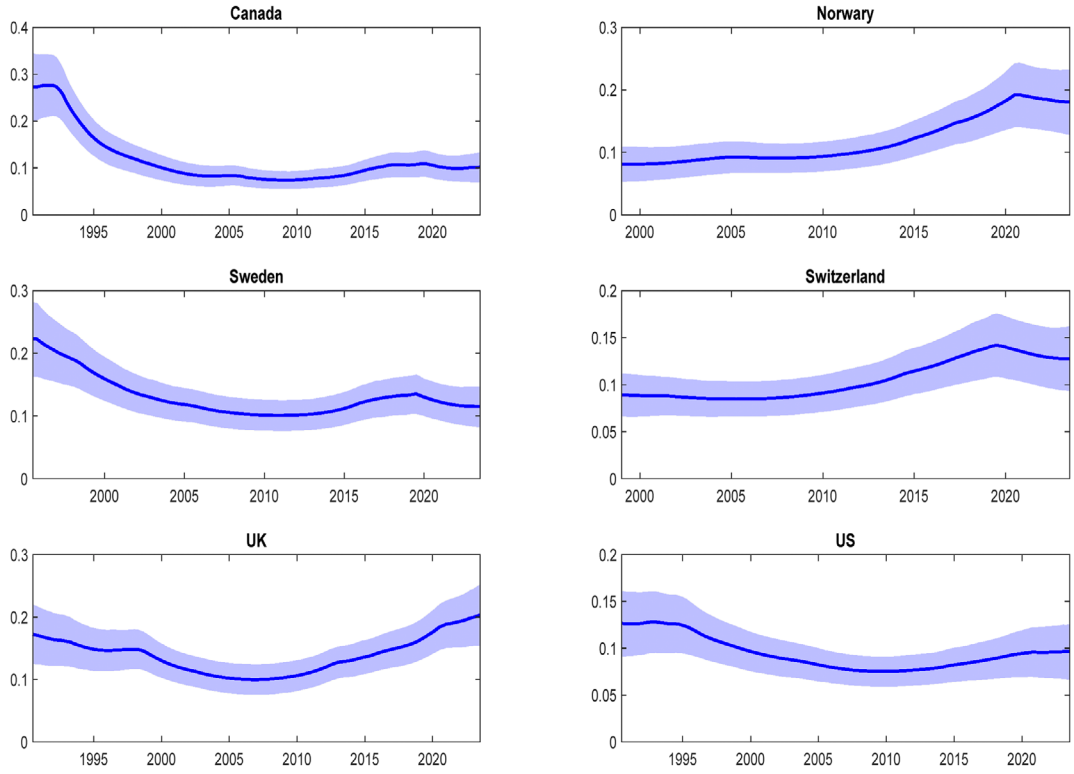

FIGURE 2 Estimated stochastic volatility of the trend interest rate. Percentage points on vertical axis. Stochastic volatility is given as the standard deviation. The shaded area is the associated the 68 percent credible interval. *Source*: Authors' own calculations.

3 | RESULTS

We present the estimated trend rates in Figure 1. In line with the development of the actual 5-year government bond rate and the long-run survey expectations, we find that the estimated trend rate has decreased substantially between 2000 and 2020 in all six countries.[8] Judging by point estimates, the decrease during this period appears to have been in the range of 1.5 to 2.8 percentage points, where Norway, Sweden and Switzerland are at the higher end of that range. As was pointed out above, the interest-rate level in Switzerland is lower than that in the other five countries which means that the trend reached a substantially lower level there; its minimum value was as low as 0.9 percent (in 2020Q4). It is worth noting though that despite the trend rate falling, it was higher than the actual 5-year government bond rate in all six countries between 2009Q1 and 2022Q1—that is, the interest-rate gap was continuously negative for more than a decade.[9]

Regarding the increase in interest rates at the end of sample, we find that this has not affected the trend rate much in Canada, Sweden and the United States. In Norway, Switzerland and the United Kingdom, on the other hand, the trend rate has increased in a non-negligible manner since 2020. This is also reflected in the estimated

[8]For Canada, Sweden, the United Kingdom and the United States, it can be noted that the trend rate was decreasing also between the beginning of the respective sample and 2000.

[9]This is reflected in an estimate of the autoregressive parameter (b_t) for the interest-rate gap which is high. Between 2010 and 2020, it takes on a value of approximately 0.9 in all six countries; see Figure A1 in the Appendix.

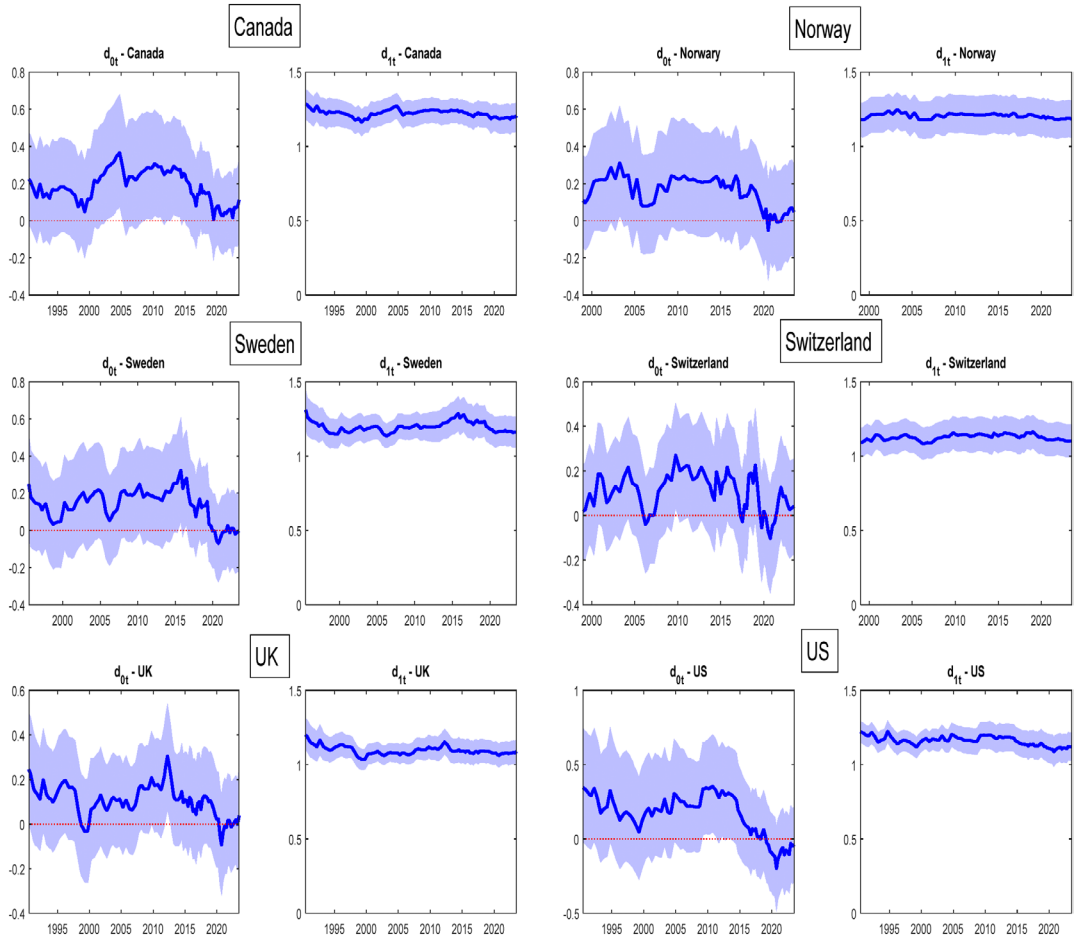

FIGURE 3 Estimates of $d_{0,t}$ and $d_{1,t}$. The blue line is the posterior mean. The shaded area is the associated the 68 percent credible interval.

volatility in the trend rate; in Norway, Switzerland and the United Kingdom, this is at its highest level at the end of the samples (see Figure 2).

However, even if the trend rate has increased non-negligibly in three countries, it is nevertheless the case that it in all six economies is fairly low at the end of the sample. No country has a trend rate in excess of 3%; in Switzerland it is as low as 1.3 percent. It accordingly seems that the model suggests that interest rates will be at a modest level in the medium-to-long run. This implies, for example, a substantial reduction in the 5-year government bond rates in the United Kingdom and the United States relative to the current levels, by approximately two and one percentage points, respectively.

As a final observation concerning our results, we note that Figure 1 shows that the estimated trend rate consistently is below the survey expectation in all six countries. This is also illustrated in Figure 3 which shows the estimates of the parameters $d_{0,t}$ and $d_{1,t}$. As can be seen, $d_{1,t}$ is larger than unity (and the point estimate of $d_{0,t}$ typically larger than zero). Using the terminology of Chan et al. (2018), this indicates that the survey expectation is a 'biased' measure of the trend rate.[10] This finding—which implies that the survey expectation should

[10]A value of zero for $d_{0,t}$ and unity for $d_{1,t}$ would imply unbiasedness.

not be treated as a direct measure of the trend rate—is in line with the results for most countries in Chan et al. (2018) for trend inflation.

4 | CONCLUDING REMARKS

After a long period associated with a downward drift in long-term nominal interest rates, there has recently been a substantial increase in such rates in many countries. The future development is disputed though. In this paper we have provided empirical analysis related to this issue—the results of which should be relevant input to the debate.

Our results indicate that there has been a substantial decrease in the trend 5-year government bond rate between 2000 and 2020 in all six countries analysed. At the end of the sample, no country has a trend rate higher than 3%; in Switzerland it is as low as 1.3 percent. This implies that the 5-year government bond rate will be fairly low in the medium-to-long run. Given that term premia presently generally are judged to be low (or in some cases even negative)[11]—and accordingly unlikely to substantially decline further—our findings also suggest that policy rates are likely to be lowered over the coming years.

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REFERENCES

Auclert, A., Malmberg, H., Martinet, F. & Rognlie, M. (2021) *Demographics, wealth, and global imbalances in the twenty-first century*. NBER Working Paper No. 29161.

Beechey, M., Österholm, P. & Poon, A. (2023) Estimating the trend interest rate in the United States. *Finance Research Letters*, 55, 103913.

Benati, L. (2023) A new approach to estimating the natural rate of interest. *Journal of Money, Credit and Banking*. https://onlinelibrary.wiley.com/doi/10.1111/jmcb.13013

Bianchi, F., Mumtaz, H. & Surico, P. (2009) The great moderation of the term structure of UK interest rates. *Journal of Monetary Economics*, 56, 856–871.

Caballero, R.J., Farhi, E. & Gourinchas, P.-O. (2008) An equilibrium model of 'global imbalances' and low interest rates. *American Economic Review*, 98, 358–393.

Carriero, A., Clark, T.E. & Marcellino, M. (2021) No-arbitrage priors, drifting volatilities, and the term structure of interest rates. *Journal of Applied Econometrics*, 36, 495–516.

Chan, J.C.C., Clark, T.E. & Koop, G. (2018) A new model of inflation, trend inflation, and long-run inflation expectations. *Journal of Money, Credit and Banking*, 50, 5–53.

Cogley, T. (2005) Changing beliefs and the term structure of interest rates: cross-equation restrictions with drifting parameters. *Review of Economic Dynamics*, 8, 420–451.

Cogley, T. & Sargent, T.J. (2005) Drifts and volatilities: monetary policies and outcomes in the post WWII US. *Review of Economic Dynamics*, 8, 262–302.

D'Agostino, A., Gambetti, L. & Giannone, D. (2013) Macroeconomic forecasting and structural change. *Journal of Applied Econometrics*, 28, 82–101.

Del Negro, M., Giannone, D., Giannoni, M.P. & Tambalotti, A. (2019) Global trends in interest rates. *Journal of International Economics*, 118, 248–262.

[11]See, for example, estimates for the United States from the Kim and Wright (2005) model (available at https://fred.stlouisfed.org/series/THREEFYTP5).

Fischer, M.M., Hauzenberger, N., Huber, F. & Pfarrhofer, M. (2023) General Bayesian time-varying parameter vector autoregressions for modeling government bond yields. *Journal of Applied Econometrics*, 38, 69–87.
Garcia, J.A. & Poon, A. (2022) Inflation trends in Asia: implications for central banks. *Oxford Economic Papers*, 74, 671–700.
Gopinath, G. (2022) *How will the pandemic and war shape future monetary policy?* Presentation at the Jackson Hole Economic Symposium, August 26.
Gourinchas, P.-O., Portes, R. & Rabanal, P. (2016) Secular stagnation, growth, and real interest rates. *IMF Economic Review*, 64, 575–580.
Guevara, C. & Rodríguez, G. (2020) The role of credit supply shocks in Pacific Alliance countries: a TVP-VAR-SV approach. *North American Journal of Economics and Finance*, 52, 101140.
Hjalmarsson, E. & Österholm, P. (2017) Households' mortgage-rate expectations – more realistic than at first glance? *Sveriges Riksbank Economic Review*, 2, 57–64.
Holston, K., Laubach, T. & Williams, J.C. (2017) Measuring the natural rate of interest: international trends and determinants. *Journal of International Economics*, 108, 59–75.
International Monetary Fund. (2023a) *World Economic Outlook Update*, January.
International Monetary Fund. (2023b) *World Economic Outlook*, April.
Jordan, T.J. (2022) *Monetary policy under new constraints: challenges for the Swiss National Bank*. Presentation at the Jackson Hole Economic Symposium, August 27.
Karlsson, S. & Österholm, P. (2023) Is the US Phillips curve stable? Evidence from Bayesian vector autoregressions. *Scandinavian Journal of Economics*, 125, 287–314.
Kim, D. & Orphanides, A. (2012) Term structure estimation with survey data on interest rate forecasts. *Journal of Financial and Quantitative Analysis*, 47, 241–272.
Kim, D. & Wright, J.H. (2005) *An arbitrage-free three-factor term structure model and the recent behavior of long-term yields and distant-horizon forward rates*. Finance and Economic Discussion Series, No. 2005–33, Board of Governors of the Federal Reserve System.
Koop, G. & Korobilis, D. (2019) Forecasting with high-dimensional panel VARs. *Oxford Bulletin of Economics and Statistics*, 81, 937–959.
Kozicki, S. & Tinsley, P. (2012) Effective use of survey information in estimating the evolution of expected inflation. *Journal of Money, Credit and Banking*, 44, 145–169.
Liu, P., Theodoridis, K., Mumtaz, H. & Zanetti, F. (2019) Changing macroeconomic dynamics at the zero lower bound. *Journal of Business and Economic Statistics*, 37, 391–404.
Marx, M., Mojon, B. & Velde, F. (2019) Why have interest rates fallen far below the return on capital? *Journal of Monetary Economics*, 124, S57–S76.
Mumtaz, H. & Surico, P. (2009) Time-varying yield curve dynamics and monetary policy. *Journal of Applied Econometrics*, 24, 895–913.
Orphanides, A. & Williams, J. (2004) Imperfect knowledge, inflation expectations, and monetary policy. In: Bernanke, B.S. & Woodford, M. (Eds.) *The inflation-targeting debate*. Chicago: University of Chicago Press.
Österholm, P. & Poon, A. (2022) Trend inflation in Sweden. *International Journal of Finance and Economics*, 28, 4707–4716.
Primiceri, G. (2005) Time varying structural vector autoregressions and monetary policy. *Review of Economic Studies*, 72, 821–852.
Romero-Ávila, D. (2007) Unit roots and persistence in the nominal interest rate: a confirmatory analysis applied to the OECD. *Canadian Journal of Economics*, 40, 980–1007.
Stock, J.H. & Watson, M.W. (2007) Why has U.S. inflation become harder to forecast? *Journal of Money, Credit and Banking*, 39, 3–33.
Summers, L.H. (2014) U.S. economic prospects: secular stagnation, hysteresis, and the zero lower bound. *Business Economics*, 49, 65–73.
Teulings, C. & Baldwin, R. (Eds.). (2014) *Secular stagnation: facts, causes, and cures*. London: CEPR Press.

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APPENDIX

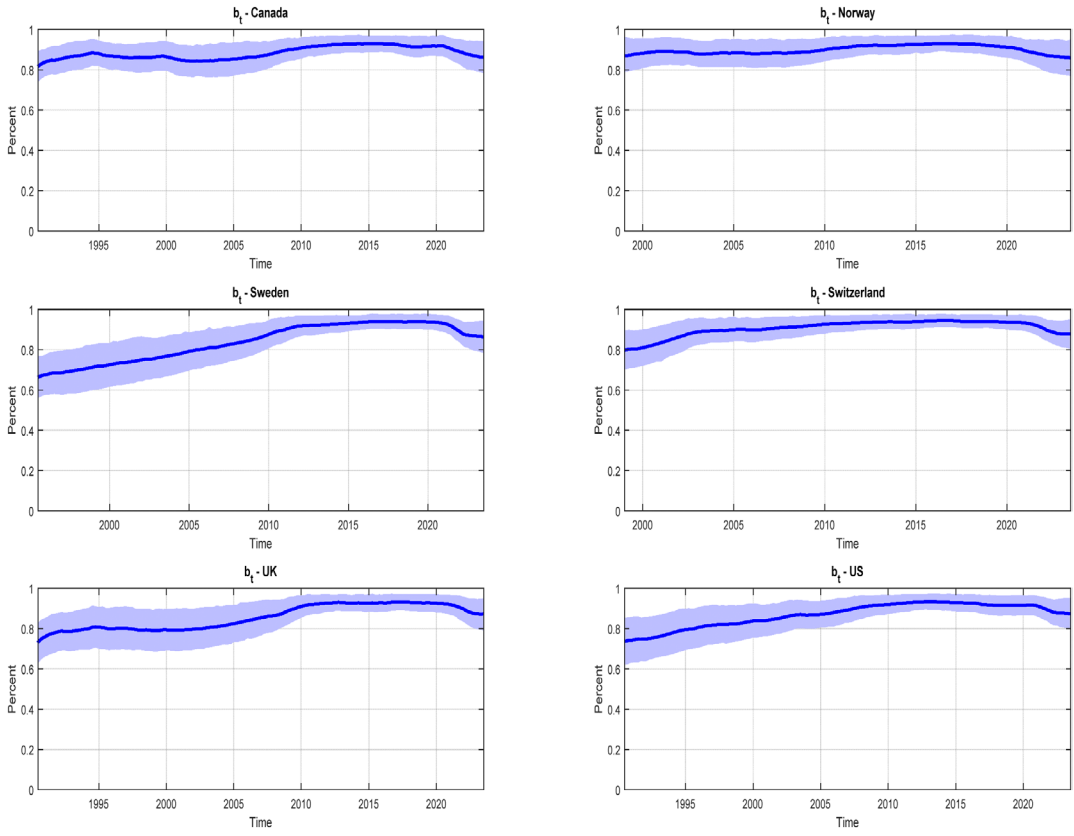

FIGURE A1 Estimated persistence of interest-rate gap. The solid blue line is the posterior mean of the estimated persistence of the interest-rate gap. The shaded area is the associated the 68 percent credible interval. *Source*: Authors' own calculations.