Global shocks, economic fluctuations and timeliness of monetary policy.*

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Abstract

Do central banks respond timely to developments in the global economy? To examine this hypothesis, we construct a real-time data set of interest rate projections from the central banks in New Zealand, Norway, and Sweden, and analyze if revisions to the interest rate path can be predicted by timely information. Our results suggest a systematic role for forward looking international indicators in predicting the revisions to the interest rate projections. In contrast, using similar indexes for the domestic economy yields insignificant results. The results suggest more efficient use of information by the central banks can be welfare improving. In line with this, we show that a more timely monetary policy response to international shocks can dampen the fluctuations in domestic output and inflation.

JEL-codes: C11, C53, C55, F17

Keywords: Monetary policy, interest rate path, forecast revisions and global indicators

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1 Introduction

Much applied research has shown that international developments play a large role in explaining business cycles and inflation in small and open economies. At the same time, the structural, small open-economy model used by many central banks to analyse and predict macroeconomic outcomes cannot account for the substantial influence of foreign-sourced disturbances identified in the numerous reduced-form studies. Accordingly, model-implied cross-correlation functions between the small open economies and global economies are small, while data suggests it to be positive and large.

In this paper we hypothesise that this discrepancy matters for how monetary policy is conducted, and ultimately in how central banks make revisions to their predicted interest rate paths. Furthermore, if monetary policy systematically respond with a lag to new development in the global economy, it will also matter for how global shocks eventually affect the small and open economy.

To examine this hypothesis, we construct a real-time data set of interest rate projections from the central banks in New Zealand (Reserve Bank of New Zealand), Norway (Norges Bank), and Sweden (Sveriges Riksbank), and run a number of predictive regressions using different information sets including both international and domestic indicators. We focus on these three countries as they are small and open, and because they were the three first countries adopting the practice of communicating their policy intentions explicitly by publishing their own forecasts of future interest rates.[1] We examine two features in particular: (i) whether international versus domestic indicators can predict the forecast revisions in the central bank's policy rate?, and (ii) whether fundamental variables versus forward looking variables matter? A key feature of our analysis is that we use real-time data, or data that is not revised. Hence, when running the predictive regression we only include information which was available to the central bank's when they made their first release of the interest rate projections, i.e., timely information.

And indeed, running a battery of predictive regressions with domestic and foreign real-time indicators we find that there is a systematic role for forward looking international indicators in predicting the revisions to the policy rate. In contrast, using similar indexes for the domestic economy yields insignificant results.

[1] The Reserve Bank of New Zealand was the first country to adopt the practice in 1997, followed by Norges Bank in 2005, and the Sveriges Riksbank in 2007. Since then, several other central banks have followed, including the Central Bank of Iceland in 2007, the Czech National Bank in 2008 and most recently, the Federal Reserve Bank in 2012.

The interest rate path published by the central bank is a forecast and not a promise. It is the best assessment the central bank can make at a given point in time, given the information that is then available. New information may change the picture of the economy and then the central bank will have to rethink how to set the key interest rate or revise their forecasts. However, if forecast revisions are predictable using timely information it means that the central bank values this information when making it's interest rate decisions, but does not incorporate it efficiently. This might have important welfare implications. After all, one of the main motivations for central banks to publish their interest rate projections is to guide the public's expectations about the future prospects of the economy in general and the interest rate in particular, and through this communication ensure a more stable economic development. If unexpected international shocks cause a surge in output and creates inflation pressure, but the central banks respond by too little or too late, a more efficient use of information by the central banks can be welfare improving.

To explore this, we next analyse the transmission of international shocks to the domestic economy by estimating structural vector autoregressive (SVAR) models for the three small open economies. Doing so, we find there is an instant and substantial surge in output and subsequently in inflation, following the international shocks. Hence, we confirm what others have found before us, foreign shocks matter for the business cycles in small open economies. We then ask, could a more timely response by the central banks have avoided these large fluctuations in output and inflation? Our results suggest that a more timely monetary policy response to foreign shocks would dampen output, and, in particular inflation, in the medium to long run, and hence be welfare improving.

Our analysis is motivated by the large and growing empirical literature showing how economic fluctuations are closely connected across borders, see, e.g., Backus et al. (1995), Kose et al. (2003), and Baxter and Kouparitsas (2005) on international business cycle synchronization, Mumtaz and Surico (2008), Monacelli and Sala (2009) and Ciccarelli and Mojon (2010) on the co-movement of inflation rates, and Canova and Marrinan (1998), Stock and Watson (2005), Eickmeier (2007), Moneta and Rüffer (2009), Mumtaz et al. (2011), Aastveit et al. (2015) and Thorsrud (2013) on regional and international transmissions of shocks. As a contrast to this substantial amount of evidence stands the predictions from theoretical business cycle models, i.e., Dynamic Stochastic General Eqilibrium (DSGE) models, where international developments play only a minor role, see, e.g., Justiniano and Preston (2010).[2] As DSGE models are the workhorse model

[2]Recent advances in this literature have tried to bridge the gap between the empirical findings and theory,

for analysing business cycles in most inflation targeting central banks, it is reasonable to assume that the large discrepancies between evidence and theory also effects policy outcomes.

The remainder of the paper is structured as follows. In Section 2 we describe how we construct the real time data set of interest rate projections, the revisions to these, and the domestic and international indicators. In Section 3 we report the predictive results and in Section 4 we discuss how these might relate to the transmission of shocks to the domestic economy more broadly using SVAR models. Section 5 concludes.

2 Interest rate projections and forecast revisions

In the following we describe the data and explain how we construct the time series of interest rate projections and forecast revisions in the three countries. In the end we present the domestic and global indicator set.

2.1 Interest rate projections

We collect interest rate projections from the Reserve Bank of New Zealand (RBNZ), Norges Bank (NB) and Sveriges Riksbank (SR) historical publication records. Details are provided in Table 6 - 8 in Appendix A for RBNZ, NB and SR respectively. Starting in March 1997, RBNZ was the first central bank to publish their interest rate forecast path. The projections are published four times a year (March, June, September, and December) in its quarterly Monetary Policy Statement.[3] NB started to publish projections for the policy rate (the folio rate) path in 2005. Up until 2012, the forecast were published three times a year in the monetary policy reports, (March, June and October/November). Since the last quarter of 2012, the projections have been published four times a year, (March, June, September and December). SR started publishing its interest rate path for the policy rate (the repo rate) in February 2007. The forecasts are published in the Monetary Policy Report and the Monetary Policy Update which normally are published six times a years, (February, April, July, September, October and December).

Figures 1 - 3 illustrate how the interest rate predictions have evolved in RBNZ, NB and RB respectively. For each forecast vintage we plot the whole predicted policy rate path. We also report, the dotted black line, the actual outcomes. As can be clearly seen

see, e.g., Bergholt and Sveen (2013) among others.

[3] Although we have data available back to 1997 for New Zealand, we choose to start the analysis in March 1999 which is the date the RBNZ adopted the Official Cash Rate (OCR).

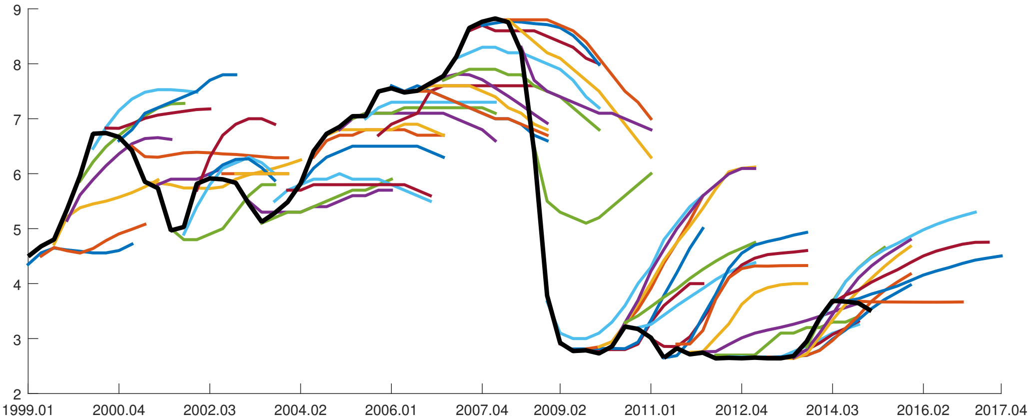

Figure 1. Reserve Bank of New Zealand policy rate; predictions and actual (solid black)

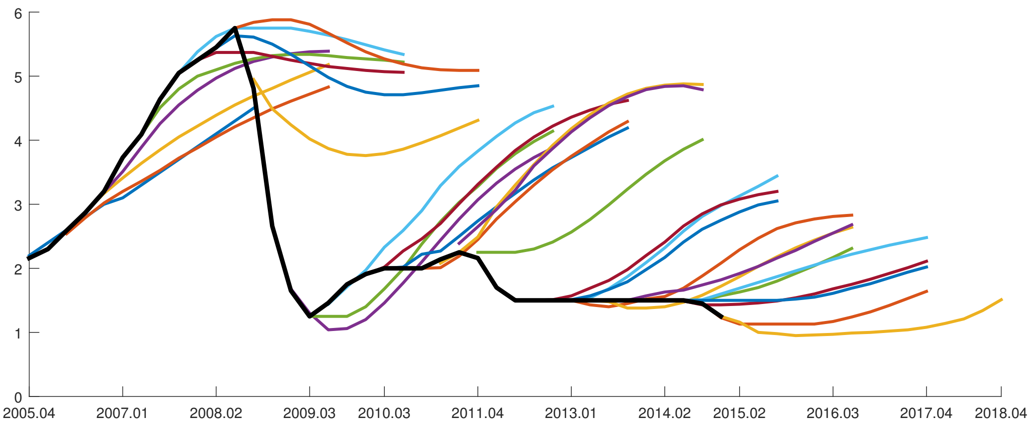

Figure 2. Norges Bank policy rate; predictions and actual (solid black)

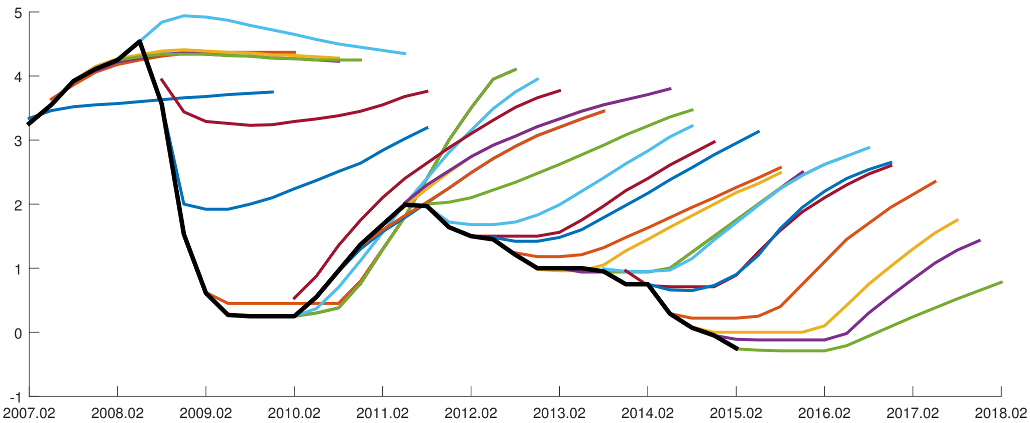

Figure 3. Sveriges Riksbank policy rate; predictions and actual (solid black)

from the figures, there have at times been large revisions to the interest rate projections from one vintage to the next. We also observe that the projections are often very far off compared to the actual outcomes in all countries. The latter is maybe not that surprising given the large macro economic shocks that have happened during this sample.

2.2 Forecast revisions

To construct a time series for the revisions of the projected interest rate paths (forecast revisions for short) we do the following steps: First, let $f_{2t+1|I_{t-1}}$ be the two-steps ahead forecast of the policy rate given information at time $t-1$, and let $f_{1t+1|I_t}$ be the one-step ahead (counterpart) forecast made one quarter later and given information up to time t, i.e., the most recent forecast of the policy rate at quarter $t+1$.[4] The forecast revisions between these two series (the one-step ahead and the two-steps ahead forecast series) can then be found as: $r_{12,t+1} \equiv f_{1t+1|I_t} - f_{2t+1|I_{t-1}}$. Similarly, revisions between the two-steps ahead and the three-steps ahead counterpart forecast series, conditioning on time $t-1$ and $t-2$ respectively, can be found as $r_{23,t+1} \equiv f_{2t+1|I_{t-1}} - f_{3t+1|I_{t-2}}$ or more generally, $r_{ij,t+1} \equiv f_{it+1|I_{t+1-i}} - f_{jt+1|I_{t+1-j}}$ where $j = i-1$. In the analysis below, we will focus on the most recent forecast revisions; i.e., between one-step ahead and two-steps ahead, $r_{12,t+1}$, while also discuss revisions between earlier time periods when relevant.

2.3 Global and domestic indicators

Our set of explanatory variables consists of various global and domestics indicators, see Table 9 in Appendix B for details. Key to the analysis is the fact that we use real-time data, or data that is not revised. Hence, when running the predictive regression we only include information which was available to the central bank's when they made their first release of the interest rate projections, i.e., timely information.

To capture the fundamental part of Central banks's information set at the time they made the forecast, we include consumer prices, import prices, industrial production, exchange rates, etc. We also include a set of forward looking variables that are available to the central banks, such as the term structure spread (an indicator of the future stance of monetary policy), the stock return index (reflecting the general sentiment of investors) and a consumer confidence indicator (CCI) which is a proxy of consumer expectation about future economic conditions.[5] For all of these variables, we include both the domestic and the foreign counterparts, where the latter group consists of one common global country (the US) and one or two regional trading partners; for New Zealand the region is

[4] Here for simplicity we assume that all central banks produce these forecasts at regular interval four times year; however, in practice, the frequency of publications varies among the central banks as explained in details in Appendix A.

[5] Variables such as Gross Domestic product (GDP), investment, consumption, as well as leading indicators such as the OECD's Composite Leading Indicator (CLI), are all excluded because some of the subcomponents, and then the series themselves, are revised.

Australia; for Norway the country/regions are Sweden and the Euro; and for Sweden the country/regions are Norway and the Euro. In addition, we also include some common global indexes, such as oil prices, a volatility index and the terms of trade for each country.

3 Predicting Forecast Revisions

Having constructed time series of the forecast revisions of the policy rate, we first analyse if we can predict these revisions using timely data. To do so we examine if there is persistence in the interest rate forecast revisions. Evidence of significant autoregression implies that the central bank makes systematic errors in forecasting the interest rate, say because they systematically disregard an important information set. Equation 1 describes the autoregressive model of forecast revision series.

$$r_{ij,t+1} = \alpha_{ij} + \sum_{\tau=0}^{k} \gamma_\tau r_{ij,t-\tau} + \varepsilon_{ij,t+1}. \tag{1}$$

The number of lags used in the equation are determined based on the Bayesian information criterion (BIC) in model selections. Only the first lag, however, turns out to be significant and is therefore reported.

Table 1 reports the results of the most recent forecast revisions (that is between the two-steps ahead forecast and the one-step ahead counterpart forecast made in the following quarter); $r_{12,t+1}$, as well as for the second most recent revisions $r_{23,t+1}$ and the third most recent revisions $r_{34,t+1}$. The results reveal that there is statistically significant evidence of autocorrelation in all series. That is, for all countries, time series of the revisions to the forecast of a policy rate are all significantly autocorrelated. Hence, there is persistence in the interest rate forecast revisions.

Having established that the interest rate forecast revisions are autocorrelated, the interesting question is then, can we predict these revisions using different information sets? In the second step we therefore test if various domestic and global indicators have predictive power for the interest rate forecast revisions by fitting Autoregressive Distributed Lag (ADL) models. Our goal is to inspect whether the central banks efficiently use all available information when making its forecast. If this is true we should not expect to find any significant relationship between our candidate indicators and the forecast revisions. If, on the other hand a central bank gradually incorporates this initial information by systematically adjusting the forecast as time goes by, we would expect to see a statistically significant relationship between certain indicators and the forecast revisions. Equation 2

Table 1. Autoregressive Model of Forecast Revisions

$$r_{ij,t+1} = \alpha_{ij} + \sum_{\tau=0}^{k} \gamma_\tau r_{ij,\tau} + \varepsilon_{ij,t+1}$$

	γ_0	α_{ij}	R^2	$\bar{R}^2$	N
New Zealand					
$r_{12,t+1}$	0.329**	-0.054	0.10	0.09	65
	(0.120)	(0.043)			
$r_{23,t+1}$	0.401***	-.071	0.16	0.14	64
	(0.117)	(0.059)			
$r_{34,t+1}$	0.389***	-0.061	0.15	0.13	63
	(0.120)	(0.068)			
Norway					
$r_{12,t+1}$	0.182**	-0.05	0.12	0.10	37
	(0.840)	(0.049)			
$r_{23,t+1}$	0.218***	-0.01	0.20	0.17	36
	(0.076)	(0.053)			
$r_{34,t+1}$	0.295***	-0.041	0.23	0.20	35
	(0.096)	(0.078)			
Sweden					
$r_{12,t+1}$	0.503***	-0.085	0.25	0.23	32
	(0.157)	(0.067)			
$r_{23,t+1}$	0.382**	-0.132	0.15	0.12	31
	(0.170)	(0.170)			
$r_{34,t+1}$	0.345**	-0.157	0.12	0.09	30
	(0.174)	(0.100)			

Notes: $\bar{R}^2$ is the R-squared adjusted for the number of observations (N) and the number of parameters fit by the regression. *, **, and, ***, indicate that coefficients are statistically significant at 10%, 5%, 1% level respectively. The numbers in parentheses are standard deviations

presents the general formulation of our ADL model (with only one lag being significant):

$$r_{ij,t+1} = \alpha_{ij} + \gamma_0 r_{ij,t} + \beta_n I_{n,t-1} + \varepsilon_{ij,t+1}. \tag{2}$$

where I_n stands for different indicators, observed in time $t-1$. Key to the analysis is the fact that we use real-time data, or data that is not revised. Hence, when running the predictive regression we only include information which was available to the central bank's when they made their first release of the interest rate projections, i.e., timely information. As described in Section 2.3 above, our indicator set includes real, nominal and financial variables as well as consumer sentiment variables. Tables 2 - 4 present

Table 2. New Zealand: Predictive regression for forecast revisions two- and one-step ahead

$$r_{12,t+1} = \alpha_{12} + \gamma_0 r_{12,t} + \beta_n I_{n,t-1} + \varepsilon_{12,t+1}$$

	γ_0	β_n	$\bar{R}^2$
Consumer Confidence Index			
New Zealand	0.247**	0.011***	0.16
Australia	0.133	0.018***	0.21
U.S.	0.292***	0.003	0.10
Stock Price Index			
New Zealand	0.191	0.02***	0.15
Australia	0.182	0.013*	0.12
U.S.	0.274*	0.004	0.08
Yield Curve Spread			
New Zealand	0.325***	0.022	0.08
Australia	0.288***	0.083*	0.12
U.S.	0.329***	-0.000	0.07
Industrial Production			
New Zealand	0.359***	-0.008	0.09
Australia	0.334***	-0.030*	0.12
U.S.	0.317***	0.003	0.08
Consumer Price Index			
New Zealand	0.334***	-0.278***	0.23
Australia	0.341***	-0.151**	0.13
U.S.	0.482***	-0.196***	0.21
Interest Rate			
Australia	0.290***	-0.075**	0.14
U.S.	0.331***	-0.003	0.07
Exchange Rate			
TWI	0.309**	0.004	0.08
AUD/NZD	0.337***	-0.011	0.08
USD/NZD	0.294**	-0.005	0.08
International indexes			
Terms of trade	0.326***	0.00	0.08
Global volatility index	0.345***	0.001	0.08
Import Price Index	0.279***	-0.031***	0.18
Crude Oil Price	0.361***	-0.003*	0.12

Notes: All variables are first differenced, quarter on quarter (QoQ) changes, except the consumer confidence index, the yield curve spread and the interest rate, that are measured in levels, while industrial production is measured as year on year (YoY) changes.

the summary results of our regressions for the first forecast revision series $r_{12,t+1}$ for New Zealand, Norway and Sweden, respectively. For brevity, the results for the second forecast revision series i.e. $r_{23,t+1}$, are reported in Appendix C.

Table 3. Norway: Predictive regression for forecast revisions two- and one-step ahead

$$r_{12,t+1} = \alpha_{12} + \gamma_0 r_{12,t} + \beta_n I_{n,t-1} + \varepsilon_{12,t+1}$$

	γ_0	β_n	$\bar{R}^2$
Consumer Confidence Index			
Norway	0.058	0.015***	0.21
Sweden	0.082	0.033***	0.36
Euro Zone	0.040	0.044***	0.25
U.S.	0.176**	0.016***	0.21
Stock Price Index			
Norway	0.104	0.004	0.08
Sweden	0.047	0.014**	0.19
Euro Zone	0.65	0.012**	0.17
U.S.	0.063	0.012	0.13
Yield Curve Spread			
Norway	0.081	0.142***	0.22
Sweden	0.084	0.141***	0.23
Euro Zone	0.186**	0.026	0.07
U.S.	0.187**	-0.019	0.07
Industrial Production			
Norway	0.176**	-0.003	0.07
Sweden	0.208***	-0.008	0.12
Euro Zone	0.210***	-0.009	0.10
U.S.	0.131***	0.033	0.13
Consumer Price Index			
Norway	0.193**	0.094	0.11
Sweden	0.220***	-0.153**	0.17
Euro	n.a	n.a.	n.a.
U.S.	0.306***	-0.114	0.13
Interest Rate			
Sweden	0.187**	-0.014	0.07
Euro Zone	0.181**	-0.016	0.07
U.S.	0.171**	0.017	0.08
Exchange Rate			
TWI	0.227**	0.015	0.08
EU/NOK	0.221**	0.012	0.07
USD/NOK	0.155	-0.003	0.07
International indexes			
Terms of trade	0.135	0.015	0.09
Volatility index	0.192**	0.000	0.07
Import Price Index	0.473***	-0.081**	0.19
Crude Oil Price	0.570***	-0.005	0.14

Notes: See notes to Table 2

Table 4. Sweden: Predictive regression for forecast revisions two- and one-step ahead

$$r_{12,t+1} = \alpha_{12} + \gamma_0 r_{12,t} + \beta_n I_{n,t-1} + \varepsilon_{12,t+1}$$

	γ_0	β_n	$\bar{R}^2$
Consumer Confidence Index			
Sweden	0.439***	0.018	0.27
Norway	0.421***	0.019***	0.41
Euro zone	0.344**	0.035*	0.29
U.S.	0.506***	0.003	0.26
Stock Price Index			
Sweden	0.294*	0.016**	0.32
Norway	0.228	0.013**	0.32
Euro zone	0.325*	0.013*	0.28
U.S.	0.217	0.018*	0.30
Yield Curve Spread			
Sweden	0.386***	0.149***	0.35
Norway	0.312**	0.188***	0.44
Euro zone	0.510***	0.127**	0.30
U.S.	0.471***	0.056	0.22
Industrial Production			
Sweden	0.585***	-0.008	0.23
Norway	0.489***	-0.017	0.25
Euro zone	0.576***	-0.009	0.22
U.S.	0.503***	-0.000	0.20
Interest Rate			
Norway	0.378***	-0.105***	0.38
Euro zone	0.459***	-0.086**	0.32
U.S.	0.516***	-0.025	0.21
Consumer Price Index			
Sweden	0.658***	-0.229***	0.33
Norway	0.503***	-0.007	0.20
U.S.	0.604***	-0.077	0.22
Exchange Rate			
TWI	0.301	-0.041	0.26
EU/SEK	0.387**	-0.026	0.23
USD/SEK	0.261	-0.027**	0.31
International indexes			
Terms of Trade	0.335*	-0.062*	0.28
Volatility Index	0.485***	-0.005	0.26
Import Price Index	0.500***	0.003	0.20
Crude Oil Price	0.646***	-0.004	0.25

Notes: See notes to Table 2

The results suggest a systematic role for international forward looking variables in predicting the revisions to the projected policy rate path. That is, for New Zealand, Norway and Sweden, variables such as the international consumer confidence index, stock returns and the yield curve spreads are by and large significant in the predictive regressions. Furthermore, the autocorrelation coefficient is generally no longer significant when these variables are included in each of the regressions, suggesting the systematic pattern in the revisions of the policy rate is captured well by these indicators. R^2 also increases substantially relatively to the pure autoregressive specification when these variables are included. Generally, the foreign regional country (or group of countries) is more important than the U.S in predicting the interest rate forecast revisions. Regarding the domestic forward looking variables, while some of these indicators are also significant in the predictive regression, they generally have a lower R^2 than their foreign counterpart. We discuss the role of domestic versus foreign forward looking indicators in more detail below.

Turning now to the fundamental variables typically included in a central banks policy rules, i.e., foreign and domestic inflation, industrial production, exchange rates and the foreign interest rates, we find very few of these to be significant in the predictive regressions.[6] What's more, none of these variables can account for the autoregressive pattern in the interest rate forecast revisions, which remains significant in all regressions. Consistent with this, R^2 is also generally small in these cases.[7] Similar results are also found for the global indexes such as terms of trade, oil prices and the international volatility index.

Hence, the forward looking variables stand out by capturing well the persistence in the interest rate forecasts revisions. However, as seen above, for some of these variables, both the domestic and foreign counterparts were significant in the predictive regressions. This should come as no surprise. Typically, there is a common component in the foreign and the domestic counterpart of such forward looking series, implying that they move in the same direction over the sample. This could, for instance, be due to financial integration. In particular, as agents can diversify their risk by investing in different markets, financial prices will become more synchronized through arbitrage (see e.g. Kose et al. (2003), Kose et al. (2008) and Eickmeier (2007) for discussions). Thus, we evaluate if there is independent information in the domestic variables once we have accounted for the foreign indicator, i.e., we orthogonalize the domestic and foreign forward looking variables by regressing the domestic indicator on the counterpart foreign indicator. The stored residual is then the unexplained domestic counterpart, orthogonal to the foreign indicator, see equation 3,

$$I_{n,t}^{dom} = \mu_{0,n} + \mu_{1,n} I_{n,t}^{for} + \eta_{n,t}^{dom}. \tag{3}$$

where $I_{n,t}^{dom}$ and $I_{n,t}^{for}$ are domestic and foreign indicators respectively, and $\eta_{n,t}^{dom}$ is the

[6]Results are robust for other transformations of industrial production, such as the using output gap where industrial production is detrended using the Hordrick-Prescott filter.

[7]An exception is the USD/SEK exchange rate in Sweden, which is significant in the predictive regressions and can account for the autoregressive pattern.

Table 5. Foreign forward looking indicator along with residual of domestic counterpart

$$r_{12,t+1} = \alpha_{12} + \gamma_0 r_{12,t} + \beta_n I^{for}_{n,t-1} + \delta_n \eta^{dom}_{I_{n,t-1}} + \varepsilon_{t+1}$$

		γ_0	β_n	δ_n	$\bar{R}^2$
A: New Zealand	**Consumer Confidence Index**				
	Australia	0.134	0.018***	0.005	0.21
	Stock Price Index				
	Australia	0.219	0.012	0.027*	0.15
	Yield Curve Spread				
	Australia	0.270**	0.085*	-0.054	0.12
B: Norway	**Consumer Confidence Index**				
	Sweden	0.059	0.034***	0.004	0.35
	Euro Zone	-0.015	0.048***	0.010*	0.29
	Stock Price Index				
	Sweden	0.513*	0.022*	-0.042	0.27
	Euro Zone	0.308	0.015	-0.005	0.13
	Yield Curve Spread				
	Sweden	0.071	0.151***	0.072	0.22
	Euro Zone	n.a.	n.a.	n.a.	n.a.
C: Sweden	**Consumer Confidence Index**				
	Norway	0.431***	0.019***	-0.005	0.39
	Euro Zone	0.397***	0.021***	-0.012	0.40
	Stock Price Index				
	Norway	0.242	0.013**	0.008	0.30
	Euro Zone	0.290	0.015**	0.15	0.29
	Yield Curve Spread				
	Norway	0.311**	0.195***	-0.022	0.42
	Euro Zone	0.408***	0.103	0.124	0.33

domestic residual. We now redo the predictive regressions, using $\eta^{dom}_{n,t}$ along with the related foreign indicator (using either the relevant regional country (or group of countries), see Table 5 for results.

The results show that, with the exception of the stock price in New Zealand, there is little independent role for the domestic residual variables in accounting for the autoregressive pattern in the interest rate forecast revisions once we have accounted for the counterpart information in the foreign indicator. Hence, foreign forward looking variables have predictive power for the revisions of the published interest rate paths.

4 Global shocks and domestic propagation

Does the unexpected international shocks cause a surge in output and creates inflation pressure that the central banks respond to by too little or too late? In the end, if the interest rate path revisions are predictable, but international shocks have no material impact on neither inflation nor output in the domestic economies, the in-efficient use of information by the central banks would be of second order importance. On the other hand, if unexpected international shocks cause a surge in output and creates inflation pressure but the central bank fail to respond sufficiently, a more efficient use of information by the central banks can be welfare improving. To examine this further, we analyse the transmission of unexpected international shocks to the domestic variables in more detail. We then ask, could a more timely response by the central banks have avoided potential large fluctuations in output and inflation?

To address these questions, we estimate one structural vector autoregressive model (SVAR) for each of the three economies already considered; New Zealand, Norway, and Sweden. Based on the results in the previous sections we use the consumer confidence variable to measure international developments. That is, for Norway and Sweden we use the change in consumer confidence in the Euro area, while for New Zealand we use the change in consumer confidence in Australia. In each VAR the international confidence variable is treated as strictly exogenous in the sense that non of the domestic variables are allowed to affect consumer confidence at any lag. Moreover, unexpected confidence innovations are identified using a simple recursive ordering where consumer confidence is ordered first. Both of these assumptions are relative standard in all empirical models trying to gauge how small and open economies respond to unexpected international developments, see, e.g., Artis et al. (2007) among many others.

In each model we naturally also include three domestic variables; output, inflation and the policy rate, in that order. Output and inflation are measured as year-on-year changes $(ln(x_t) - ln(x_{t-4}))$, while the policy rate is included in levels. More elaborate systems could have been devised, and have been used, see, e.g., Eickmeier (2007) and Aastveit et al. (2015) among many others. However, our goal is not to investigate in detail through which channels international shocks might affect small and open economies, but rather provide a stylized, clear cut, experiment including only the most important variables in any inflation targeting central bank loss function; inflation and output, alongside the policy instrument itself.

We start the estimation period in 1998:Q1. At this point in time, all three countries had either adopted inflation targeting, or were about to do so. The sample used ends in 2014:Q3, and we allow for 4 lags in all three models.[8] Finally, we estimate all model specifications using Gibbs simulations. See Appendix D for a more technical description

[8]Our results are robust to changing both the estimation sample and the lag order.

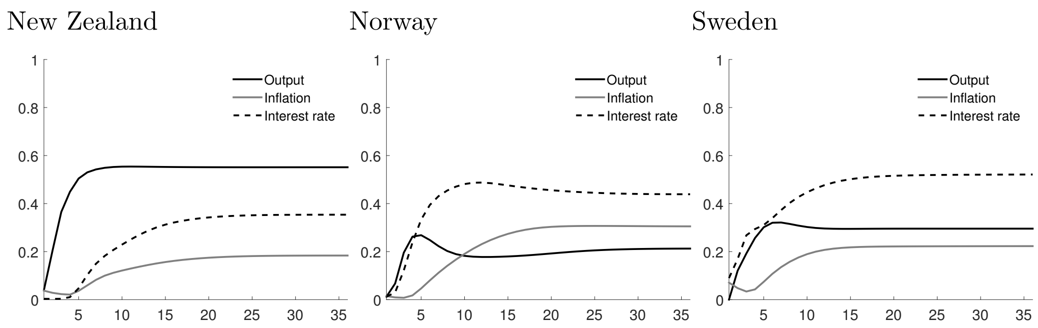

Figure 4. Variance decompositions. Variance explained (in percent) by international confidence shock at the different response horizons (in quarters). The variance decomposition for international consumer confidence itself is not reported because it is 1 across all response horizons.

of the VAR system, estimation and identification procedure.

Figure 4 reports the variance decompositions for domestic output, inflation, and interest rates, following an international shock. Two points are worth highlighting. First, as is already well documented in a large body of literature, international shocks matter. In Norway and Sweden, up to 30 percent of the variation in output and inflation is attributed to the international confidence shock. In New Zealand, this shock explains an even bigger fraction, roughly 60 percent, of the long-run variation in output. Second, also for the interest rate does the international confidence shock explain a very large fraction of the variation, but substantially more so in the medium- to long-run horizons, than in the short-run. In fact, for New Zealand in particular, the confidence shock explains almost nothing of the variation in the interest rate the first year following the initial shock, but then starts to matter more and more. We observe a similar pattern for inflation, where confidence shocks seems to matter most after roughly one year. Thus, it is tempting to interpret these decompositions through the lens of an inflation targeting central bank which observes inflation pressure after an international confidence shock, and then responds by using its policy instrument. However, to confirm this we need to analyse the impulse response functions themselves.

Figure 5 reports the systematic responses in output, inflation and the interest rate following a 1 percent international confidence shock. For brevity, the impulse response of the confidence variable itself is reported in Appendix D. The results across the three countries are surprisingly similar. Following the confidence innovation, output growth picks up rapidly, and peaks at 2 to 6 percent after roughly one year. Inflation, on the other hand, shows a much more sluggish behaviour, likely increasing in response to the positive output developments. But, while output returns to steady state within a few

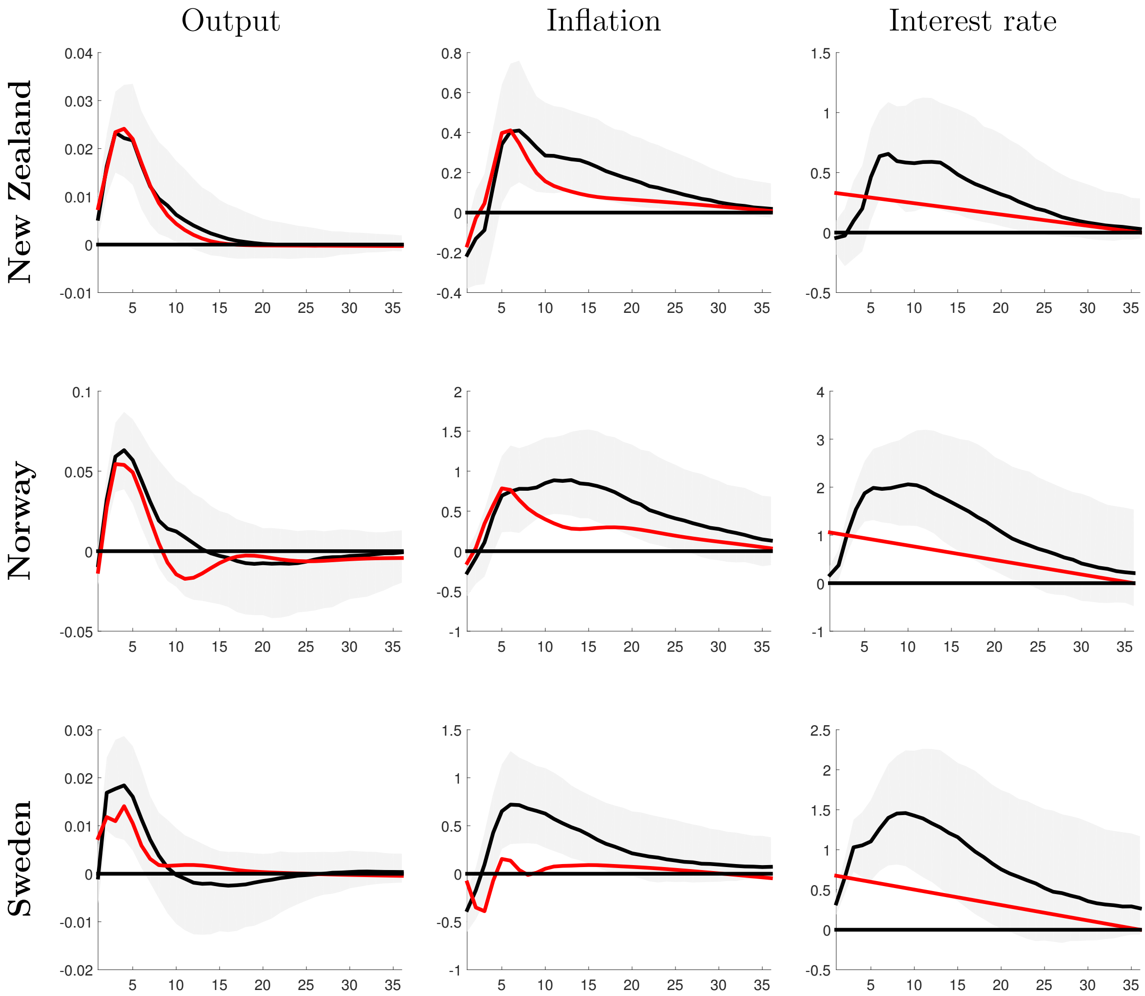

Figure 5. Responses following an international (1 percent) confidence shock. The grey areas correspond to 68 percent of the posterior distribution. The black solid line is the median. The red lines are the responses conditional on the future path of the confidence variable itself, and the hypothetical interest rate path. The impulse response in international consumer confidence itself is reported in Figure 6 in Appendix D.

years, the increase in inflation is much more persistent. Most interesting, however, is the response in the interest rate itself. Despite the strong initial responses in output, the interest rates do not increase substantially before the inflation pressure starts to pick up, after roughly 2 to 4 quarters. Then, the level of the interest rates stay elevated for a long period of time, tracking the paths for inflation closely.

The sluggish, but positive, responses in the interest rates documented in Figure 5 are consistent with the results reported in the previous section, but also raises the question: Could the central banks have acted differently in response to the international confidence shocks, and thereby avoided the large fluctuations in output and inflation? The red lines in Figure 5 addresses this question, and unambiguously signal that the answer is yes.

The lines are constructed as conditional forecasts where the information we condition on is the original impulse response path of consumer confidence following an international confidence innovation, see Figure 6 in Appendix D, and the interest rate paths (red lines) depicted in the last column of Figure 5.[9] The latter paths are constructed as simple linear monotonically decreasing functions initialized at a value corresponding to the maximum of the original interest rate path divided by 2. Importantly, this assumes that the impact response of the interest rate across all countries is substantially higher than as estimated in the data, and that the central banks do not subsequently increase the interest rate in response to the international confidence shock.

As clearly seen in Figure 5, conditioning on the original confidence path and the hypothetical interest path results in output responses that are not too different from the original responses in the short run, but slightly less in the medium to long run. The most significant change however, is for the inflation paths that depart significantly. For Norway and New Zealand, for example, the inflation paths estimated in the data and the ones implied by the conditional forecast experiment are almost identical up to the 5 quarter horizon, but then the counter-factual inflation paths become substantially lower. In Sweden, the differences between the two paths are even bigger as hardly any inflation pressure builds up at all.

We acknowledge that the hypothetical interest rate paths we condition on are somewhat arbitrary, but they highlight the main message: If the central banks had responded more timely to international confidence shocks, inflation pressure could have been curbed without any substantial loss in output. Clearly, other interest rate paths might give different results.[10] Moreover, if the systematic interest rate responses of the central banks following international confidence shocks had actually been as described by the red lines in Figure 5, the historical relationship between output, inflation, and the interest rate would likely also have been different. Thus, as for all counter-factual experiments of this sort, we can not give any clear cut conclusions. Still, the predictive results documented in Section 3 clearly shows that international information could have been used more efficiently by central banks (in Norway, New Zealand, and Sweden at least). The results and

[9] We stress that we make no structural assumptions when constructing the counter-factual output and inflation paths reported in Figure 5, other than treating international consumer confidence as exogenous. Thus, we would have obtained the same impulse responses under the counter-factual experiment as those estimated from the data if we had not also conditioned on the hypothetical interest rate paths.

[10] For example, one could construct hypothetical interest rate paths with the goal of minimizing the variation in inflation following an international confidence shock.

counter-factual experiment reported above suggests that this is not a second order issue, but might be welfare improving (in terms of lowering inflation fluctuations).

5 Conclusion

This study investigates whether the monetary policy forecast revision path of three central banks: New Zealand (RBNZ), Norway (Norges Bank), and Sweden (Sveriges Riksbank) can be efficiently improved by incorporating domestic or global forward looking variables in the information set. Our results indicate that international indicators contain significant information that the central banks do not incorporate into their first release projections. Only after a one to three quarter delay do they revise their forecasts in response to the already published information. Furthermore, we find international forward looking variables to have a particular important role.

These results suggest that a more efficient use of information by the central banks can be welfare improving. We explore this by analysing the transmission of international shocks to the domestic economy in more detail by estimating structural vector autoregressive models (SVAR). We then ask, could a more timely response by the central banks have avoided large fluctuations in output and inflation? Our results suggest that while the impact on output and inflation would remain relatively unchanged in the short term, a more timely interest rate response would dampen output and inflation significantly in the medium to long run.

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Appendices

Appendix A Data

Table 6. New Zealand - The Monetary Policy Statements

Report No.	Publication date	Projection finalized	Report No.	Publication date	Projection finalized
1997/1			2006/1	09/03/2006	28/02/2006
1997/2	19/06/1997	06/06/1997	2006/2	08/06/2006	30/05/2006
1997/3	12/09/1197	04/09/1997	2006/3	14/09/2006	08/09/2006
1997/4	09/12/1997	02/12/1997	2006/4	07/12/2006	30/11/2006
1998/1	11/03/1998	27/02/1998	2007/1	08/03/2007	23/02/2007
1998/2	20/05/1998	08/05/1998	2007/2	07/06/2007	28/05/2007
1998/3	12/08/1998	29/07/1998	2007/3	13/09/2007	31/08/2007
1998/4	11/11/1998	30/10/1998	2007/4	06/12/2007	23/11/2007
1999/1	17/03/1999	01/03/1999	2008/1	06/03/2008	25/02/2008
1999/2	19/05/1999	05/05/1999	2008/2	05/06/2008	26/05/2008
1999/3	18/08/1999	03/08/1999	2008/3	11/09/2008	29/08/2008
1999/4	17/11/1999	03/11/1999	2008/4	04/12/2008	25/11/2008
2000/1	15/03/2000	03/03/2000	2009/1	12/03/2009	26/02/2009
2000/2	17/05/2000	04/05/2000	2009/2	11/06/2009	29/05/2009
2000/3	16/08/2000	02/08/2000	2009/3	10/09/2009	28/08/2009
2000/4	06/12/2000	17/11/2000	2009/4	10/12/2009	27/11/2009
2001/1	14/03/2001	22/02/2001	2010/1	11/03/2010	26/02/2010
2001/2	16/05/2001	30/04/2001	2010/2	10/06/2010	28/05/2010
2001/3	15/08/2001	27/07/2001	2010/3	16/09/2010	03/09/2010
2001/4	14/11/2001	26/10/2001	2010/4	09/12/2010	29/11/2010
2002/1	20/03/2002	01/03/2002	2011/1	10/03/2011	02/03/2011
2002/2	15/05/2002	26/04/2002	2011/2	09/06/2011	27/05/2011
2002/3	14/08/2002	26/07/2002	2011/3	15/09/2011	02/09/2011
2002/4	20/11/2002	07/11/2002	2011/4	08/12/2011	25/11/2011
2003/1	06/03/2003	25/02/2003	2012/1	08/03/2012	24/02/2012
2003/2	05/06/2003	23/05/2003	2012/2	14/06/2012	01/06/2011
2003/3	04/09/2003	22/08/2003	2012/3	13/09/2012	31/08/2011
2003/4	04/12/2003	21/11/2003	2012/4	06/12/2012	23/11/2011
2004/1	11/03/2004	27/02/2004	2013/1	13/03/2013	01/03/2014
2004/2	10/06/2004	28/05/2004	2013/2	12/06/2013	31/05/2013
2004/3	09/09/2004	30/08/2004	2013/3	11/08/2013	30/08/2013
2004/4	09/12/2004	30/11/2004	2013/4	11/12/2013	27/11/2013
2005/1	10/03/2005	01/03/2005	2014/1	12/03/2014	26/02/2014
2005/2	09/06/2005	31/05/2005	2014/2	11/05/2014	30/05/2014
2005/3	15/09/2005	06/09/2005	2014/3	10/09/2014	28/08/2014
2005/4	08/12/2005	28/11/2005	2014/4	10/12/2014	26/11/2014
			2015/1	11/03/2015	25/02/2015

Notes: The three columns contain, respectively, the reports' series number, the publication date and the date for when the projections were finalised.

Table 7. Norway - The Monetary Policy Reports

Report No.	Publication date	Information date
2005/3	02-Nov	27-Oct
2006/1	16-Mar	10-Mar
2006/2	29-Jun	22-Jun
2006/3	01-Nov	26-Oct
2007/1	15-Mar	09-Mar
2007/2	27-Jun	21-Jun
2007/3	31-Oct	25-Oct
2008/1	13-Mar	10-Mar
2008/2	25-Jun	20-Jun
2008/3	29-Oct	23-Oct
2008/3*	17-Dec	
2009/1	25-Mar	19-Mar
2009/2	17-Jun	11-Jun
2009/3	28-Oct	22-Oct
2010/1	24-Mar	18-Mar
2010/2	23-Jun	17-Jun
2010/3	27-Oct	21-Oct
2011/1	16-Mar	10-Mar
2011/2	22-Jun	16-Jun
2011/3	19-Oct	13-Oct
2012/1	14-Mar	09-Mar
2012/2	20-Jun	15-Jun
2012/3	31-Oct	25-Oct
2013/1	14-Mar	11-Mar
2013/2	20-Jun	13-Jun
2013/3	19-Sep	12-Sep
2013/4	05-Dec	02-Dec
2014/1	27-Mar	20-Mar
2014/2	19-Jun	12-Jun
2014/3	18-Sep	11-Sep
2014/4	11-Dec	05-Dec
2015/1	19-Mar	12-Mar

Notes: The three columns contain, respectively, the reports' series number, the publication date and the cut of date for information used in the report.

* On 17 Dec. 2008 Norges Bank revised the projections given in the report no. 2008/3 because of the impact of the financial crisis.

Table 8. Sweden - The Monetary Policy Reports and Monetary Policy Updates

Report No.	Publication Date	Report No.	Publication Date
2007/1	15/02/2007	2011/2	05/07/2011
2007/2	20/06/2007	2011/2*	07/09/2011
2007/3	30/10/2007	2011/3	27/10/2011
2007/4	19/12/2007	2011/3*	20/12/2011
2008/1	13/02/2008	2012/1	16/02/2012
2008/1*	23/04/2008	2012/1*	18/04/2012
2008/2	03/07/2008	2012/2	04/07/2012
2008/2*	04/09/2008	2012/2*	06/09/2012
2008/3	23/10/2008	2012/3	25/10/2012
2008/3*	04/12/2008	2012/3*	18/12/2012
2009/1	11/02/2009	2013/1	06/02/2013
2009/1*	21/04/2009	2013/1*	17/04/2013
2009/2	02/07/2009	2013/2	03/07/2013
2009/2*	03/09/2009	2013/2*	05/09/2013
2009/3	22/10/2009	2013/3	24/10/2013
2009/3*	16/12/2009	2013/3*	17/12/2013
2010/1	11/02/2010	2014/1	13/02/2014
2010/1*	20/04/2010	2014/1*	09/04/2014
2010/2	01/07/2010	2014/2	03/07/2014
2010/2*	02/09/2010	2014/2*	04/09/2014
2010/3	26/10/2010	2014/3	28/10/2014
2010/3*	14/12/2010	2014/3*	16/12/2014
2011/1	15/02/2011	2015/1	12/02/2015
2011/1*	20/04/2011	2015/2	29/04/2015

Notes: The monetary policy updates are indicated with *.

A.1 Real-time data set

Important to our set up is the construction of a real-time data set of interest rate projections from the published monetary policy reports issued by the central banks. From this, we construct and store separately the one-step ahead, the two-steps ahead, the three-steps ahead and the four steps-ahead real time forecasts for the interest rates.[11] A forecast revision will then be the difference between a forecast made in one quarter, and the counterpart (updated) forecast made in the following quarter.

For instance, from the monetary policy report in New Zealand published in, say, Q1 2010 (2010/1), we collect the two-steps ahead forecast for Q3 2010. Moving one period forward, we collect from the monetary policy report 2010/2, what is now the one-step ahead forecast for Q3 2010. The revision to these forecasts will be the difference between

[11] Note that the forecast horizons in each report is not fixed, varying from one-step (i.e., one quarter) ahead, normally ending up to 8- or 12-steps ahead.

the one-step ahead forecast made in Q2 2010 and the initial two-steps ahead forecast made in Q1 2010. We continuously collect such forecasts from the quarterly monetary policy reports, so that in the end we have constructed a quarterly real-time data set of forecast revisions between the one- and the two-steps ahead forecasts, between the two- and the three-steps ahead forecasts, etc.

Having constructed times series of forecast revisions, we next regress these series on the domestic and foreign macroeconomic indicators that were available to the policy makers when they first made the initial forecasts. Given that data is published with a lag, the conditioning information will be collected from the preceding quarter, i.e, from Q4 2009q in the example from above.

An important issue is the timing of the projections when constructing the real time dataset. Ideally, we want the timing of the forecast to be consistent across the three countries. For New Zealand, the construction of the quarterly real-time data set of forecast revisions is straightforward, as RBNZ publishes it's interest rate projection regularly in the monetary policy reports four times a year, typically late in the quarter; Q1 (March), Q2 (June), Q3 (September) and Q4 (December). This implies, however, that the RBNZ may have observed one or two months of data when it makes the forecast in a given quarter, giving it an advantage relative to our set up.

For Norway the construction of the quarterly real-time data set of forecast revisions is slightly more complicated, as until 2012, NB published forecasts only three times a year; In February/March, June and October/November. Hence, there is no forecast made in the third quarter. To construct a quarterly time series, we therefore have to collect forecasts for both Q3 and Q4 (and onwards) from the monetary policy report published in Q2 (end of June).[12] This gives NB one quarter information disadvantage relative to the other central banks, when forecasting the fourth quarter (and onwards). From 2012, however, NB starts publishing interest rate projection regularly in the monetary policy reports four times a year, typically late in the quarter as was the case also for the RBNZ; Q1 (March), Q2 (June), Q3 (September) and Q4 (December). Hence, from 2012, it has the same advantage relative to our set up as RBNZ.

The construction of time series for Sweden involves making some choices, as SR publishes interest paths six times a year; typically in February, April, July, September, October and December. To get a quarterly real-time data set of forecast revisions that is consistent with the data-set constructed for the two other central banks, we decide to

[12] That is, the one-step ahead forecast for Q4 that should have been constructed in Q3, is actually the two-steps ahead forecast made in Q2, etc.

store and use the interest paths published in the reports from February, July, September and December (report number 1, 2, 2*, and 3* respectively). However, this means that the projections 'made' in Q2 are essentially made in the first month of Q3 (July), rather than in the last month in the second quarter (June) as is the case for the other two central banks. However, from Table 8, we see that the reports are published very early in July, giving SR only a few days advantage relative to the other central banks. Alternatively we could have used the projections from April (report nr 2), but this would give SR over two months disadvantage relative to the other central banks.

Appendix B Global and Domestic Indicators

Table 9. Indicators Description

Indicator	Source	Additional information
Exchange Rate		
USD/NZD, USD/NOK, USD/SEK	IMF-IFS	
New Zealand Trade Weight Index, AUD/NZD	Reserve Bank of New Zealand	
Norway Trade Weight Index	Norges Bank	
Sweden KIX Index	Riks Bank	TWI adjusted for emerging market increased importance
Consumer Confidence Indicator		
Australia	ANZ/Roy Morgan	NSA
China	National Bureau of Statistics of China	NSA
Euro Zone, Swden	DG ECFIN	NSA
New Zealand	Westpac - McDermott Miller	NSA
Norway	TNS Gallup	NSA
U.S.	UMSC	NSA
Consumer Price Index		
Australia	Australia Bureau of Statistics	NSA, price index
New Zealand	Statistics New zealand	NSA, price index
Norway	Statistics Norway	NSA, price index
Swden	Statisitcs Sweden	NSA, price index
U.S.	Bureau of Labor Statistics, U.S. Dep. of Labor	NSA, price index
Import Price Index		
New Zealand	Statistics New zealand	NSA, price index
Norway	Statistics Norway	NSA, price index
Swden	Statisitcs Sweden	NSA, price index
Industrial Production (Output Gap Data)		
AU, NZ, NO, SW, U.S.	IMF-IFS	NSA, price index
Euro Zone	OECD	SA, price index
Industrial Production		
AU, NZ, NO, SW, U.S.	IMF-IFS	NSA, y/y changes
Euro Zone	Eurostat	SA, y/y changes
Interest Rate		
Australia	Reserve Bank of Australia	Interbank Rate - 3-Month
Euro Zone	ECB	Euro Interbank Rate - 3-Month (Mean)
New Zealand	Reserve Bank of New Zealand	Interbank Rate - 3-Month
Norway	Norges Bank	Interbank Rate - 3-Month
Swden	Riksbank	Interbank Rate - 3-Month
U.S.	IMF-IFS	Money Market rate - 3-Month
Stock Price Index		
Australia	Standard and Poors (S&P)/ASX	Covers app. 80% of Australian equity market
Euro Zone	Stoxx Limited	Euro Stoxx 50
New Zealand	The National Bank of New Zealand	All Share Price Index
Norway	Statistics Norway	Oslo Stock Exchange Benchmark Index
Swden	Talentum Sweden - Affarsvarlden	Stockholm Stock Exchange Affarsvarlden Index
U.S.	Standard and Poors (S&P)	S&P 500 composite
Yield Curve Spread		
AU, NO, SW, U.S.	ICAP	10-year & 3-month government zero curve rates
Euro Zone	ECB	10-year & 3-month AAA-rated government bonds
New Zealand	Reserve Bank of New Zealand	10-year & 1-year government bond yield
Term of Trade		
New Zealand	Statistics New Zealand	NSA, price index
Norway	Statistics Norway	NSA, price index
Swden	Statistics Sweden	NSA, price index
Stock Market Volatility Index	Stoxx Limited	VSTOXX Volatility Index, Currency: Euro
Crude Oil Brent Spot Price	Energy Information Administration, U.S.	

Notes: NSA: not seasonally adjusted, SA: seasonally adjusted.

Appendix C Additional Forecast results [To be completed]

Table 10. New Zealand: Predictive regression for forecast revisions three- and two-steps ahead

$$r_{23,t+1} = \alpha_{23} + \gamma_0 r_{23,t} + \beta_n I_{n,t-2} + \varepsilon_{23,t+1}$$

	γ_0	$\beta_{n,2}$	$\bar{R}^2$
Consumer Confidence Index			
New Zealand	0.288***	0.017***	0.22
Australia	0.213*	0.022***	0.22
U.S.	0.345***	0.006	0.16
Stock Price Index			
New Zealand	0.255*	0.026**	0.19
Australia	0.335**	0.007	0.13
U.S.	0.415***	-0.002	0.13
Yield Curve Spread			
New Zealand	0.398***	0.016	0.13
Australia	0.354***	0.086	0.15
U.S.	0.404***	-0.011	0.13
Industrial Production			
New Zealand	0.434***	-0.018	0.16
Australia	0.374***	-0.038	0.17
U.S.	0.402***	-0.000	0.13
Interest Rate			
Australia	0.354***	-0.092*	0.18
U.S.	0.401***	0.000	0.13
Consumer Price Index			
New Zealand	0.366***	-0.358***	0.27
Australia	0.425***	-0.318***	0.27
U.S.	0.495***	-0.263***	0.27
Exchange Rate			
TWI	0.373***	0.006	0.13
AUD/NZD	0.422***	-0.032*	0.17
USD/NZD	0.364***	-0.006	0.13
International Indexes			
Term of trade	0.405***	-0.000	0.13
Volatility Index	0.415***	0.003	0.14
Import Price Index	0.321***	-0.045***	0.24
Crude Oil Price	0.423***	-0.005**	0.18

Notes: See notes to Table 2

Table 11. Norway: Predictive regression for forecast revisions three- and two-steps ahead

$$r_{23,t+1} = \alpha_{23} + \gamma_0 r_{23,t} + \beta_n I_{n,t-2} + \varepsilon_{23,t+1}$$

	γ_0	$\beta_{n,2}$	$\bar{R}^2$
Consumer Confidence Index			
Norway	0.130	0.014**	0.25
Sweden	0.162***	0.082***	0.31
Euro Zone	0.139	0.030*	0.22
U.S.	0.217***	0.004	0.16
Stock Price Index			
Norway	0.085	0.009	0.20
Sweden	0.131	0.012*	0.22
Euro Zone	0.138	0.011*	0.22
U.S.	0.152	0.008	0.17
Yield Curve Spread			
Norway	0.234***	-0.030	0.15
Sweden	0.203***	0.030	0.15
Euro Zone	0.201***	-0.073	0.19
U.S.	0.222***	-0.063	0.20
Industrial Production			
Norway	0.222***	0.003	0.15
Sweden	0.235***	-0.006	0.18
Euro Zone	0.243***	-0.010	0.19
U.S.	0.254***	0.018*	0.22
Interest Rate			
Sweden	0.171**	0.126**	0.26
Euro Zone	0.210***	0.071**	0.26
U.S.	0.178***	0.053**	0.25
Consumer Price Index			
Norway	0.235***	0.112	0.19
Sweden	0.207***	0.054	0.16
U.S.	0.081	0.152*	0.23
Exchange Rate			
TWI	0.200**	-0.007	0.15
EU/NOK	0.245***	0.109	0.15
USD/NOK	0.039	-0.028*	0.24
International Indexes			
Term of trade	0.152	0.030	0.22
Volatility Index	0.192***	-0.003	0.18
Import Price Index	0.232***	0.017	0.16
Crude Oil Price	0.225***	-0.001	0.15

Notes: See notes to Table 2

Table 12. Sweden: Predictive regression for forecast revisions three- and two-steps ahead

$$r_{12,t+1} = \alpha_{12} + \gamma_0 r_{12,t} + \beta_n I_{n,t-1} + \varepsilon_{12,t+1}$$

	γ_0	β_n	$\bar{R}^2$
Consumer Confidence Index			
Sweden	0.308*	0.024	0.16
Norway	0.307**	0.023***	0.29
Euro zone	0.235	0.040	0.16
U.S.	0.399***	0.011	0.11
Stock Price Index			
Sweden	0.201	0.017*	0.18
Norway	0.153	0.014*	0.19
Euro zone	0.135	0.021*	0.19
U.S.	0.224	0.015	0.16
Yield Curve Spread			
Sweden	0.256	0.188**	0.24
Norway	0.200	0.222***	0.32
Euro zone	0.379**	0.143*	0.17
U.S.	0.356**	0.062	0.10
Industrial Production			
Sweden	0.434**	-0.006	0.10
Norway	0.363**	-0.027	0.15
Euro zone	0.412**	-0.004	0.09
U.S.	0.352*	0.005	0.09
Interest Rate			
Norway	0.284*	-0.124**	0.25
Euro zone	0.355**	-0.096*	0.19
U.S.	0.391**	-0.016	0.09
Consumer Price Index			
Sweden	0.546***	-0.284**	0.22
Norway	0.380**	0.047	0.09
U.S.	0.450**	-0.068	0.10
Exchange Rate			
TWI	0.143	-0.062*	0.19
EU/SEK	0.215	-0.048	0.15
USD/SEK	0.124	-0.036**	0.22
International indexes			
Terms of Trade	0.175	-0.102**	0.24
Volatility Index	0.371**	-0.004	0.11
Import Price Index	0.186	-0.136***	0.22
Crude Oil Price	0.246	-0.006*	0.06

Notes: See notes to Table 2

Table 13. Autoregressive Model of Forecast Errors, actual and recent interest rate forecasts

$$e_{i,t+1} = \alpha_i + \sum_{\tau=0}^{k} \gamma_\tau e_{i,t-\tau} + \varepsilon_{i,t+1}$$

	γ_0	γ_1	α_i	R^2	$\bar{R}^2$	N
New Zealand						
$e_{1,t+1}$	0.131	-	0.001	0.03	0.02	66
	(0.124)		(0.016)			
$e_{2,t+1}$	0.466***	-	-0.038	0.21	0.20	65
	(0.112)		(0.042)			
$e_{3,t+1}$	0.828***	-0.276**	-0.099	0.47	0.45	64
	(0.124)	(0.124)	(0.073)			
Norway						
$e_{1,t+1}$	0.117	-	-0.008	0.01	-0.01	39
	(0.167)		(0.017)			
$e_{2,t+1}$	0.419***	-	-0.106	0.17	0.15	37
	(0.157)		(0.102)			
$e_{3,t+1}$	0.892***	-0.499***	-0.199	0.51	0.48	36
	(0.157)	(0.157)	(0.131)			
Sweden						
$e_{1,t+1}$	0.243	-	-0.038*	0.05	0.02	33
	(0.177)		(0.023)			
$e_{2,t+1}$	0.804***	-0.415**	-0.135	0.44	0.40	32
	(0.174)	(0.173)	(0.074)			
$e_{3,t+1}$	0.946***	-0.458***	-0.220*	0.54	0.50	31
	(0.173)	(0.170)	(0.123)			

Notes: r^2 and $\bar{r}^2$ are R-squared and adjusted R-squared and N is the number of observations. *, **, and ***, indicate that coefficients are statistically significant at the 10%, 5%, 1% level respectively.

Appendix D VAR specification, estimation, and identification

The VAR model used in Section 4 of the main paper can be written as:

$$y_t = \alpha + \phi_1 y_{t-1} + \ldots + \phi_p y_{t-p} + u_t \tag{4}$$

where y_t is a $(n \times 1)$ vector of endogenous variables, α is a $(n \times 1)$ vector of constants, ϕ_i, for $i = 1, \ldots, p$, is a $(n \times n)$ matrix of parameters. u_t are the reduced form residuals, with covariance $E(u_t u_t') = Q$.

For notational purposes it is helpful to put the VAR in SUR form. By abusing notation we define:

$$y = X\beta + \epsilon \tag{5}$$

where $y = [y_1, \cdots, y_T]'$, $X = [X_1, \cdots, X_T]'$, $\epsilon = [\epsilon_1, \cdots, \epsilon_T]'$ and $\beta = [\beta_1, \cdots, \beta_n]'$, with $\beta_k = [\phi_{1,k}, \cdots, \phi_{p,k}]$ for $k = 1, \ldots, n$. Further,

$$X_t = \begin{pmatrix} x_{t,1} & 0 & \cdots & 0 \\ 0 & x_{t,2} & \ddots & \vdots \\ \vdots & \ddots & \ddots & \vdots \\ 0 & \cdots & \cdots & x_{t,q} \end{pmatrix}$$

with $x_{t,k} = [y'_{t-1}, \cdots, y'_{t-p}]$. Finally, $\epsilon \sim i.i.d.N(0, I_q \otimes Q)$.[13]

We simulate the SUR system sequentially using Gibbs simulations and the Normal-Wishart prior:

$$p(\beta, Q) = p(\beta)p(Q^{-1}) \tag{6}$$

where

$$p(\beta) = f_N(\beta | \underline{\beta}, \underline{V}_\beta) \tag{7}$$

$$p(Q^{-1}) = f_W(Q^{-1} | \underline{v}_Q, \underline{Q}^{-1}) \tag{8}$$

To avoid over-fitting, $\underline{\beta}$, $\underline{V}_\beta$, and $\underline{Q}^{-1}$ are set in a Minnesota style fashion, see, e.g., Koop and Korobilis (2010). That is, $\underline{\beta}$ for each dependent variable is set at its univariate AR estimate, and zero everywhere else. $\underline{V}_\beta$ is a diagonal matrix where each element is a scaled measure of the variance associated with the AR equation estimate. For lags of the dependent variable itself we use a scale of 1; for other lags we use a scale of 0.4. For

[13] With the VAR specified in SUR form it becomes easy to adjust the VAR(p) model such that different regressors can potentially enter the n equations of the VAR(p).

exogenous measures, i.e., the constant, we use 0.3. $\underline{Q}^{-1}$ is set equal to its initial OLS estimate. Lastly, we set $v_Q = 30$, reflecting our relatively uninformative view on what the parameters of the VAR should be.

Based on these priors the conditional posterior of β is:

$$\beta | y, Q^{-1} \sim N(\overline{\beta}, \overline{V}_{\beta})_{I[s(\beta)]} \tag{9}$$

with

$$\overline{V}_{\beta} = (\underline{V}_{\beta}^{-1} + \sum_{t=1}^{T} X_t' Q^{-1} X_t)^{-1} \tag{10}$$

and

$$\overline{\beta} = \overline{V}_{\beta}(\underline{V}_{\beta}^{-1} \underline{\beta} + \sum_{t=1}^{T} X_t' Q^{-1} y_t) \tag{11}$$

$I[s(\beta)]$ is an indicator function used to denote that the roots of β lie outside the unit circle.

The conditional posterior of Q^{-1} is:

$$Q^{-1} | y, \beta \sim W(\overline{v}_Q, \overline{Q}^{-1}) \tag{12}$$

with

$$\overline{v}_Q = \underline{v}_Q + T \tag{13}$$

and

$$\overline{Q} = \underline{Q} + \sum_{t=1}^{T} (y_t - X_t \beta)(y_t - X_t \beta)' \tag{14}$$

D.1 Identification

The mapping from the reduced form residuals, u_t in equation (4) to the structural innovations, e_t, is in this paper obtained using a Cholesky decomposition of $E(u_t u_t') = Q$, such that $u_t = A_0 e_t$. From this it follows that:

$$\begin{bmatrix} u_{1,t} \\ u_{2,t} \\ \vdots \\ u_{n,t} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ \vdots & \vdots & \ddots & 0 \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ \vdots \\ e_{n,t} \end{bmatrix} \tag{15}$$

where e_t are the structural disturbances, with $\Sigma_e = I$, such that $Q = A_0 A_0'$.

Appendix E Additional VAR results

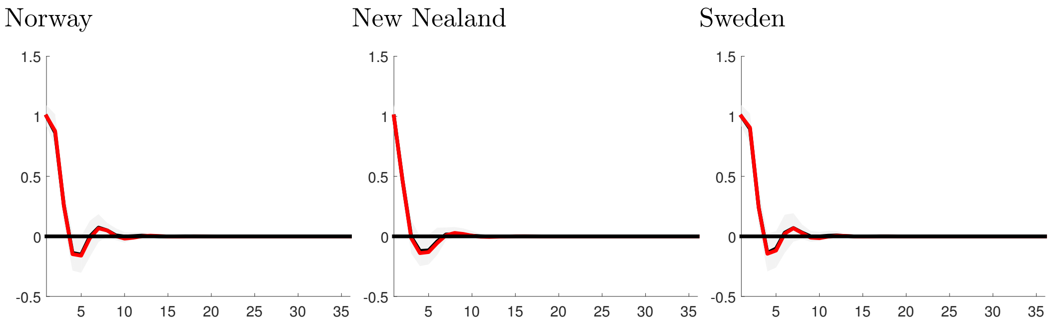

Figure 6. Responses (in percent) in consumer confidence following a 1 percent confidence shock. The grey areas correspond to 68 percent of the posterior distribution. The black solid line is the median. The red lines (on top of the black ones) are the responses conditional on the future path of the confidence variable itself, and the hypothetical interest rate path. See the discussion in Section 4.