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Adverse Effects of Monetary Policy Signalling

Jan Filáček, Jakub Matějů[*]

Abstract

Assuming information asymmetry between private agents and the central bank about the state of the economy, an unexpected change in interest rates signals the central bank's perceived state of the economy and facilitates an update of private expectations in an adverse, perhaps unintended way. This "updating channel" might counteract the standard transmission from interest rates to inflation and output. We develop a simple model laying down a theoretical basis for the adverse effects of monetary policy signalling. We also detect the presence of the updating channel in private forecasts of inflation in a cross-country sample of selected OECD countries.

Abstrakt

Za předpokladu informační asymetrie mezi soukromými subjekty a centrální bankou ohledně stavu ekonomiky neočekávaná změna úrokových sazeb signalizuje, jak centrální banka vnímá aktuální a budoucí stav ekonomiky, a napomáhá protichůdnému – a možná nezamýšlenému – přizpůsobení očekávání soukromých subjektů. Tento „informační kanál" měnové politiky může působit proti standardní transmisi úrokových sazeb do inflace a výstupu. Pro teoretické odvození protichůdných efektů signalizace měnové politiky jsme sestavili jednoduchý model. Dále zjišťujeme existenci informačního kanálu v datech o inflaci očekávané soukromými subjekty pro panel vybraných zemí OECD.

JEL Codes: E17, E43, E58.

Keywords: Asymmetric information, monetary policy, monetary transmission, signalling, updating channel.

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Nontechnical Summary

In this paper we explore how a central bank's actions can influence private agents' expectations in an adverse, perhaps unintended way. The main idea, in short, is that the central bank's actions are based on information about the state of the economy which is not available to private agents. Assuming such information asymmetry, monetary policy actions send out informative signals to private agents about the current and future state of the economy. This "updating channel" can act against the intended monetary policy measure and reduce its effects on inflation and output. In the extreme case, inflation expectations might even rise after an interest rate hike, in sharp contrast to the common understanding of interest rate transmission.

To illustrate the possibility of these adverse effects taking place, we set up a simple model where part of the economy is populated by partially rational agents, who observe the actions of the central bank and infer from them signals about future economic developments. Following a forward-looking Taylor rule, the central bank by conducting its monetary policy signals its forecast of inflation and the output gap. Observing the short-term interest rate, the partially rational agents update their expected inflation and output and adjust their behaviour accordingly, which may counteract the intended monetary policy adjustment. We show that a restrictive monetary policy shock makes the partially rational agents in the economy believe that the output gap and inflation will be higher than expected, which reduces the strength of transmission of monetary policy. In some model specifications this adverse effect might even lead to reversed transmission of monetary policy, where inflation and the output gap rise with a monetary policy contraction.

In the empirical part of the paper we measure the adverse effects of monetary policy signalling on a panel of selected OECD countries, including both small open inflation-targeting countries and large economies (the U.S. and the euro area). We measure how an unexpected change in the monetary policy rate affects private expectations about inflation and output. Although the standard understanding of monetary policy transmission would suggest that inflation expectations fall after a restrictive monetary policy shock, the data show the opposite reaction, i.e. an increase in inflation expectations. Using different specifications of the monetary policy surprise (both as a deviation from the expected interest rate change and as a deviation from the forward- and backward-looking Taylor rule) we show that the positive correlation between unanticipated interest rate changes and adjustments of inflation expectations is robust and stable across all specifications. For expectations about GDP we find results consistent with the standard functioning of monetary transmission, which may indicate that private agents interpret monetary policy surprises as reactions to expected inflation rather than output. We do not find any stable effect of central bank transparency on the strength of the updating channel.

1. Introduction

In this paper we explore how a central bank's actions can influence private agents' expectations in an adverse, perhaps unintended way. The main idea is that the central bank's actions are based on information about the state of the economy which is not available to private agents. Information asymmetry between the central bank and private agents can arise for several reasons. First, central banks may have access to more detailed, not publicly available data (Peek et al., 2003). Second, central banks typically assign more resources to producing reliable forecasts than private forecasters. And third, central bank forecasts are to some extent self-fulfilling, as policymakers typically conduct monetary policy in accordance with the forecast in order to meet their policy targets. Assuming such information asymmetry, monetary policy actions send out informative signals to private agents about the current and future state of the economy.

To illustrate the adverse effects of monetary policy signalling, consider the example of a surprising interest rate cut by the central bank. With this measure, a forward-looking central bank reveals information, signalling worse economic developments in the future. If the central bank's new information and the forecast based on this information are perceived to be reliable, private agents revise their assessment of future developments downwards and adjust their consumption/investment decisions accordingly to reflect the central bank's more pessimistic perception of the (future) state of the economy. As some authors use the term "signalling channel" in a more general sense including "forward guidance" about future policy changes, we label the adverse effects of monetary policy signalling explored in this paper as the "updating channel", reflecting the fact that the information contained in an unexpected policy rate change leads private agents to update their expectations about future economic developments.

The updating channel can act against the intended effects of monetary policy measures. In the extreme case, inflation expectations and inflation itself might even decline after an interest rate cut, in sharp contrast to the common understanding of interest rate transmission. Indeed, a negative reaction of inflation to an interest rate cut (and a positive reaction to an interest rate hike) has been found in some VAR models. Impulse responses where inflation initially increases after a restrictive monetary policy shock were first noted by Sims (1992) and labelled the "price puzzle" by Eichenbaum (1992). This anomaly casts serious doubts on the ability of central banks to control inflation in the short run. The updating channel might be one of the explanations of this anomaly, conditional on information asymmetry between private agents and the central bank. In this paper, we lay down the theoretical foundations of the updating channel in a simple New Keynesian framework, and also attempt to determine its presence (and strength) in the data using panel models of Consensus Forecasts revisions, with a particular focus on the transparency and communication aspects of monetary policy.

If the updating channel exists, an important question is how it interacts with the degree of central bank transparency. More transparent central banks might make monetary policy less surprising (and therefore reduce the effects of monetary policy actions on expectations) by revealing other information (e.g. targets, forecasts, minutes, comments) which puts the measure in the right perspective. But it also holds that with a more transparent central bank, a surprising interest rate change might have more pronounced effects on private expectations. Because the updating channel is identified on interest rate surprises, it is not *a priori* evident what the effect of greater transparency should be on the strength of the updating channel.

In this paper we build a simple New Keynesian general equilibrium model with both fully and partially rational agents where interest rate changes by a forward-looking central bank carry information about future inflation and output. The partially rational agents update their expectations upon observing the actions of the central bank, which leads to distortions in the functioning of the monetary transmission mechanism. For example, if the partially rational agents observe an interest rate hike, they interpret it as a reaction of the central bank to higher expected inflation (and output, depending on the nature of the monetary policy regime) and update their inflation expectations upwards, which reduces the efficiency of monetary policy. Under specific parameter values, this effect leads to reversed transmission of monetary policy shocks at early horizons (the price puzzle). Further, we test for the presence of the updating channel on a panel of selected OECD countries (previous studies – Melosi, 2012, and Tang, 2013 – draw on U.S. data only). We find that the updating channel has a relatively strong impact on inflation expectations (based on Consensus Forecasts surveys), while expectations about output behave in accordance with standard monetary policy transmission.

The structure of the paper is as follows. In Section 2 we review the existing literature. In Section 3 we set up a simple New Keynesian model to illustrate the logic and motivate the empirical part of the paper. In Section 4 we test for the existence and significance of the updating channel on a sample of OECD countries. Section 5 concludes the paper.

2. Literature Review

The theoretical foundations of the adverse effects of monetary policy signalling have been established recently as progress has been made in the literature on the role of information frictions in monetary policy (Sims, 2010; Angeletos and La'O, 2011; Maćkowiak and Wiederholt, 2010; Paciello and Wiederholt, 2011; Adam, 2007). For the adverse channel of monetary policy signalling to function, the crucial assumption is that the central bank knows more than the public. This issue has been investigated empirically before: Romer and Romer (2000) show that the Federal Reserve (Fed) has substantially more knowledge about future inflation and that monetary policy actions provide signals to commercial forecasters, who substantially revise their forecasts in response to these signals. Similarly, Caporale and Perry (2006) find that changes in the Fed's monetary policy rate are informative about future excess returns on U.S. stocks, and argue that this is because the Fed possesses inside information not known to the public.

Peek et al. (2003) also find that the Fed has an information advantage over the public. Going deeper into the structure of the information, their paper concludes that the information advantage comes from confidential supervisory knowledge (for example about non-traded troubled companies) which could stay undisclosed for a prolonged period of time.

A number of papers (Cukierman and Meltzer, 1986; Faust and Svensson, 2001; Geraats, 2005) link the information asymmetry between the public and the central bank to the existence of average inflation bias. For example, Geraats (2005) assumes that all private agents share the same information set and have no independent information about shocks. When the public can observe the central bank's actions prior to forming expectations, a lack of transparency results in an average inflation bias because the policy action does not fully reveal the central bank's information.

Morris and Shin (2002) look at information asymmetry from a slightly different perspective, with the central bank forecast being a coordination device for private agents. In their model, the central bank sends signals to private agents, which have dispersed information about the state of the economy. They show that private agents tend to put more weight on the public signal than is justified by the level of its precision. Too much attention paid to public signals might be harmful, because they crowd out private signals. However, Svensson (2006) shows that in the Morris-Shin model, more public signals enhance welfare within a reasonable range of model parameters.

The signalling effects of monetary policy are also scrutinised in Walsh (2010), who uses a model with heterogeneous information among private agents to analyse the effects of central bank opacity on the optimal degree of central bank flexibility. He finds that an opaque central bank should put more weight on achieving its inflation objective than the public does. Berkelmans (2011) accounts for the existence of multiple shocks (a monetary policy shock, a mark-up shock and an aggregate demand shock) in the economy and finds that under imperfect information the optimal policy response to one shock depends on the existence of other shocks.

Another influential paper in the imperfect information literature is Lorenzoni (2009). In his model, households are hit by heterogeneous productivity shocks. They observe their own productivity and a noisy public signal regarding aggregate productivity. The public signal gives rise to "noise shocks", which resemble aggregate demand shocks – they increase output, employment and inflation in the short run and have no effects in the long run. Rousakis (2013) extends the model to include heterogeneity among producers and shows that noise shocks can resemble both demand and supply shocks.

A parallel strand of literature related to the imperfect information literature is focused on studying the effects of purely expectational shocks on an economy (Beaudry and Portier, 2006; Barsky and Sims, 2011; Blanchard et al., 2013). In these models, however, private agents and the monetary authority basically share the same set of information and monetary policy is neutral unless we assume some kind of heterogeneity in private agents' expectations.

The studies closest to ours are Melosi (2012) and Tang (2013). Melosi (2012) developed a general equilibrium model with dispersed information where the central bank observes several shocks hitting the economy (technology, demand and monetary policy shocks) and signals these shocks to private agents via setting the policy rate. The model is fitted to the U.S. data, which include inflation expectations from the Survey of Professional Forecasters (SPF). The results of Bayesian estimations suggest that the central bank's signals improve the effectiveness of monetary policy stabilisation in the face of demand shocks, whereas no such effect is found in the case of technology shocks.

Tang (2013) derives optimal monetary policy in a model similar to Melosi (2012). Optimal discretionary policy with an updating channel leads to more emphasis on inflation. If the signal-update effect is strong, optimal policy under discretion converges to optimal policy under commitment. Tang uses SPF probability distributions to calculate a measure of subjective uncertainty and shows that when uncertainty about future inflation is high, the responses of inflation forecasts to policy rate surprises are strongly positive.

3. Model of the Updating Channel of Monetary Policy Signalling

In this section, we set up a model where the signals issued by a central bank's monetary policy may have adverse, perhaps unintended effects. Following a forward-looking Taylor rule, the central bank by conducting its monetary policy signals its forecast of inflation and the output gap. Observing the short-term interest rate, the partially rational agents update their otherwise static expectations about future inflation and output and adjust their behaviour accordingly, which may counteract the intended monetary policy adjustment. We show that a restrictive monetary policy shock makes the partially rational agents in the economy believe that the output gap and inflation will be higher than expected, which reduces the strength of the transmission of monetary policy. In some model specifications this adverse effect might even lead to reversed transmission of monetary policy, where inflation and the output gap rise with a monetary policy contraction (and fall with a contraction).

Model Setup

We use a very standard New Keynesian "three-equation" setup based on Clarida, Gali and Gertler (1999), extended such that there are two sectors in the economy, one consisting of fully rational agents, who know the model and are able to form rational forecasts, and the other consisting of partially rational agents, who are not able to form expectations based on the rational expectations' solution of the model. In other words, the partially rational agents are not able (or willing) to solve the model, but behave according to the IS curve and Phillips curve. However, the partially rational agents still observe the actions of the central bank and can update their naïve (static) expectations by filtering the information contained in interest rate decisions.

One of the key assumptions of our model is that the central bank forecast is formed rationally and in a similar manner to the expectations formed by fully rational agents. These expectations (forecasts) of the fully rational sector and the central bank outperform the expectations (forecasts) of the partially rational agents. The assumption that central banks to some extent have an informational advantage is supported by empirical studies (Romer and Romer, 2000) and is also used by Melosi (2012) and others.

We denote the fully rational sector of the economy by the superscript F and the partially rational sector by the superscript P. Each sector consists of consumers, producers and monopolistically competitive price-setting retailers. Their behaviour is described by the following log-linear equations.

The IS curve of the fully rational sector is:

$$y_t^F = E^F\{y_{t+1}^F\} - \frac{1}{\sigma}(i_t - E^F\{\pi_{t+1}^F\} - r_t^n) + \varepsilon_t^D \qquad (1)$$

The IS curve of the partially rational sector is:

$$y_t^P = E^P\{y_{t+1}^P\} - \frac{1}{\sigma}(i_t - E^P\{\pi_{t+1}^P\} - r_t^n) + \varepsilon_t^D \quad (2)$$

The IS curves describe consumers' inter-temporal behaviour, linking the output gap y_t^k in each sector $k \in [F, P]$ negatively to the common nominal interest rate i_t net of expected inflation $E^k\{\pi_{t+1}^k\}$ and the common neutral real interest rate r_t^n, and positively to the sector-specific expected output gap $E^k\{y_{t+1}^k\}$. Expectations are formed differently in each sector and will be explained later. We also include a common demand shock ε_t^D, which follows an AR(1) process:

$$\varepsilon_t^D = \rho^D \varepsilon_{t-1}^D + \nu_t^D$$

Consumers in each sector have identical Dixit-Stiglitz preferences over the whole consumption good space, including the products of both the fully rational and partially rational sectors, which ensures symmetric demand for goods from both sectors. Retail goods producers are monopolistically competitive, with the Calvo-pricing constraint. This gives rise to standard New Keynesian Phillips curves.

The Phillips curve of the fully rational sector is:

$$\pi_t^F = E^F\{\pi_{t+1}^F\} + \kappa y_t^{AG} + \varepsilon_t^{CP} \quad (3)$$

The Phillips curve of the partially rational sector is:

$$\pi_t^P = E^P\{\pi_{t+1}^P\} + \kappa y_t^{AG} + \varepsilon_t^{CP} \quad (4)$$

The Phillips curves link current inflation π_t^k in each sector to sector-specific inflation expectations $E^k\{\pi_{t+1}^k\}$ and the current aggregate output gap y_t^{AG}. The output gap in the Phillips curves is not sector-specific because the retailers in each sector are also allowed to sell goods to consumers from the other sector. We include a generic cost-push shock ε_t^{CP}, which follows an AR(1) process:

$$\varepsilon_t^{CP} = \rho^{CP} \varepsilon_{t-1}^{CP} + \nu_t^{CP}$$

The forward-looking central bank sets a common interest rate for both sectors:

$$i_t = \rho + \phi^\pi E^F\{\pi_{t+1}^{AG}\} + \phi^y E^F\{y_{t+1}^{AG}\} + \varepsilon_t^{MP} \quad (5)$$

The central bank decides on the setting of the short-term nominal interest rate i_t based on the natural rate of interest ρ and its fully rational forecasts of aggregate inflation $E^F\{\pi_{t+1}^{AG}\}$ and the output gap $E^F\{y_{t+1}^{AG}\}$ for the following period. Therefore, there is some additional information contained in the interest rate decisions which the partially rational agents otherwise would not have. ϕ^π and ϕ^y are parameters of the sensitivity of central bank decisions with respect to inflation and the output gap respectively. The monetary policy shock ε_t^{MP} follows an AR(1) process:

$$\varepsilon_t^{MP} = \rho^{MP} \varepsilon_{t-1}^{MP} + \nu_t^{MP}$$

The error terms ν_t^D, ν_t^{CP} and ν_t^{MP} are all serially and mutually independent and identically distributed.

Aggregation of the two sectors yields:

$$y_t^{AG} = \Omega y_t^F + (1-\Omega) y_t^P \quad (6)$$

$$\pi_t^{AG} = \Omega \pi_t^F + (1-\Omega) \pi_t^P$$

where Ω is the share of the fully rational sector in the economy. To avoid possible divergence of accumulated wealth in the two sectors, we assume that there is a representative household which gathers agents from both the partially and fully rational sectors and pools their income at the end of the period to ensure symmetric distribution of wealth. Importantly, however, household members do not transfer information until the end of the period.

The agents in the partially rational sector behave optimally given their expectations. However, those expectations are not rational, but partly static and partly updated using the information contained in the monetary policy decisions of the central bank. In other words, consumers create their optimal consumption plans according to the standard IS curve, and monopolistically competitive retailers maximise their profits under the Calvo-pricing constraint consistently with the Phillips curve, but neither of them is able to solve the general equilibrium model to form rational expectations. However, all partially rational agents observe the behaviour of the central bank (the short-term interest rate *i*) and are able to invert the monetary policy rule to update their expectations E^P about the following period:

$$E^P\{\pi_{t+1}^P\} = \gamma^\pi \frac{i_t - \rho - \phi^y E^P\{y_{t+1}^{AG}\}}{\phi^\pi} + (1-\gamma^\pi)\,\pi_t^P \quad (7)$$

where γ^π is the learning parameter of updating expected inflation using the information contained in the central bank's interest rate decisions. The $(1-\gamma^\pi)$ fraction of the partially rational sector's inflation expectations is static. In fact, in this setup the partially rational agents do not expect aggregate inflation (or inflation in the fully rational sector) to differ from inflation and output in their own partially rational sector in the future:

$$E^P\{X_{t+1}^{AG}\} = E^P\{X_{t+1}^P\} = E^P\{X_{t+1}^F\} X \in \{\pi, y\} \quad (8)$$

This may be interpreted as if they ignore the existence of the fully rational sector, or are unable (or unwilling because of high costs) to derive the expectations of the fully rational agents. In an extension later, we show that if the partially rational agents do the proper expectations aggregation by forming different expectations for each sector, the results do not qualitatively change. In fact, the updating channel becomes even stronger and the price puzzle becomes even more evident. However, we consider the partially rational expectations formation in the extension to be "too rational" given the nature of the partial rationality. As a baseline we therefore use a simpler version where the partially informed agents ignore the fully rational sector when forming their expectations.

Expectations about the output gap are formed in a similar manner, with the learning coefficient γ^y:

$$E^P\{y_{t+1}^P\} = \gamma^y \frac{i_t - \rho - \phi^\pi E^P\{\pi_{t+1}^{AG}\}}{\phi^y} + (1-\gamma^y)\, y_t^P \qquad (9)$$

As can easily be seen from the equations above, the interest rate adjustment has a direct effect on partially rational agents' expectations. Particularly, raising interest rates signals to the partially rational agents that the central bank expects higher inflation or output (or both).

The expectations of the fully rational agents E^F are formed according to the rational expectations solution of the model:

$$E^F\{X_{t+1}\} = E\{X_{t+1}\}, X \in \{\pi,\, y\} \qquad (10)$$

This also holds for the expectations of the central bank as they appear in the monetary policy rule (5). The model could be extended to incorporate features such as an open economy and various additional rigidities (capital instalment costs, labour market rigidities, financial frictions). However, a simple model is sufficient to illustrate the functioning of the adverse signalling effects of monetary policy. The only extension we make is to employ habit persistence to make the impulse response functions hump-shaped and smoother after impact.

Extension: Habit Persistence

Habit persistence is a common feature of medium-scale macroeconomic models (for example, Christiano, Eichenbaum and Evans, 2005; Smets and Wouters, 2004). Introducing habit persistence in our model makes the impulse response functions to economic shocks smoother and hump-shaped, in line with the empirically observed responses of consumption and output.

According to Smets and Wouters (2004) and Dennis (2008), the IS curves under (external) habit persistence change to

$$y_t^F = \frac{1}{1+\chi} E^F\{y_{t+1}^F\} + \frac{\chi}{1+\chi} y_{t-1}^F - \frac{1-\chi}{\sigma(1+\chi)}(i_t - E^F\{\pi_{t+1}^F\} - r_t^n) + \varepsilon_t^D$$

and (11)

$$y_t^P = \frac{1}{1+\chi} E^P\{y_{t+1}^P\} + \frac{\chi}{1+\chi} y_{t-1}^P - \frac{1-\chi}{\sigma(1+\chi)}(i_t - E^P\{\pi_{t+1}^P\} - r_t^n) + \varepsilon_t^D$$

where χ is the external habit persistence parameter. When $\chi = 0$, the model collapses to the previous case with monotonic impulse responses.

Model Implications

The distinctive features and key parameters of our model are the share of fully rational agents Ω and the learning parameters $\gamma^\pi$and γ^y of partially rational agents. In the limit case of $\Omega = 1$ the model collapses to the simple New Keynesian model with fully rational agents only. For $\Omega = 0$

the model is undetermined. In the case where partially rational agents have fully static expectations $\gamma^{\pi} = \gamma^{y} = 0$, they do not filter any information from the interest rate setting and no adverse effects of signalling emerge.

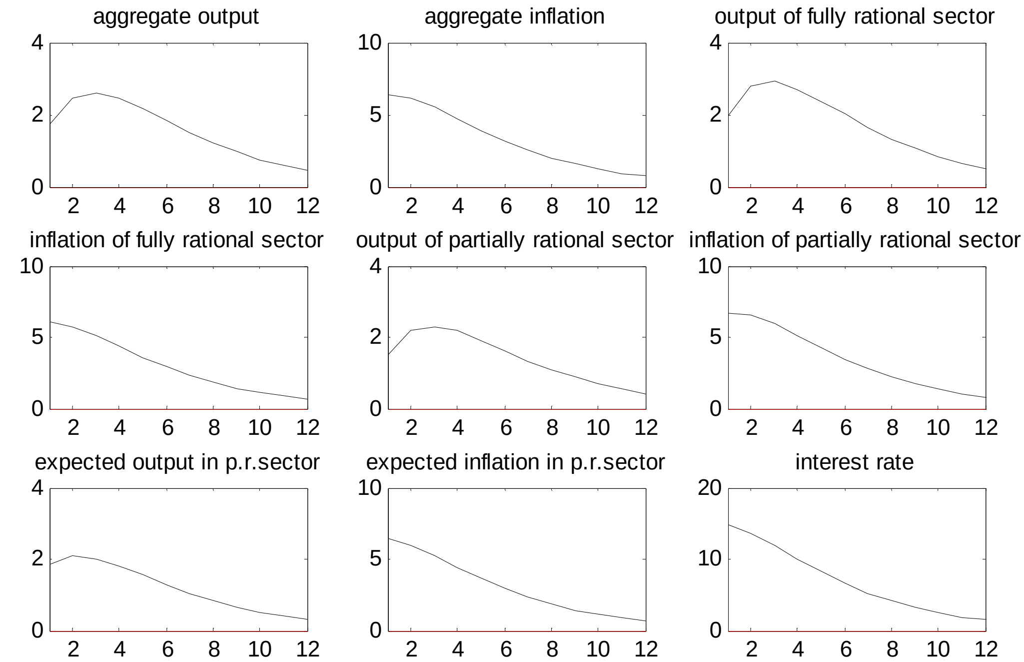
We start by assuming that half of the agents are fully rational and that partially rational agents derive their expectations based one to one on learning and past observations, $\Omega = \gamma^{\pi} = \gamma^{y} = 0.5$. The habit persistence parameter is set to $\chi = 0.9$, in line with Fuhrer (2000), who estimates χ to be either 0.8 or 0.9 depending on the estimator used. The other model parameters are calibrated in line with Clarida, Gali and Gertler (1999). In Figure 1 we report the impulse response functions to all three types of shocks in the model – the demand shock, the cost-push shock and the monetary policy shock. The sizes of the shocks are deviations of 1 per cent (demand shock) and 1 percentage point (cost-push and monetary policy shocks) from the steady state. The responses represent log-deviations from the respective steady state values, i.e. per cent deviations for output and percentage point deviations for inflation and the interest rate.

The demand shock has standard effects on all the variables of the model. Higher output leads to higher inflation in both the fully (πF) and partially rational (πP) sectors. The reaction of the fully rational sector is more pronounced, as it completely reflects the information about the shock realisation. The central bank reacts by raising interest rates (i), which gradually pushes aggregate output (yAG) and inflation (πAG) towards the steady state.

The impulse response functions of the cost-push shock also show standard behaviour. A positive shock to inflation augments inflation expectations in both sectors. The shock is observed by both sectors simultaneously and the impulse response of their expectations is similar. The central bank reacts to the shock by hiking interest rates. The higher interest rates reduce output, with a larger impact on the expectations of partially rational agents, who cannot distinguish whether the central bank hike is a response to a demand or cost-push shock, leading to even higher inefficiency and output loss.

Figure 1: Impulse Response Functions

Demand shock (ν_t^D)



Cost-push shock (ν_t^{CP})

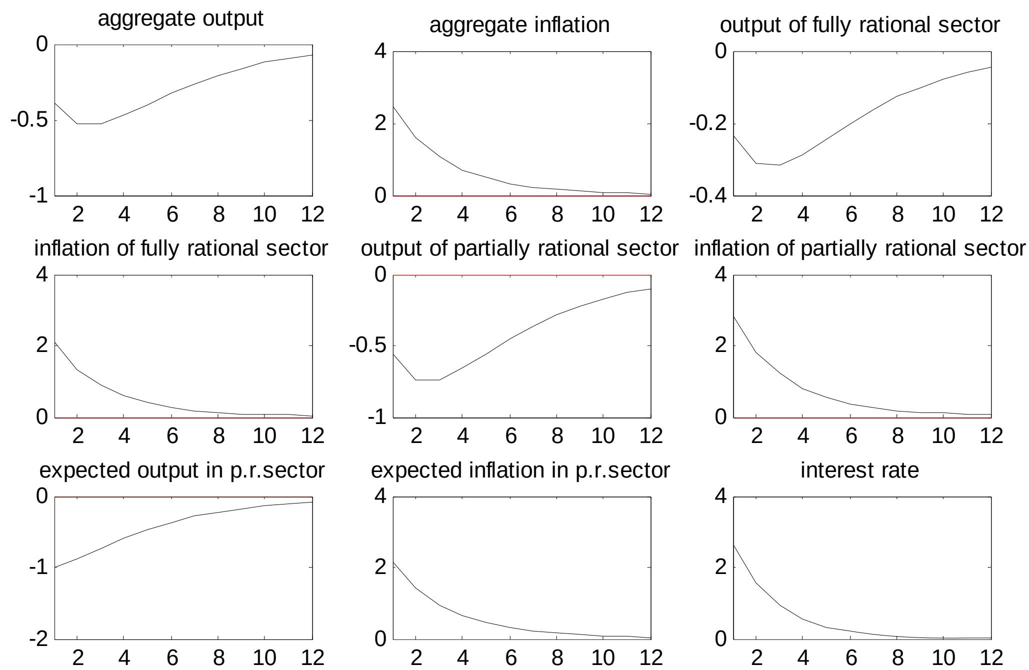
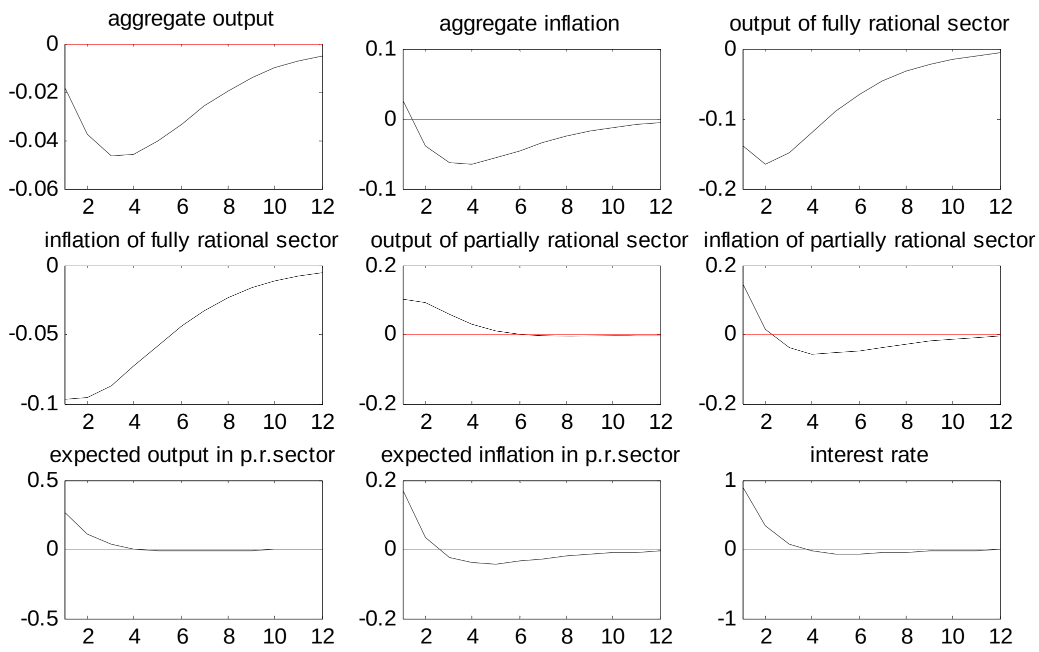


Figure 1 contd.: Impulse Response Functions

Monetary policy shock (ν_t^{MP})

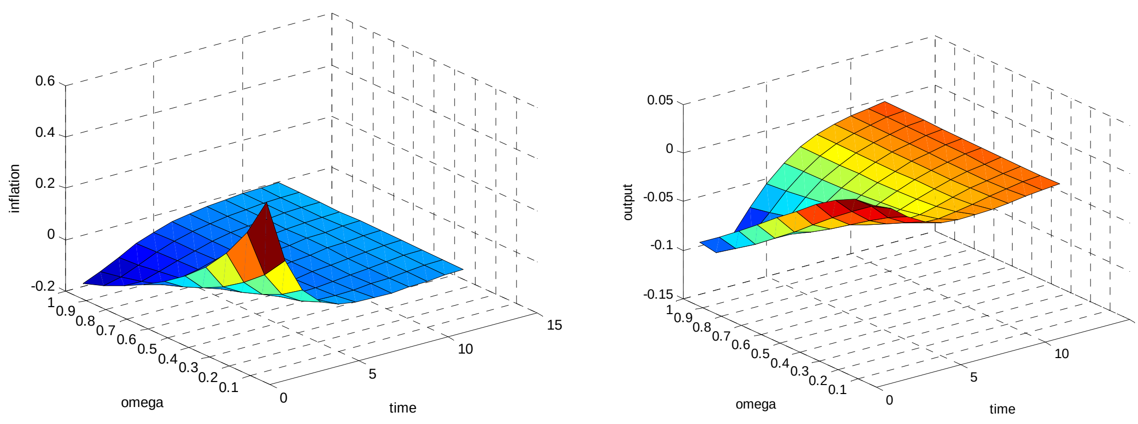


The monetary policy shock is of key interest to us. The partially rational agents interpret the change in interest rates as a standard monetary policy reaction to expected inflation and output. Therefore, in the case of a contractionary monetary policy shock, the partially rational agents expect higher inflation and output (given a positive value of ϕ^y in the reaction function). In contrast, the fully rational agents interpret the increase in interest rates as a shock to the rule and expect lower inflation and output.

Sensitivity to Key Parameter Values

The overall effect of the monetary policy shock on the economy (aggregate inflation and output) depends heavily on the share of fully rational agents in the economy. Figure 2 shows the impulse response functions as the share of fully rational agents Ω varies between 0 and 1. The remaining parameter values are identical to the benchmark case described above.

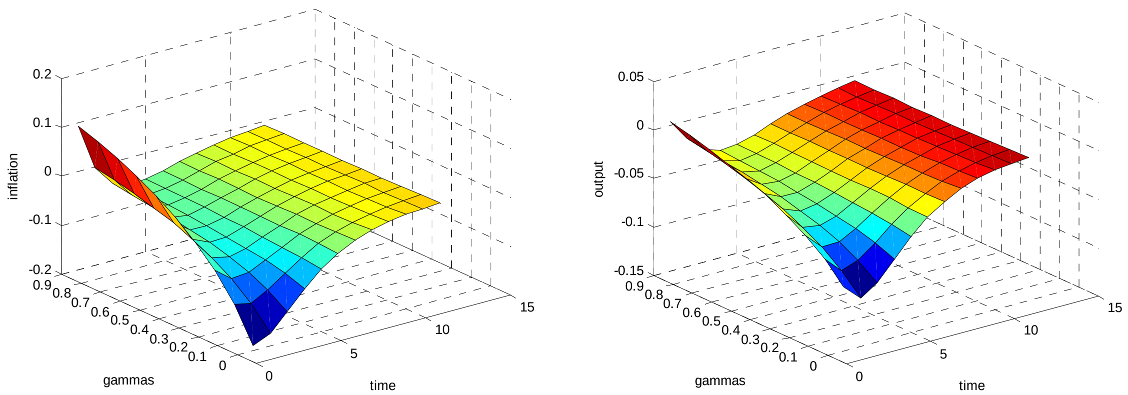
Figure 2: Sensitivity of Monetary Policy Shock Responses to Parameter Ω



When almost all agents are partially rational (Ω = 0.01), inflation and output rise immediately after a contractionary monetary policy shock, as the partially rational agents expect higher inflation and output. In the opposite case of all agents being fully rational (Ω = 1), inflation and output decline after a monetary policy contraction. In the baseline model (Ω = 0.5), as also presented in Figure 1, our simulations reveal a conventional reaction of the economy to the monetary shock, i.e. declining inflation and output, although the initial reaction of inflation is slightly positive, as the partially rational agents initially expect higher output. This also offers an explanation of the empirically observed "price puzzle".

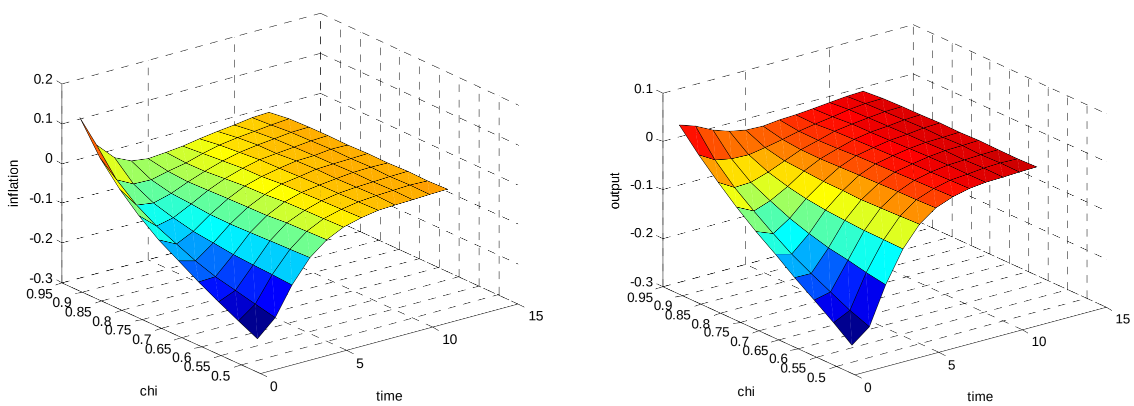
Another important parameter of our model is the learning parameter of partially rational agents γ. When these agents form their expectations in a purely static manner ($\gamma^{\pi} = \gamma^{y} = 0$), inflation and output conventionally decline in reaction to a monetary policy tightening, as the partially rational agents do not react to the monetary policy signal. However, when the partially rational agents react fully to the policy signal ($\gamma^{\pi} = \gamma^{y} = 1$), inflation rises in the first period and then falls to slightly negative values (Figure 3), i.e. the adverse effects of the updating channel are strong.

Figure 3: Sensitivity of Monetary Policy Shock Responses to Parameters γπ = γy



The impulse responses of inflation and output to the monetary policy shock may also depend on the habit persistence parameter χ. In the model without habit persistence ($\chi = 0$), both inflation and output decline in response to the monetary policy shock. However, with high persistence (close to 0.9), the impulse responses of inflation become positive (Figure 4).

Figure 4: Sensitivity of Monetary Policy Shock Responses to Parameter χ



Overall, the simulation results suggest that our model is sensitive to the calibration of its key parameters – the share of fully rational agents, the learning parameter and habit persistence. A slight shift in the values of the key parameters from their initial values can change the direction of the impulse response reactions to a monetary policy shock.

Extension: Partially Rational Agents Form Expectations about the Fully Rational Sector

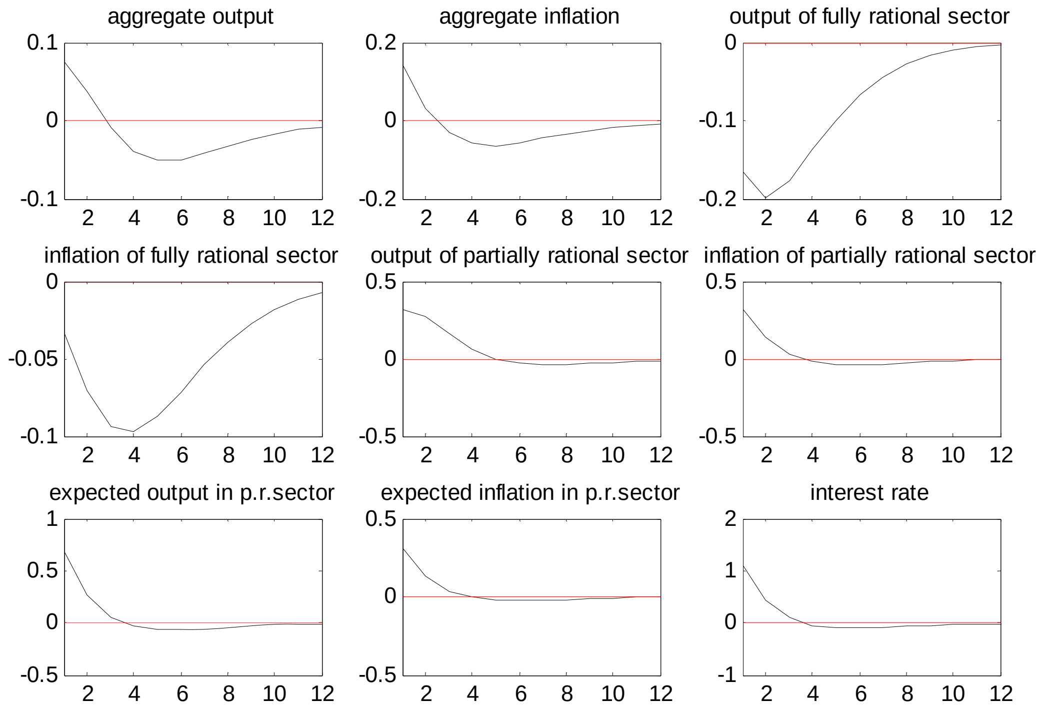
In this part, we consider an alternative version of the formation of aggregate inflation expectations in the partially rational sector. In the baseline specification, the partially rational agents' expectations about aggregate variables were identical to their expectations about the corresponding variables in their own sector. In other words, the partially rational agents ignored the existence of the fully rational sector when forming expectations about aggregate variables.

Here, we consider a more elaborate version of aggregate variables expectations formation in the partially rational sector. Specifically, the partially rational agents recognise that part of the economy is fully rational and that inflation and output in this part of the economy may differ from inflation and output in the partially rational sector. Therefore, the partially rational agents form expectations about inflation and output in each sector separately, but still in the same manner as in the baseline model. The expectations formation of the partially rational sector behaves according to the inverted monetary policy rules using the aggregation formula (6):

$$
\begin{aligned}
E^P\{\pi_{t+1}^P\} &= \gamma^\pi \frac{i_t - \rho - \phi^y[\Omega E^P\{y_{t+1}^F\} + (1-\Omega)E^P\{y_{t+1}^P\}]}{\phi^\pi} + (1-\gamma^\pi)\,\pi_t^P \\
E^P\{y_{t+1}^P\} &= \gamma^y \frac{i_t - \rho - \phi^\pi[\Omega E^P\{\pi_{t+1}^F\} + (1-\Omega)E^P\{\pi_{t+1}^P\}]}{\phi^y} + (1-\gamma^y)\,y_t^P \\
E^P\{\pi_{t+1}^F\} &= \gamma^\pi \frac{i_t - \rho - \phi^y[\Omega E^P\{y_{t+1}^F\} + (1-\Omega)E^P\{y_{t+1}^P\}]}{\phi^\pi} + (1-\gamma^\pi)\,\pi_t^F \\
E^P\{y_{t+1}^F\} &= \gamma^y \frac{i_t - \rho - \phi^\pi[\Omega E^P\{\pi_{t+1}^F\} + (1-\Omega)E^P\{\pi_{t+1}^P\}]}{\phi^y} + (1-\gamma^y)\,y_t^F
\end{aligned}
\tag{12}
$$

This is basically a set of four equations with four unknown expectations terms, which is easily solved. Figure 5 shows the impulse response functions to a monetary policy shock. Under the same parameter values, the responses are more hump-shaped and the price puzzle is stronger. Both inflation and output expectations in the partially rational sector rise after a restrictive monetary policy shock, as the interest rate hike is interpreted as a signal of high inflation and output. The elevated expectations also drive the realisations of output and inflation, which outweigh the fully informed sector in the first few quarters after the impact of the restrictive shock. The updating channel is stronger compared to the previous form of expectations formation in the partially rational sector, leading to an adverse reaction of both aggregate inflation and output. This is because the partially informed agents continue to fully believe the interest rate signals. When they correctly estimate the negative reaction of expectations in the fully informed sector, they believe in an even larger positive demand shock, which, within their information set, is consistent with inflation being at the inflation target.

Figure 5: Impulse Response Functions – Monetary Policy Shock (ν_t^{MP})



4. Empirical Assessment of the Updating Channel

In this section we evaluate the significance and magnitude of the updating channel of monetary policy on a cross-country sample of OECD countries, using the Consensus Forecasts professional survey (CF) as a proxy for inflation and output expectations.

Methodology

The question to be tested is whether an unexpected interest rate decision triggers an update of private agents' inflation expectations in an unintended direction. In particular, the model presented in Section 3 suggests that an unexpected hike in the policy rate can signal to the partially rational agents that the central bank expects high inflation, leading to an update of inflation expectations in an adverse direction, counteracting the intended effects of the hike. To test for the presence and strength of the updating channel, we conduct an empirical estimation of how interest rate surprises influence inflation expectations in a panel of selected OECD countries.

We estimate the following basic specification:

$$\Delta E_{t,i}^{PUB}[\pi_{t+h}] = \delta_i + \lambda^{PUB}\Delta E_{t-1,i}^{PUB}[\pi_{t+h,i}] + \lambda^{CB}\Delta E_{t-1,i}^{CB}[\pi_{t+h,i}] + \varphi r_{t-1,i}^{SURP} + \tau^r TI_t r_{t-1,i}^{SURP} + \tau^E TI_t \Delta E_{t-1,i}^{CB}[\pi_{t+h,i}] + \tau TI_t + \beta \Delta X_{t,i} + \mu CE_t + \nu_{t,i} \quad (13)$$

In this equation, we examine whether the change in the public's inflation forecast $E_{t,i}^{PUB}[\pi_{t+h}]$ (a similar equation is used to test the effects on the output growth forecast) for horizon h depends on the lagged change of the central bank's forecast $E^{CB}_{t-1,i}[\pi_{t+h,i}]$ and the lagged policy interest rate surprise $r^{SURP}_{t-1,i}$, while controlling for the effects of contemporaneous macroeconomic news contained in the vector $X_{t,i}$ and the calendar effect CE_t. The country fixed effects δ_i make the specification equivalent to running the regression in differences and thus controlling for time-invariant country-specific endogeneity.

Although in the model presented above the partially rational agents update their inflation and output gap forecasts according to changes in the interest rate, it is clear that many central banks guide expectations by publishing forecasts rather than by signalling via interest rate shocks. Therefore, we control for published central bank forecasts in the estimated equations. We suppose that if there was any additional value in a published central bank forecast, the public would use it to update their forecasts. This effect is captured by the estimated parameter $\lambda_{CB} > 0$.

However, we expect that there is additional information contained in the interest rate decision itself. This is either because the published forecast may be biased by "wishful thinking" intended to guide expectations in a desired way, or because the interest rate decision may contain more judgement-based and/or more recent information than the published forecast. The differences between the views of the staff preparing the forecast and the views of the decision-making committee may also carry a valuable signal. We estimate equation (13) to examine whether interest rate surprises affect private agents' expectations about inflation and output growth, and if so, in which direction and to what degree. This effect is captured by the parameter φ. Non-zero values of φ would imply that the central bank's interest rate surprise conveys extra information in addition to its published forecasts and other publicly available information. The standard understanding of monetary policy transmission would imply negative φ: an unexpected interest rate hike would drive down expected inflation, as higher interest rates (a contractionary monetary policy shock) are understood to reduce inflation in the medium term. However, if the updating channel works as hypothesised in the previous section, we would observe positive φ (which is indeed the case): an unexpected interest rate hike increases the inflation expectations of private agents. This may be because the agents update their prior information on future inflation by filtering the signal of perceived inflationary pressures, which is revealed by the central bank hiking its rates.

Finally, we include the central bank transparency index TI_t and the interaction terms of $\mathrm{r}^{\mathrm{SURP}}_{\mathrm{t-1,i}}$ and $\mathrm{E}^{\mathrm{CB}}_{\mathrm{t-1,i}}[\pi_{\mathrm{t+h,i}}]$ with the transparency index. When the central bank reveals detailed information about future macroeconomic developments, an interest rate surprise can only be understood as an unexpectedly timed expected policy. However, when the central bank does not publish its forecast, an interest rate surprise conveys much more information and private agents may change their expectations about the fundamental trends in the economy. On the other hand, central bank transparency and credibility may strengthen the value of the information contained in surprising interest rate decisions. As we show later, the empirical results for the effects of central bank transparency are as inconclusive as these theoretical considerations.

Data, Timing and Estimation

The explained variables in the main regression equations – the change in private agents' inflation expectations $\Delta E^{PUB}_{t,i}[\pi_{t+h}]$ and the change in their output expectations $\Delta E^{PUB}_{t,i}[y_{t+h}]$ – are drawn from the Consensus Forecasts professional survey for the countries concerned. Although Consensus Forecasts are published monthly, the surveys only refer to the current and next calendar years and report the expected change in the price level over the following 12 months. This causes problems in January, when the current year and next year reference switches to another year. We mitigate the problem by constructing the change of private expectations in January as the difference between the January forecast for the current year and the previous month (December) forecast for the next year. Furthermore, using lagged values of forecast changes forces us leave out the January observation in every year. Due to the use of calendar years, a jump in the forecast horizon occurs at the beginning of each year, with a horizon of less than one year ahead in December changing to a horizon of one-to-two years ahead in February. We account for this effect by adding a time variable CE_t which starts from 1 in January and increases monotonically to 12 in December each year.

For the construction of the central bank forecast change we gathered vintage data of central banks' inflation and GDP growth forecasts from their websites and inflation reports. Here again, the published forecast figures usually refer to calendar years, which makes them consistent with the Consensus Forecast data. In some cases in earlier periods, the projections were reported for the following 12 months. Where these one-year-ahead forecasts roughly correspond to a given calendar year, we include these observations in the sample. Further, central bank forecasts are generally not issued every month. We assume, for example, that a forecast issued in March is still valid in April and May, until the new forecast is released in June.

Another key explanatory variable is the interest rate surprise. As the main hypothesis of this paper concerns the effects of this variable, we construct three alternative measures of the interest rate surprise to ensure robustness of the results. First, we construct the interest rate surprise as the difference between Consensus Forecast's expected change in the 3-month money market rate and the realised change in the monetary policy rate. However, we were concerned that this definition of the policy rate change might be prone to endogeneity, because news arriving between the past Consensus Forecast release (and thus affecting the change in the forecast) and the interest rate decision does affect both the interest rate surprise and the change in Consensus Forecasts expectations. To reduce the endogeneity problem, we lag the interest rate surprise by one month and use instrumental estimation. Furthermore, we construct an alternative measure of surprise as the deviation from the Taylor rule-implied policy rate. We use both a backward-looking (based on current observations) and forward-looking Taylor rule (based on central banks' forecasts), which are estimated for each country separately. The endogeneity bias should be smaller in the latter case, as new information or central bank forecasts embedded in the forward-looking Taylor rule (against which the surprise is measured) already contain the news.

We interact the policy rate surprise and central bank forecast variables with a measure of central bank transparency. As the proxy for central bank transparency we use Siklos' (2010) transparency index database, which we update for improvements in central banks' transparency after 2009. As further macroeconomic control variables we include the change in the inflation rate (we use one lag because inflation data are typically published with a one-month lag) and the real-time most recently observed change in real GDP growth (we use the OECD database of real-time data to get the vintages of GDP revisions). We also include the change in the nominal effective exchange rate as a control variable. Inclusion of these variables should further reduce the endogeneity problem.

We use data from 12 economies, including both inflation-targeting countries (Canada, the Czech Republic, Hungary, Norway, Poland, Sweden, Turkey, Japan and the United Kingdom) and economies where inflation targeting is not explicit (the euro area, Switzerland and the United States). The selection of countries was guided by data availability and structural similarity (developed economies, inflation targeters). Availability of both central bank forecasts and Consensus Forecasts was another criterion. The sample covers the period between January 2001 and March 2013. We compiled around 1,100 effective observations, which enter the regressions.

Table 1: Summary Statistics of Key Variables

	Mean	sd	min	max
Change of CPI forecast, CF	-.0092975	.302191	-3.1	2.5
Change of CPI forecast, CB	.0027563	.3507938	-1.8	3.7
Policy rate surprise, CF	.0174932	.54146	-2.8	9.9
Policy rate surprise, Taylor BW	-1.67e-09	.3828077	-3.666882	5.534725
Policy rate surprise, Taylor FW	2.95e-09	.2434574	-2.052365	3.05042

Table 1 shows the summary statistics of the key variables entering the regressions. Notably, all the measures of the policy interest rate surprise are centred around mean values which are not statistically different from zero (the standard deviation comes from the pooled sample). The same holds for the mean changes in the central bank forecasts and Consensus Forecasts. Interestingly, the standard deviations of the surprises are marginally lower when the deviation from the Taylor rule is used as the definition, suggesting that simple Taylor rules may be better predictors for interest rate changes than surveys among forecasters and analysts. The summaries for individual countries (available upon request) show that the forecast changes and policy rate surprises were generally higher in converging economies such as the Czech Republic, Hungary and Turkey than in the other economies in the sample.

We ran both fixed effects and random effects estimators when estimating equation (13). Although the fixed effects estimator is more likely to be consistent, as it controls for time-invariant endogeneity, the Hausman test suggests that there is no significant difference between the two, possibly because the explained and the core explanatory variables are used in differences. Because of this and the higher efficiency of the random effects estimator, we present only the results of the random effects regressions.

In the estimations, we attempt to control for further sources of endogeneity in estimating the key parameters. We control for the endogeneity resulting from employing a lagged dependent variable in a panel regression by GMM-style instrumenting for the lagged dependent variable in the spirit of Arellano and Bond (1991).

Further endogeneity might arise from the fact that some important macroeconomic news (not immediately observed in macroeconomic data, e.g. the fall of Lehman Brothers in October 2008) might have arrived between the time when the Consensus Forecast was released and the date of the monetary decision. To eliminate this source of endogeneity we lag the interest surprise in regression (13) and instrument the interest rate surprise by using its own lagged values and other exogenous regressors. However, part of this type of endogeneity may still be present, as it is not clear exactly when the Consensus Forecast responders updated their forecasts and what information they took into account. Therefore, the lag of the Consensus Forecast revision after an event may be even longer than one month.

In equation (13), all the coefficients except the intercept are assumed to be uniform across countries, which gives us a sufficient number of observations for the estimation. However, this assumption might be too strong and the coefficients might differ significantly between countries. To some degree, we treat this potential heterogeneity by defining interest rate surprises as deviations from Taylor rules estimated separately for each country. In the Appendix, we present the results of extending the estimated equation to include the interaction terms of $r^{SURP}_{t-1,i}$, $E^{CB}_{t-1,i}[\pi_{t+h,i}]$ and $E^{CB}_{t-1,i}[GDP_{t+h,i}]$ with the ratio of the estimated Taylor coefficients ϕ^{π}/ϕ^{y}. It turns out that some of these interaction terms are statistically significant in our specifications, and when significant, they display negative signs. However, the core parameters we examine (the effects of an interest rate surprise and central bank forecasts) and the power of the estimation remain mostly unchanged. Therefore, and for the sake of clarity of the results, in the rest of this section we comment on the estimation results based on equation (13).

5. Results

The Effect of Central Banks' Signals on Inflation Expectations

The estimation results for inflation expectations suggest that the effects of central banks' signals are robustly significant for all three specifications of the interest rate surprise (Table 2). This is consistent with the results of other empirical studies (Romer and Romer, 2000; Filacek and Saxa, 2012). What is striking is the robust significance of the coefficient on the interest rate surprise, which goes in the direction of our hypothesis of the adverse effect of monetary policy signalling.

According to the estimation results in all specifications, a contractionary monetary policy surprise triggers an increase in private inflation expectations, which contradicts the intuitive understanding of monetary policy transmission. Our hypothesis is that part of this effect can still be ascribed to endogeneity resulting from common news, but part is the adverse effect of monetary policy signalling. As private agents observe an unexpected interest rate hike, they may infer that the central bank expects inflation to rise and adjust their expectations accordingly. It is important to stress that this effect is present even when we control for the effect of published central bank forecasts. The sensitivity of private expectations to the interest rate surprise is roughly of the same size as the sensitivity to the central bank forecast. This suggests that the information contained in the unanticipated interest rate decision complements the information contained in the forecast.

The signalling effect seems to be independent of the degree of central bank transparency. Transparency does not appear to play a significant role in affecting private forecasts in the regression, regardless of whether we use the overall transparency index or its economic transparency subcomponent. This might be explained by the ambiguous effects of central bank transparency on the strength of the updating channel. As mentioned in the introduction, higher transparency reduces the effects of surprising monetary policy actions on expectations on the one hand, but on the other makes surprises less likely and therefore once they appear, they might have more pronounced effects.

We do not observe significant effects of macroeconomic control variables except for observed inflation; the calendar effect is significant for all specifications.

Table 2: Effects of Central Bank Decisions and Forecasts on Expected Inflation

	Basic Surprise	Taylor BW Surprise	Taylor FW Surprise
L.Change of CPI forecast, CF	-0.0491	0.0273	0.233***
	(-0.81)	(0.47)	(2.67)
L.Policy rate surprise	0.0602***	0.116***	0.102***
	(4.23)	(4.68)	(4.19)
L.Change of CPI forecast, CB	0.125***	0.108***	0.0993***
	(6.12)	(5.49)	(4.34)
Transparency	0.000284	-0.000128	-0.000953
	(0.10)	(-0.05)	(-0.38)
Transp.#P.R.surprise	0.00732	0.00913	0.00408
	(0.89)	(0.72)	(0.32)
Transp.#Chng of CPI forec.CB	-0.00309	-0.00131	0.00155
	(-0.30)	(-0.13)	(0.15)
LD.CPI Inflation	0.0829***	0.0791***	0.0716***
	(8.59)	(8.33)	(6.75)
D.NEER	0.00183	0.000943	-0.000805
	(0.74)	(0.39)	(-0.33)
D.GDP growth vintage	-0.291	-0.665	0.101
	(-0.60)	(-1.38)	(0.19)
Calendar effect	-0.00392***	-0.00471***	-0.00528***
	(-2.65)	(-3.24)	(-3.53)
Constant	0.0275**	0.0312***	0.0325***
	(2.37)	(2.78)	(2.79)
Observations	1032	1036	838
R-squared	0.122	0.167	0.190

Note: *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The Effect of Central Banks' Signals on Output Expectations

The estimation results for the effects of central bank communication on GDP growth expectations differ from the results obtained for inflation. The coefficient on the interest rate surprise is now negative for all three specifications (Table 3). The negative interest rate coefficients mean that a restrictive monetary policy surprise leads to a decrease in the output expectations of private agents, which coincides with the intuitive understanding of monetary policy transmission.

Interestingly, this result is consistent with the impulse-response functions to a monetary policy shock shown in Figure 1, where aggregate inflation reacts positively, and output negatively, to an interest rate hike for a wide range of parameter specifications, including the baseline model. The negative reaction of output expectations might be a consequence of having inflation-targeting central banks in our sample, which are presumably more sensitive to inflation than output ($\phi^{\pi} > \phi^{y}$). Consequently, private agents, upon observing an interest rate surprise, mainly update their inflation expectations. Expectations about output then react according to the standard view of monetary policy transmission. Another explanation may be that cost-push shocks were more common in the sample countries, and that restrictive monetary policy was perceived as a signal of lower output.

In contrast to inflation expectations, the central bank forecast does not have a significant effect on output expectations. This suggests lower information asymmetry between the central bank and private forecasters in the case of GDP.

The coefficient on central bank transparency is positive and marginally significant when the Taylor rule-based specifications are used. Regarding the other control variables, both observed inflation and GDP data are insignificant, whereas the nominal exchange rate is highly significant for all specifications. The estimated coefficient for the exchange rate is positive, which probably reflects the fact that nominal effective exchange rate appreciation typically coincides with stronger expected GDP growth. Analogously to the previous estimation, the calendar effect is highly significant.

Table 3: Effects of Central Bank Decisions and Forecasts on Expected GDP Growth

	Basic Surprise	Taylor BW Surprise	Taylor FW Surprise
L.Change of GDP forecast, CF	0.628***	0.699***	0.678***
	(9.25)	(10.92)	(10.56)
L.Policy rate surprise	-0.0687***	-0.197***	-0.187***
	(-2.95)	(-5.54)	(-5.18)
L.Change of GDP forecast, CB	0.0396	0.0396	0.0295
	(1.60)	(1.61)	(1.11)
Transparency	-0.00171	-0.00134	-0.000419
	(-0.46)	(-0.36)	(-0.11)
Transp.#P.R.surprise	0.00450	0.0310*	0.0342*
	(0.40)	(1.73)	(1.81)
Transp.#Chng of GDP forec.CB	-0.0162	-0.0194	-0.0154
	(-1.25)	(-1.48)	(-1.12)
LD.CPI Inflation	0.0210	0.0152	0.0150
	(1.33)	(0.96)	(0.92)
D.NEER	0.0103***	0.0104***	0.0108***
	(2.92)	(2.95)	(2.93)
D.GDP growth vintage	0.871	1.279	0.878
	(1.09)	(1.58)	(1.07)
Calendar effect	-0.00786***	-0.00635***	-0.00639***
	(-3.59)	(-2.90)	(-2.83)
Constant	0.0297*	0.0266	0.0228
	(1.79)	(1.60)	(1.32)
Observations	873	876	838
R-squared	0.270	0.275	0.269

Note: *t* statistics in parentheses,
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusions

In this paper we explored the possibility that an unexpected change in the monetary policy rate guides the expectations of private agents in an adverse direction. We label these adverse effects of monetary policy signalling as an "updating channel", because the information contained in the unexpected policy rate change leads to an update of private agents' expectations about future economic developments.

First, we built a simple New Keynesian general equilibrium model with partially rational agents to illustrate the idea of the adverse effects of monetary policy signalling, and we explored the sensitivity of the strength of this "updating channel" to model parameters such as the share of partially rational agents and their learning parameter. We illustrate that when the share of partially rational agents in the economy is high, and their parameter of learning from central bank decisions is high, the transmission of monetary policy shocks to the economy can even become reversed.

Second, we explore the behaviour of Consensus Forecasts (as a proxy for private agents' expectations) in response to unexpected interest rate changes. We document a significant and robust relationship between interest rate surprises and changes in expected inflation, which appears to counteract the standard monetary policy transmission. This effect, however, can be partially ascribed to the presence of endogeneity in the estimation, although we use several techniques to mitigate its impact. On the other hand, the reaction of output growth forecasts is in line with the standard view of monetary policy transmission, so that an interest rate hike is followed by lower output growth expectations. The "updating channel" does not appear to be strong in the case of output, possibly because the central banks in our sample react mainly to inflation. Another explanation may be that cost-push shocks are more frequent than demand shocks. However, this result is consistent with the model results, as output expectations fall after an interest rate hike for a broad range of parameters, including the baseline specification.

Overall, we have illustrated the possibility of adverse effects of monetary policy signalling in a theoretical model and documented the presence of these effects in the data. However, we have not proposed any way of mitigating or counteracting the adverse effects of the "updating channel". In addition, further empirical research is needed to explore which factors (such as the distance from the zero lower bound and the frequency of interest rate changes) determine the strength of the updating channel.

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Appendix - Estimations Allowing for Heterogeneity between Countries

Table A1: Effects of Central Bank Decisions and Forecasts on Expected Inflation

	Basic Surprise	Taylor BW Surprise	Taylor FW Surprise
L.Change of CPI forecast, CF	0.195**	0.240***	0.229***
	(2.42)	(3.00)	(2.63)
L.Policy rate surprise	0.0483**	0.194***	0.169***
	(2.53)	(6.53)	(4.72)
L.Change of CPI forecast, CB	0.102***	0.0848***	0.0897***
	(4.50)	(3.84)	(3.48)
Transparency	0.00134	0.00116	-0.00113
	(0.58)	(0.52)	(-0.45)
Transp.#P.R.surprise	0.00931	0.0165	0.00834
	(1.25)	(1.43)	(0.65)
Transp.#Chng of CPI forec.CB	0.00204	-0.00000306	0.000844
	(0.21)	(-0.00)	(0.08)
Taylor#P.R.surprise	-0.00194	-0.0823***	-0.0573***
	(-0.14)	(-4.35)	(-2.62)
Taylor#Chng of CPI forec.CB	-0.00178	0.00904	0.00903
	(-0.13)	(0.70)	(0.63)
LD.CPI Inflation	0.0778***	0.0727***	0.0720***
	(7.89)	(7.47)	(6.79)
D.NEER	0.000593	-0.000756	-0.000954
	(0.27)	(-0.35)	(-0.39)
D.GDP growth vintage	0.485	-0.116	0.0356
	(0.94)	(-0.23)	(0.07)
Calendar effect	-0.00420***	-0.00444***	-0.00532***
	(-3.06)	(-3.29)	(-3.57)
Constant	0.0226**	0.0213**	0.0325***
	(2.14)	(2.05)	(2.80)
Observations	981	984	838
R-squared	0.185	0.216	0.198

Note: *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Effects of Central Bank Decisions and Forecasts on Expected GDP Growth

	Basic Surprise	Taylor BW Surprise	Taylor FW Surprise
L.Change of GDP forecast, CF	0.642***	0.698***	0.683***
	(9.26)	(10.29)	(10.15)
L.Policy rate surprise	-0.0132	-0.112**	-0.0905*
	(-0.43)	(-2.15)	(-1.69)
L.Change of GDP forecast, CB	0.0603**	0.0626**	0.0615**
	(2.23)	(2.33)	(2.08)
Transparency	-0.00183	-0.00159	-0.000776
	(-0.50)	(-0.43)	(-0.21)
Transp.#P.R.surprise	0.0110	0.0361**	0.0385**
	(0.96)	(2.02)	(2.04)
Transp.#Chng of GDP forec.CB	-0.0185	-0.0207	-0.0194
	(-1.42)	(-1.59)	(-1.41)
Taylor#P.R.surprise	-0.0579***	-0.0789**	-0.0846**
	(-2.65)	(-2.43)	(-2.55)
Taylor#Chng of GDP forec.CB	-0.0265	-0.0273	-0.0368**
	(-1.58)	(-1.62)	(-2.02)
LD.CPI Inflation	0.0192	0.0135	0.0149
	(1.22)	(0.85)	(0.92)
D.NEER	0.00954***	0.00945***	0.0104***
	(2.69)	(2.69)	(2.81)
D.GDP growth vintage	0.893	1.207	0.851
	(1.12)	(1.50)	(1.05)
Calendar effect	-0.00732***	-0.00607***	-0.00619***
	(-3.34)	(-2.77)	(-2.74)
Constant	0.0246	0.0235	0.0198
	(1.48)	(1.41)	(1.15)
Observations	873	876	838
R-squared	0.277	0.286	0.280

Note: *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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