Taking two steps at a time: On the optimal step pattern of policy rates

Petra Gerlach-Kristen*
University of Hong Kong and University of Basel
Preliminary draft – comments welcome

February 10, 2004

Abstract

Most central banks change interest rates in steps of 25, 50 or 75 basis points at pre-scheduled dates. This paper provides a model to determine optimally the step size of interest rate changes and the frequency of policy decisions. In contrast to the existing literature, which assumes that the step pattern is due to the central bank's reluctance to unsettle financial markets, we argue that steps are necessary to focus the policy discussion. The analysis indicates that a step size of 25 basis points appears suboptimally large in many industrialised countries and that more frequent policy meetings seem desirable e.g. in the US.

Keywords: interest rate steps, monetary policy committees
JEL Classification: E43, E58

*Hong Kong Institute of Economics and Business Strategy, University of Hong Kong, 919 K.K. Leung Building, Pokfulam Road, Hong Kong, email: gerlach@hku.hk. I thank Stefan Gerlach, Anders Vredin, James Yetman and in particular Julian Wright for helpful comments and suggestions and the seminar participants at the University of Hong Kong for useful discussions.

1 Introduction

Most central banks change interest rates in multiples of 25 basis points and decide on the stance of monetary policy at pre-scheduled dates.[1] The frequency of policy decisions is e.g. eight times a year for the Federal Open Market Committee (FOMC) and twelve times a year for the Monetary Policy Committee (MPC) in the UK. Some central banks, such as the Federal Reserve, have in recent years frequently changed the level of interest rates by two steps at a time, while others have done so more rarely.

The literature on interest rate stepping tries to explain why interest rates are set in steps instead of being adjusted by variable amounts e.g. at a daily frequency. Authors typically assume that there is an optimal underlying interest rate which, if implemented, makes the economy return to equilibrium. The level of this optimal interest rate is determined by variables such as inflation and the output gap and thus does not follow a discrete pattern. Central banks are argued to change policy rates rarely and by discrete amounts since they are concerned that any policy change might disrupt financial markets. Thus, the optimal interest rate is allowed to deviate somewhat from the policy rate and the latter is only adjusted once their difference becomes "too large". In particular, policy rates are changed as soon as the costs arising from unsettling the markets are exceeded by the benefits of making the economy return to equilibrium. A consequence of this mechanism is that policy rates are always adjusted by the same amount.

The existing literature thus does not explain why central banks frequently take two interest rate steps at a time. More fundamentally, the practice of taking multiple steps casts doubt on the assumption that the concern about financial markets rationalises the step pattern. If policymakers abstain from frequent small interest rate changes because these might cause financial turmoil, they should abstain from occasionally changing the policy rate by twice the usual amount.

This paper presents a model in which the members of an MPC sometimes adjust the policy rate by several steps (the analysis can easily be adopted to a single policymaker).[2]

[1] Policy rates are occasionally also changed between scheduled dates.

[2] Papers on MPCs include Aksoy, De Grauwe and Dewachter [1], Gerlach-Kristen [7] and Mihov and Sibert [18].

The main difference compared with the existing literature is that our model does not rely on the central bank's concern about financial stability to justify the observed step pattern. Instead, we argue that considering only certain levels of the interest rate reduces the number of policy options, which is desirable because it focuses the discussion in the MPC and facilitates the communication of decisions to the public.

A second building block of the model is the assumption that the frequency of policy decisions is fixed. We argue that coordination costs which arise in re-scheduling an MPC meeting make a constant decision frequency desirable. In particular, we assume that the MPC meets at that frequency for which on average an interest rate change is necessary.

Given these assumptions, we show that the step size is closely linked to the extent to which policymakers' views in the MPC differ. If the committee members' views diverge much, too small a step size makes it unlikely that one level of the policy rate finds the support of a "large" majority. Increasing the step size reduces the number of factions in the MPC and thereby focuses the policy discussion. We demonstrate that the step size moreover depends on the frequency of policy meetings and the variability of the underlying optimal interest rate.

The frequency of MPC meetings depends on the step size and the variance of the optimal interest rate. Since the decision frequency depends on the step size and vice versa, the two have to be determined jointly. We find that a large step size and rare policy decisions are optimal if the MPC members have great difficulties observing the optimal interest rate.

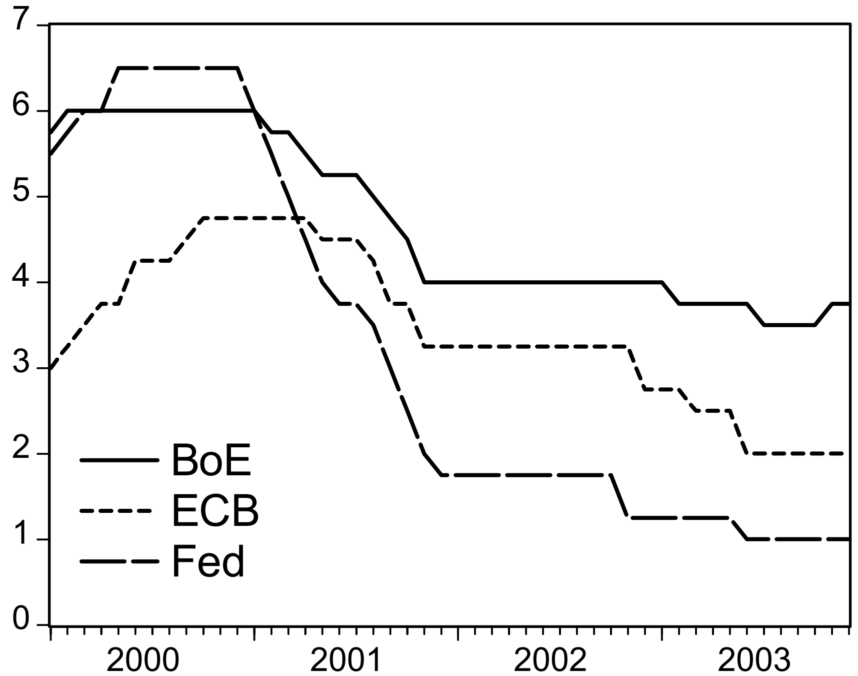
On a practical level, the analysis suggests that a step size smaller than 25 basis points is desirable in the core industrialised countries. Moreover, more frequent policy decisions seem beneficial e.g. in the US.

The rest of the paper is structured as follows. Section 2 presents empirical evidence on the step pattern of interest rates in different economies. Section 3 briefly reviews the existing literature. Section 4 studies the static version of the model and derives the optimal step size of the policy rate in this setup. Section 5 examines the step size in a dynamic setup, studies the optimal frequency of policy meetings and discusses under what circumstances the policy rate is changed by several steps in one go. Section 6 concludes.

2 Empirical evidence

To illustrate the step pattern of interest rates, we plot the policy rates for the Bank of England, the European Central Bank and the Federal Reserve for the period January 2000 to December 2003. Figure 1 shows that the step pattern is evident for all three economies. One striking difference is that the MPC of the Bank of England and the Governing Council of the European Central Bank changed interest rates most of the time by 25 basis points, while the FOMC often took two steps at a time. A second difference is that the federal funds rate moved over a larger range than the repo rate in the UK and the euro area. This might indicate that the underlying optimal interest rate, which we assume to be continuous, was more volatile in the US. Intuitively, Figure 1 suggests that in economies with a volatile optimal interest rate a large step size and / or frequent policy decisions are desirable.

Figure 1: Policy interest rates



Note: Policy rates of the Bank of England, the European Central Bank and the Federal Reserve, January 2000 to December 2003.

The step pattern of policy rates has three dimensions: the step size, the frequency of policy decisions and the occurrence of interest rate changes by several steps. Table 1 shows that, while the latter two features differ between economies, the step size is 25 basis points in the core industrialised economies. The number of scheduled policy meetings a year ranges from eight in Canada, the US and New Zealand to twelve in the UK.[3] Policy decisions are spread at roughly equal intervals over the year, but occasionally, monetary policy is changed on days for which no decision has been scheduled beforehand, such as in the aftermath of September 11, 2001.

The third line of Table 1 indicates that decisions in favour of a policy rate change were most frequent in Canada (59.4% of all occasions) and rarest in the UK (24.5%). Moreover, some central banks changed interest rates by 50 basis points more frequently than others. The fraction of interest rate changes of 50 basis points was 62.5% in the US and 8.3% in the UK.[4] This translates to average monthly changes of 13.5 basis points in the US and 6.6 basis points in the UK. Since this might indicate differences in the volatility of the underlying optimal rate, it is surprising that the different central banks use the same step size.

One important element of the model below is the size of the majority agreeing on one stance of policy. We therefore also report summary statistics about the dissents in MPCs (New Zealand as the exception has a single policymaker). The second to last line in Table 1 shows that all decisions at the Bank of Canada, the European Central Bank and the Reserve Bank of Australia were taken unanimously. By contrast, the frequency of unanimous decisions ranges between 30.1 and 80.0 percent for the Bank of England, the Federal Reserve and the Riksbank. The average size of the majority is with 85.1% smallest for the Bank of England.[5]

It is commonly believed that also the policymakers in Australia, Canada and the euro area disagree with one another about the appropriate stance of policy. Arguably, they present their decisions as being unanimous towards the outside in order to communicate

[3] The MPC of the Swedish Riksbank meets either eight or nine times a year.

[4] In the period under consideration, the Bank of Canada was the only central bank in the sample to change the policy rate on one occasion by as much as 75 basis points.

[5] See Gerlach-Kristen [6] for a detailed discussion of the voting record of the MPC of the Bank of England.

Table 1: Empirical evidence on interest rate changes

	Bank of Canada	Bank of England	European Central Bank	Federal Reserve	Reserve Bank of Australia	Reserve Bank of New Zealand	Swedish Riksbank
Step size (basis points)	25	25	25	25	25	25	25
Scheduled policy decisions a year	8	12	11	8	11	8	8 to 9
Fraction of decisions in favour of an interest rate change (%)	59.4	24.5	30.4	50.0	32.6	48.5	34.4
Fraction of interest rate changes larger than 25 basis points (%)	21.0	8.3	35.7	62.5	21.4	25.0	27.3
Average monthly interest rate change (basis points)	12.5	6.6	9.5	13.5	9.1	10.1	7.3
Frequency of unanimous decisions (%)	100	30.9	20.0	80.0	100	single policy-maker	55.9
Average size of majority (%)	100	85.1	100	98.7	100	single policy-maker	90.7

Note: Scheduled policy meetings January 2000 to December 2003. Data from the websites of the central banks. The average monthly interest rate change is computed as average interest rate change $\times$ decision frequency / 12.

unambiguously the stance of policy. This suggests that central banks have a preference for decisions to be taken by a "large" majority.

As a last empirical observation, it is interesting to note that the fixed frequency of policy decisions and the step size of 25 basis points are relatively new phenomena at least in the US. Rudebusch [20] documents that the step size of the federal funds rate was 6.25 basis points in the 1970s and that policy was adjusted much more frequently than thereafter. In 1975 for instance the rate was changed 24 times, and the shortest interval between two changes was two days. The last time the federal funds rate was changed by 6.25 basis points was in 1989, the third year of Alan Greenspan's tenure as FOMC chairman. Since then, the smallest step taken was 25 basis points, and Meade [16] reports that the frequency of dissents has been lower under Greenspan's chairmanship than it was under both Miller's and Volcker's. This suggests that using a larger step size makes it easier for policymakers to agree on the level of interest rates.

3 Brief review of the literature

Goodfriend [8] argues that policymakers use a fixed step size since this allows financial market participants to focus their expectations on a small set of possible policy rate changes. He states that as a consequence, policy rate adjustments do not "whipsaw" the markets, i.e. not cause large swings in market rates.

Commonly, Goodfriend's argument is interpreted to suggest that policymakers are concerned that any, even a minute, interest rate change might unsettle the markets.[6] Using this assumption, Eijffinger, Schaling and Verhagen [5] show that monetary policy is adjusted as soon as the underlying optimal interest rate deviates by a certain margin from the policy rate. They show that the higher the costs reflecting the risk of causing financial market turmoil, the larger this margin. Moreover, the higher these costs, the larger the interest rate step and the longer the average waiting time before a policy change.

Guthrie and Wright [10] assume that the costs associated with monetary policy changes

[6] Huizinga and Eijffinger [14] and Verhagen [22] suggest as alternative reason that policymakers fear that frequent adjustments might be interpreted as a sign of incompetence.

have one constant component and one proportional to the size of the policy rate change, while the cost of leaving the policy rate unchanged is assumed to be the higher, the more this rate deviates from its optimal level. They show that in this setup the policy rate is smoothed in the sense that its changes are autocorrelated. Moreover, the time between two policy adjustments in the same direction is shorter than if the direction is reversed. These results match the empirical evidence on policy rates well (see BIS [3] and Goodhart [9]).

The shortcoming of the existing literature is that, since policy is adjusted as soon as the policy rate and the optimal rate differ by a certain margin, interest rates are always changed by the same amount and never by two steps in one go. The fact that central banks often take multiple steps thus is not explained. More fundamentally, if policymakers think that markets can handle interest rate changes twice the size of the ordinary policy move, it seems unrealistic to assume that they refrain from interest rate changes smaller than the adopted step size for fear of disrupting the markets.

The analysis above has two implications for the desired model. First, the frequency of policy decisions should not determined by the current deviation of the policy rate from its optimal level. If it were, policy would never be adjusted by several steps in one go. We therefore assume that there are coordination costs which make it optimal to re-evaluate monetary policy when on average an interest rate change is necessary. Consequently, it is the expected, and not the actual, deviation of the interest rate from its optimal level which determines the frequency of policy decisions in our model. Second, the reason why interest rates are changed in steps must be another than the central bank's concern about financial markets. We assume that the step size is chosen such as to focus the discussion in the MPC on a few alternatives.[7] This ensures that a "large" majority in the MPC agrees on one level of the policy rate.

[7] To the extent that the alternative levels of the policy rate are one step each apart from one another, our model is related to the literature on spatial competition sparked by Hotelling [13].

4 The static model

Much modern theorising about monetary policy assumes that the optimal level of interest rates depends on the state of the economy, in particular on inflation and the output gap. For simplicity, we do not model the economy explicitly but instead assume that there is an optimal interest rate, i^*, which, if implemented, makes the economy return to equilibrium. It is the central bank's task to set the policy rate as close as possible to this optimal rate. In this section we study the static version of the model on interest rate stepping. Section 5 turns to the dynamic version.

Table 1 reports that MPC members often disagree about the optimal level of interest rates. If the committee members agree on the central bank's task and do not behave strategically, the degree to which their views diverge reflects their uncertainty about the optimal level of interest rates.[8] We model this by letting each policymaker j observe i^* with an error such that

$$i_j = i^* + u_j, \tag{1}$$

where $u_j \sim N(0, \sigma_u^2)$. We assume that the observation errors are uncorrelated between committee members for simplicity, so that $Eu_j u_k = 0$ for all $j \neq k$.[9] We furthermore let policymakers be equally "skilled" in the sense that their observation errors have the same variance. Finally, we assume that the committee members do not behave strategically and that each of them relies exclusively on his own observation of i^*.[10, 11] MPC member j votes for that level of the policy rate which is closest to i_j. The level which finds the support of the median voter is implemented. For the discussion below, it is important to note that if a majority of more than 50 percent votes for one level of the policy rate, the median voter necessarily is part of this faction.

We denote the standardised rate of change of the policy rate by s. In contrast to the existing literature, we do not assume that s is determined by costs which reflect the

[8] See e.g. see Blinder [4] and Goodhart [9] for a discussion of monetary policy under uncertainty.

[9] Allowing for correlation would not alter the conclusions below substantially.

[10] See Gerlach-Kristen [7] for a discussion of how differing abilities within the MPC impact on interest rate setting.

[11] The latter assumption is not critical for the main conclusions but renders the analysis more tractable. Meade and Stasavage [17] model how committee members influence each other's views.

risk that a policy change might trigger financial market turmoil. Instead, we let s be chosen such that a "large" majority in the MPC agrees on the stance of policy (a single policymaker may want to choose the step size such that the majority of the public as a whole tends to agree with his decisions).

To see the link between the step size and the size of majority, assume that there are three members in the MPC and that they perceive i^* to be 3.0, 3.1 and 3.4 percent, respectively. Furthermore, let s be ten basis points and assume that the policy rate is normalised such that zero is a step. In this situation each committee member votes for that level of the policy rate which corresponds to his i_j, and no majority in favour of one rate is formed. Next, set s equal to 25 basis points. Now the first two policymakers vote for a policy rate of 3.0 percent, while the third prefers a rate of 3.5 percent. Thus, if the step size is chosen large enough, a majority of more than 50 percent (i.e. an absolute majority) in the MPC agrees on the stance of policy even though the committee members forming the majority observe slightly different i_j:s. A step size of one percentage point would make the committee unanimously vote for a policy rate of 3.0 percent.

However, s should not be chosen too large since this would make the policy rate frequently rate deviate by a large margin from the unknown optimal rate. When choosing the step size one thus is faced with a trade-off between the negative welfare effects arising from a deviation of the policy rate from the optimal level and the problems that may result if no clear majority in the MPC is formed.

4.1 A simple example

It is important to note that the size of s which brings about an absolute majority depends on the relative position of the underlying optimal interest rate and the closest step of the policy rate. In particular, the further away i^* is from the next step, the larger the s which brings about an absolute majority. We next illustrate this point with a simple example.

We assume in this example only that u_j follows a symmetric triangular distribution given by $Tri(-1, 0, 1)$. Thus, policymaker j's observation of the optimal interest rate is distributed around i^* as shown in Figure 2. We denote the lowest possible i_j by $i_{\min}$ and the highest by $i_{\max}$. The less certain policymaker j is about i^*, the larger the support of the distribution of i_j, i.e. the larger the difference between $i_{\max}$ and $i_{\min}$. Since the committee members are equally skilled, their observations follow the same distribution.

Panel A shows the situation in which the optimal interest rate i^* coincides with a step of the policy rate. We denote this step by P, and the next lower and higher step by P_{low} and P_{high}, respectively. D_{low} and D_{high} are the lower and upper division lines. If policymaker j observes i_j to the left of D_{low}, he votes for P_{low}. If the observation lies between D_{low} and D_{high}, he favours P, and if $i_j > D_{high}$, he champions P_{high}. The step size s is given by $P_{high} - P = P - P_{low} = D_{high} - D_{low}$.

In the figure, s is chosen such that the area between D_{low} and D_{high} corresponds to half the area of the triangle. In an infinitely large committee, this implies a majority of exactly 50 percent votes for P. Correspondingly, a majority of 50 percent votes on average for P in an MPC with a finite number of members. Two smaller factions of equal size are expected to favour P_{low} and P_{high}, respectively. If s were increased, the expected size of majority would become larger.

Panel A is a special case in that we assume that i^* coincides with P. Panel B relaxes this assumption. Here, the optimal interest rate lies below the closest step of the policy rate. Given the distance between i^* and P, how large does the step size have to be so that on average, an absolute majority in the MPC votes for P? Appendix A shows that

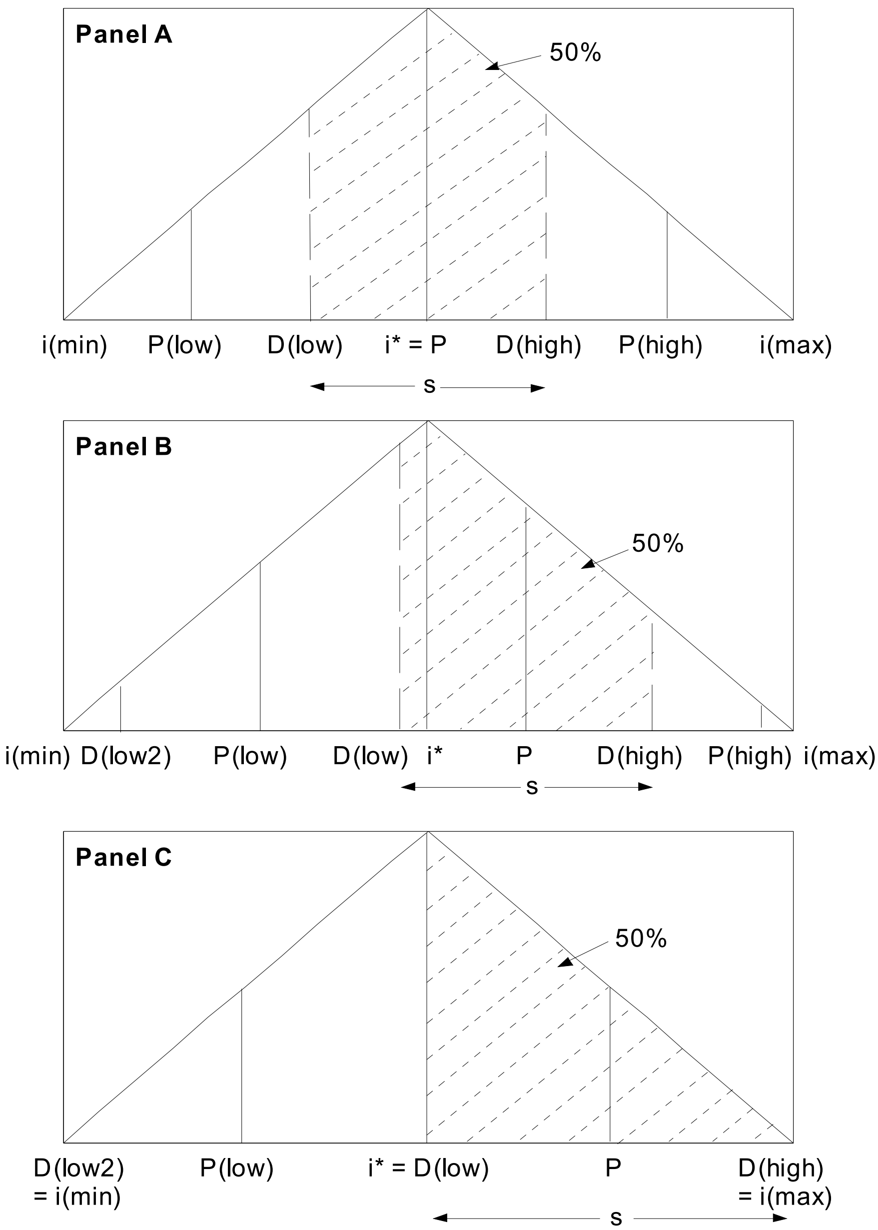
$$s = 2 - \sqrt{2 - 4(P - i^*)^2}.$$

Hence, the further apart i^* and P, the larger s, and it is for this reason that the step size in Panel B is larger than in Panel A. Note that in Panel B, those policymakers with $i_j < D_{low2}$ vote for P_{low2}, so that we expect four factions of different sizes in the MPC.

Panel C shows the case in which the step size needed to achieve an absolute majority is largest. In this border-line case i^* lies half-way between two steps of the policy rate, so that s has to span half the support of the distribution of i_j to make 50 percent of the committee members vote for P on average. Note that Panel C shows a tie outcome: the remaining 50 percent are expected to vote for P_{low}.[12]

[12]MPC regulations commonly attribute the chairman of the committee the decisive vote in case of a tie.

Figure 2: Majority formation and step size



Note: The figure assumes a triangular distribution of u_j. i^* denotes the optimal interest rate, $i_{\min}$ / $i_{\max}$ the lowest / highest observation of it, P a step of the policy rate, s the step size and D divisions lines at which a policymaker j with $i_j = D$ is indifferent between two steps of the policy rate.

If the MPC aims at a majority of at least 50 percent no matter what the relative position of i^* and P, s has to equal half the support of the distribution of i_j. With $s = (i_{\max} - i_{\min})/2$, the average majority is larger than 50 percent. For the case in which i^* coincides with P, the expected majority is for instance 75 percent.

We draw two conclusions from this example. First, the larger the desired majority, the larger s. Second, the more uncertain policymakers are about i^*, the larger both the support of i_j and the optimal step size.

4.2 Determining the step size

The example above assumed a triangular distribution of the observation error. We now return to the assumption in equation (1) that u_j follows a normal distribution. Since the support of a normal distribution is infinite, no finite s guarantees a majority of 50 percent for the situation corresponding to Panel C in Figure 2. Panel A in Figure 3 illustrates this problem.

We therefore assume that s is chosen such that it yields a majority of less than 50 percent if i^* lies half-way between two steps of the policy rate. We denote the expected size of majority for this case by m and refer to it as the majority parameter.

Panel B in Figure 3 shows the situation for an m of 45 percent. The step size is given by

$$s = \Phi^{-1}(m)$$

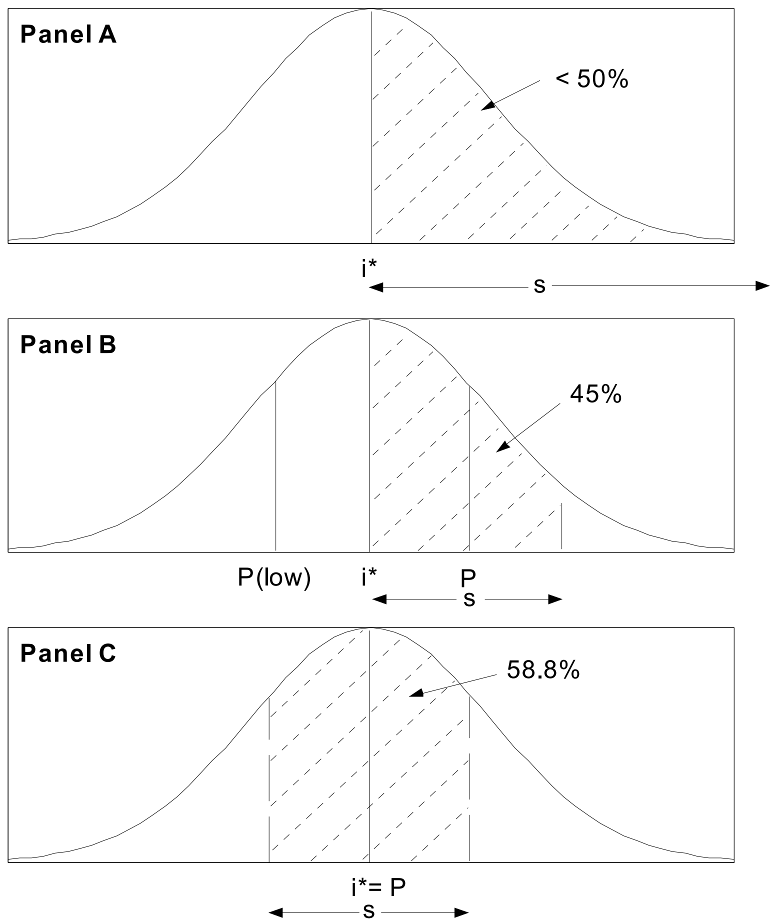
for the case in which $u_j \sim N(0,1)$, where Φ^{-1} denotes the inverse of the cumulative density of the unit normal distribution. For $u_j \sim N(0, \sigma_u^2)$,

$$s = \sigma_u \Phi^{-1}(m).$$

As in Section 4.1, the optimal step size thus is the larger, the more uncertain policymakers are about i^* $(\partial s / \partial \sigma_u^2 > 0)$ and the larger the desired majority $(\partial s / \partial m > 0)$.

Panel C shows that for $s = \Phi^{-1}(0.45)$, the expected size of majority is 58.8 percent if i^* happens to coincide with a step of the policy rate. Thus, even though there are extreme cases in which the largest faction in the MPC is smaller than 50 percent, we often expect for an absolute majority to agree on one level of the policy rate.

Figure 3: Majority formation assuming a normally distributed observation error



Note: The figure assumes a normal distribution of u_j. i^* denotes the optimal interest rate, P a step of the policy rate and s the step size.

Table 1 showed that the average majority in the MPC of the Bank of England was 85.1 percent between January 2000 and December 2003 and that the majorities for the other central banks considered were even larger. This suggests that a step size of 25 basis points focusses the debate in the committees on too few alternative levels of the policy rate. By decreasing s slightly, a sizeable majority still would be formed, while the average deviation of the policy rate from its optimal level could be reduced.

5 The dynamic model

The examples in Section 4 assumed a one-shot policy decision, which allowed us to study s in terms of i^* and i_j only. To determine the optimal frequency at which interest rate decisions should be taken, we need to introduce the time dimension.

We assume that the optimal interest rate evolves smoothly over time by modelling it as an Ornstein-Uhlenbeck process given by

$$di_t^* = -\alpha i_t^* dt + dw_t, \tag{2}$$

where w_t is a Wiener process and dw_t has a mean of zero, the variance $\sigma_w^2 dt$ and is uncorrelated over time.[13] We let $\alpha > 0$, so that the optimal interest rate is stationary and normalise i_t^* such that it has a mean of zero. Another way of expressing equation (2) is

$$i_t^* = e^{-\alpha\tau} i_{t-\tau}^* + \int_0^\tau e^{-\alpha(\tau-v)} dw_v dv, \tag{3}$$

where τ denotes the time elapsed between two observations of the optimal rate. Thus, the optimal interest rate follows an AR(1) process in discrete time.

5.1 Signal extraction

We let τ denote the frequency of policy decisions and assume for the time being that it is given.[14] If the optimal interest rate evolves according to equation (3), the individual

[13] See e.g. Arnold [2] for a discussion of Ornstein-Uhlenbeck processes.

[14] We focus on policy decisions taken at scheduled dates. Unscheduled policy adjustments could, however, easily be implemented in the model. The policy rate would be changed between two scheduled

MPC members do not only use their current observation of i^*,

$$i_{j,t} = i_t^* + u_{j,t} \tag{4}$$

to decide what level of the policy rate to vote for, but also their past observations. Technically, equations (3) and (4) represent a signal-extraction model.[15] Policymaker j's optimal assessment of the current optimal interest rate, $i_{j,t|t}$, is given by

$$i_{j,t|t} = ki_{j,t} + (1-k)e^{-\alpha\tau} i_{j,t-\tau|t-\tau} \tag{5}$$

with $k = V/(V+\sigma_u^2)$, where $V = \sigma_w^2/2 + \sqrt{(\sigma_w^2/2)^2 + \sigma_u^2\sigma_w^2}$ is the variance of the forecast error.[16] The subscript $t \mid t$ indicates that all information available at time t is used to form the assessment at time t.

Equation (5) implies that policymaker j's current assessment of the optimal interest rate depends on his past assessment at $t-\tau$ and the new observation $i_{j,t}$. The larger his difficulties in observing the optimal interest rate, the smaller k and the more backward-looking the assessment of i_t^*. In the committee meeting, policymaker j votes for that level of the policy rate which is closest to $i_{j,t|t}$.

5.2 Step size

We can now determine the optimal step size of interest rate changes. Section 4 discussed that s depends on policymaker j's uncertainty about his view of the optimal rate. While in the static version of the model this view was given by i_j, it now is captured by $i_{j,t|t}$. We therefore need to determine the variance of $i_{j,t|t}$. Appendix B shows that it is given by

$$Var(i_{j,t|t}) = \frac{k^2}{1-(1-k)^2e^{-2\alpha\tau}} \left[\sigma_u^2 + \frac{\sigma_w^2\tau}{\alpha}\left\{\frac{1}{2} + \frac{(1-k)e^{-2\alpha\tau}}{1-(1-k)e^{-2\alpha\tau}}\right\}\right].$$

Applying the same analysis as in Figure 3, the optimal step size then equals

$$s = \sqrt{Var(i_{j,t|t})}\Phi^{-1}(m). \tag{6}$$

dates if the benefits arising from the adjustment exceed the costs associated with the re-scheduling of a policy decision.

[15] See Harvey [11] for a discussion of signal-extraction problems in continuous time.

[16] We assume for simplicity that policymakers use the steady state values of k and V.

As in the static model, s is the larger, the larger the majority parameter ($\partial s/\partial m > 0$) and the more difficulties policymakers have in observing the optimal rate ($\partial s/\partial \sigma_u^2 > 0$). Moreover, s is the larger, the more variable the optimal interest rate ($\partial s/\partial \alpha < 0$ and $\partial s/\partial \sigma_w^2 > 0$). The reason for this is that a variable optimal interest rate causes policymakers' views to diverge much. To focus the policy discussion, a large step size is necessary. Finally, the step size is the larger, the more time passes between policy meetings ($\partial s/\partial \tau > 0$). The intuition is that, the longer ago the last policy decision, the more likely it is that the optimal interest rate has moved much. Consequently, committee members' views may diverge considerably, which again makes a large step size desirable.

5.3 Frequency of policy decisions

Next we turn to the question how often the stance of monetary policy should be re-evaluated. We assume that the re-scheduling of MPC meetings is costly and that they are therefore scheduled such that on average an interest rate change is expected (a single policymaker may want to publish a schedule for policy decisions to make it easier for financial market participants to forecast the timing of interest rate changes). Since the likelihood of a policy change depends on the step size of interest rates and since that step size is a function of the frequency of policy decisions, τ and s are determined jointly.

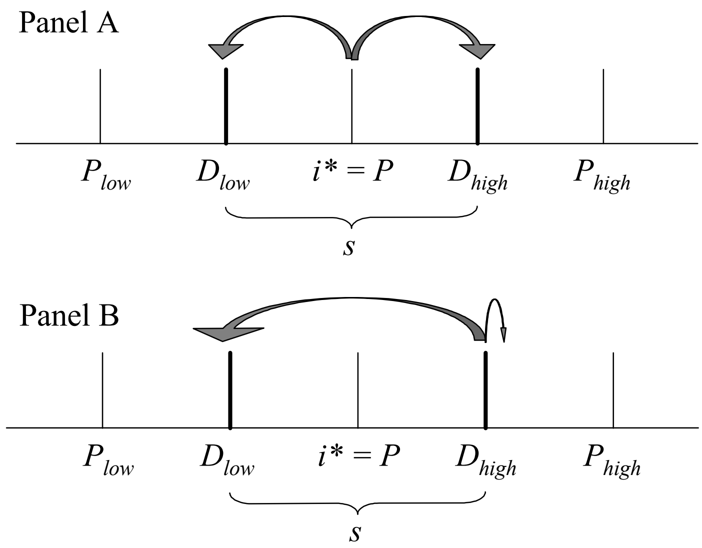
How much does the optimal interest rate have to move to trigger the expectation of an interest rate change? Again, the relative position of i_t^* and P is crucial.[17] Panel A in Figure 4 shows the situation in which the two coincide. In this case, i_t^* has to move by at least plus (minus) $0.5s$ to make an interest rate adjustment desirable.

Panel B shows the situation in which the optimal interest rate lies half-way between two steps of the policy rate. Two scenarios arise. An infinitely small change of i_t^* upwards ought to cause a tightening of monetary policy. If i_t^* were to move downwards instead, policy should be adjusted only if the optimal rate decreased all the way to D_{low}. On average, i_t^* thus also has to move by $0.5s$.

Therefore, if MPC meets at a frequency for which on average a policy rate change is

[17] Note that we concentrate for simplicity on the movement of i_t^* rather than on the change of the median voter's $i_{j,t|t}$.

Figure 4: Interest rate change



necessary, the condition

$$prob(\mid i_t^* - i_{t-\tau}^* \mid > 0.5s) = 0.5$$

has to be met. Re-arranging and noting that $Var(i_t^* - i_{t-\tau}^*) = (1 - e^{-\alpha\tau})\tau\sigma_w^2/\alpha$, we thus have that

$$2\left[1 - \Phi\left(\frac{0.5s\sqrt{\alpha}}{\sqrt{(1 - e^{-\alpha\tau})\tau\sigma_w^2}}\right)\right] = 0.5. \tag{7}$$

The expression

$$\frac{0.5s\sqrt{\alpha}}{\sqrt{(1 - e^{-\alpha\tau})\tau\sigma_w^2}}$$

does not have a closed-form solution. We therefore differentiate it implicitly to analyse how τ depends on the other variables in the model. Ceteris paribus, the committee should meet more often, the larger the innovations of the optimal interest rate ($\partial\tau/\partial\sigma_w^2 < 0$). This makes intuitive sense since large movements of i_t^* increase the chance that the optimal rate approaches a new step of the policy rate. Moreover, the MPC should convene frequently if the step size is small ($\partial\tau/\partial s > 0$), since in this case the optimal rate is likely to move soon close to another step of the policy rate. The impact of α on τ is unclear.

Since the step size and the frequency of policy meetings depend on each other, the question arises what combinations of s and τ are optimal. The model suggests that an

MPC should meet rarely and use a large step size if policymakers' uncertainty about the optimal interest rate is large (because $\partial s/\partial\sigma_u^2 > 0$ and $\partial\tau/\partial s > 0$) or if the majority parameter is large (since $\partial s/\partial m > 0$). Since a larger σ_w^2 increases s but decreases τ, the impact of σ_w^2 as well as α on the step pattern as a whole is ambiguous.

Our assumption that policy decisions are scheduled such that on average an interest rate change is necessary roughly fits the data. Table 1 reports that the frequency of decisions in favour of a policy adjustment ranges between 24.5 percent in the UK and 59.4 percent in Canada. Given the step size of 25 basis points, less frequent policy decisions appear recommendable for Australia, the euro area, Sweden and the UK. However, since we argued above that a smaller step size seems desirable and since $\partial\tau/\partial s > 0$, it is unclear whether interest rates should be re-evaluated more or less frequently in these economies. For Canada, New Zealand and the US, however, a smaller step size implies that policy decisions should be more frequent than they currently are so as to ensure that on average every other policy decision is in favour of an interest rate change.

5.4 Multiple steps

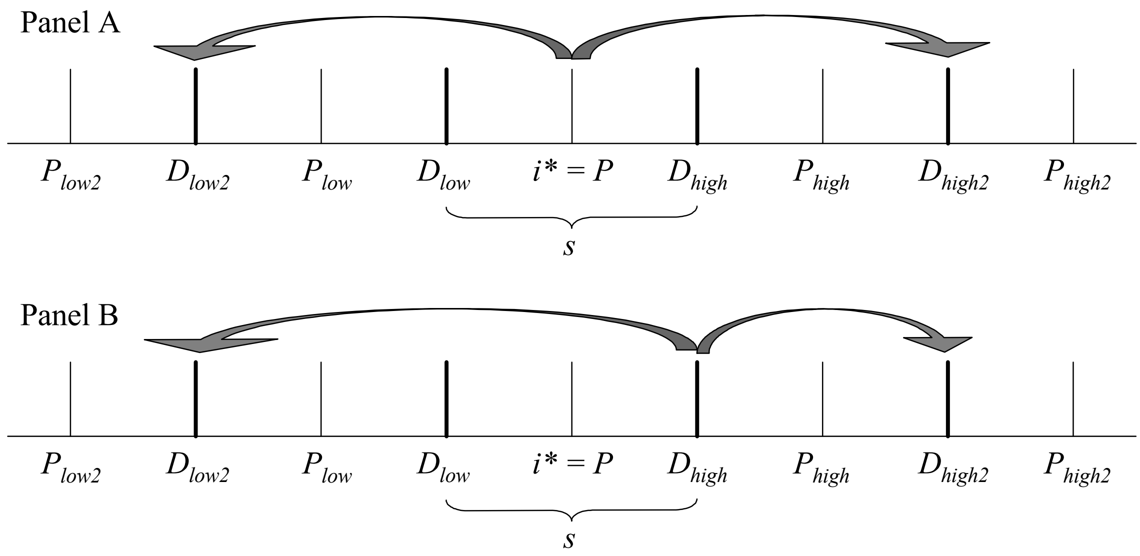
Table 1 suggested that especially in the US policymakers often changed interest rates by two steps at a time over the period from January 2000 to December 2003. In fact, the FOMC changed interest rates more frequently by two than by one step. Figure 5 shows that a multiple policy rate change should occur if i_t^* has moved not by $0.5s$ but by $1.5s$.

Clearly, a movement of the optimal interest rate by $1.5s$ is less likely than $\mid i_t^* - i_{t-\tau}^* \mid = 0.5s$. Assuming for instance $\alpha = \tau = \sigma_w^2 = 1$ and setting $s = 0.136$, so that the optimality condition (7) is met, the probability of a multiple policy rate change is given by

$$2\left[1 - \Phi\left(\frac{1.5 * 0.136}{\sqrt{(1-e^{-1})}}\right)\right] = 4.32\%.$$

Correspondingly, the probability of a single step change is 45.68%. In comparison to the rather high frequency of multiple steps reported in Table 1, this might suggest that the distribution of the shocks affecting the optimal interest rate is leptokurtic rather than normal. Alternatively, these shocks may have been unusually large during the period

Figure 5: Multiple interest rate changes



under consideration, especially so for the US. In this context, the collapse of the IT bubble and September 11, 2001 come to mind.

6 Conclusions

Central banks set policy rates in discrete steps. While the frequency of policy decisions differs across economies and while some central banks take several interest rate steps at a time more often than others, the step size of interest rate changes is equal for many industrialised countries.

This paper studies the choice of step size and the frequency of interest rate decisions. The model makes two main assumptions. First, we argue that interest rates are set in steps because this facilitates the formation of a "large" majority in the MPC, which in turn renders the communication of policy decisions easier. Second, we assume that the re-scheduling of committee meetings is costly. As a consequence, interest rate decisions are taken at a frequency for which on average a policy adjustment is necessary.

The model shows that the optimal step size is the larger, the more variable the optimal interest rate is, the more difficulties policymakers have observing that rate, and the more rarely policy decisions are taken. MPC meetings should be frequent if the step size is small and if the optimal interest rate is variable. Since the step size depends on the frequency of policy meetings and vice versa, they should be determined simultaneously. We show that large steps and rare meetings are optimal if policymakers' uncertainty about the optimal rate is large.

The empirical evidence on dissents at MPC meetings suggests that the commonly used step size of 25 basis points is too large in the core industrialised economies. Besides adopting a smaller step size, scheduling more frequent policy decisions appears desirable in Canada, New Zealand and the US.

A Deriving the step size for Figure 2

For the area between D_{low} and D_{high} in Panel B of Figure 2 to equal 0.5, the sum of the triangles to the left of D_{low} and to the right of D_{high} has to equal 0.5 as well. Thus,

$$\frac{1}{2} = \frac{(D_{low} - i_{\min})^2}{2} + \frac{(i_{\max} - D_{high})^2}{2}.$$

Multiply by 2, note that $i_{\min} = i^* - 1$, $i_{\max} = i^* + 1$, $D_{low} = P - s/2$ and $D_{high} = P + s/2$ and replace to yield

$$\begin{aligned} 1 &= (i^* - 1)^2 - 2(i^* - 1)(P - \frac{s}{2}) + (P - \frac{s}{2})^2 \\ &\quad + (i^* + 1)^2 - 2(i^* + 1)(P + \frac{s}{2}) + (P + \frac{s}{2})^2. \end{aligned}$$

Solving for s and noting that the step size has to be smaller than the support of the distribution yields

$$s = 2 - \sqrt{2 - 4(P - i^*)^2}.$$

B Variance of $i_{j,t|t}$

To derive the variance of $i_{j,t|t}$, note that

$$Var(i_t^*) = e^{-2\alpha\tau} Var(i_t^*) + E\left[\int_0^\tau e^{-\alpha(\tau-v)} dw_v\right]^2$$

which can be shown to equal

$$Var(i_t^*) = \frac{\sigma_w^2 \tau}{2\alpha}.$$

Correspondingly, the covariance between i_t^* and $i_{t-l\tau}^*$ is given by

$$Cov(i_t^*, i_{t-l\tau}^*) = E\left[e^{-\alpha l\tau} i_{t-l\tau}^* i_{t-l\tau}^*\right] = e^{-\alpha l\tau}\frac{\sigma_w^2 \tau}{2\alpha}.$$

Note that equation (5) can be re-written as

$$\begin{aligned} i_{j,t|t} &= k(i_t^* + u_{j,t}) \ + (1-k)e^{-\alpha\tau}[k(i_{t-\tau}^* + u_{j,t-\tau}) \ + (1-k)e^{-\alpha\tau}\{k(i_{t-2\tau}^* + u_{j,t-2\tau}) + ...\}] \\ &= k\sum_{l=0}^{\infty}(1-k)^l e^{-\alpha l\tau}(i_{t-l\tau}^* + u_{j,t-l\tau}). \end{aligned}$$

Taking expectations of the square of this expression yields

$$\begin{aligned} Var(i_{j,t|t}) \quad = \quad & \frac{k^2}{1-(1-k)^2 e^{-2\alpha\tau}}[\sigma_u^2 + Var(i_t^*)] + \\ & 2k^2[(1-k)e^{-\alpha\tau}Cov(i_t^*, i_{t-\tau}^*) + (1-k)^2 e^{-2\alpha\tau}Cov(i_t^*, i_{t-2\tau}^*) + ... \\ & +(1-k)^3 e^{-3\alpha\tau}Cov(i_{t-\tau}^*, i_{t-2\tau}^*) + (1-k)^4 e^{-4\alpha\tau}Cov(i_{t-\tau}^*, i_{t-3\tau}^*) + ...]. \end{aligned}$$

Noting that $Cov(i_t^*, i_{t-\tau}^*) = Cov(i_{t-\tau}^*, i_{t-2\tau}^*)$ and rearranging gives

$$\begin{aligned} Var(i_{j,t|t}) \quad = \quad & \frac{k^2}{1-(1-k)^2 e^{-2\alpha\tau}}\left[\sigma_u^2 + \frac{\sigma_w^2\tau}{2\alpha}\right] + \\ & k^2\frac{\sigma_w^2\tau}{\alpha}[(1-k)e^{-\alpha\tau} + (1-k)^3 e^{-3\alpha\tau} + ...] \\ & [e^{-\alpha\tau} + (1-k)e^{-2\alpha\tau} + (1-k)^2 e^{-3\alpha\tau} + ...]. \end{aligned}$$

Thus,

$$Var(i_{j,t|t}) = \frac{k^2}{1-(1-k)^2 e^{-2\alpha\tau}}\left[\sigma_u^2 + \frac{\sigma_w^2\tau}{\alpha}\left\{\frac{1}{2} + \frac{(1-k)e^{-2\alpha\tau}}{1-(1-k)e^{-2\alpha\tau}}\right\}\right].$$

References

[1] Aksoy, Yunus, Paul De Grauwe, and Hans Dewachter (2002), Do asymmetries matter for European monetary policy?, European Economic Review 46 (3), 443-469.

[2] Arnold, Ludwig (1974), Stochastic differential equations: Theory and applications, Wiley, New York.

[3] Bank for International Settlements (1998), 68th annual report.

[4] Blinder, Alan S. (1997), "What central bankers could learn from academics – and vice versa", Journal of Economic Perspectives, 11 (3), pp. 2-19.

[5] Eijffinger, Sylvester, Eric Schaling and Willem H. Verhagen (1999), A theory of interest rate stepping: Inflation-targeting in a dynamic menu cost model.

[6] Gerlach-Kristen, Petra (2003), Insiders and outsiders at the Bank of England, 2003, Central Banking, XIV(1), 96-102.

[7] Gerlach-Kristen, Petra (forthcoming), Monetary policy committees and interest rate setting, European Economic Review.

[8] Goodfriend, Marvin (1991), Interest rates and the conduct of monetary policy, Carnegie-Rochester Conference Series on Public Policy 34, 7-30.

[9] Goodhart, Charles Goodhart, Charles (1999), Central bankers and uncertainty, Bank of England Quarterly Bulletin, February, 102-121.

[10] Guthrie, Graeme and Julian Wright (forthcoming), The optimal design of interest rate target changes, Journal of Money, Credit, and Banking.

[11] Harvey, Andrew C. (1989), Forecasting, structural time series models and the Kalman filter, Cambridge University Press, Cambridge.

[12] Hogg, Robert V. and Elliot A. Tanis (1997), Probability and statistical inference, Prentice Hall, Upper Saddle River.

[13] Hotelling, Harold (1929), Stability in competition, Economic Journal 39, 41-57.

[14] Huizinga, Harry and Sylvester Eijffinger (1999), Should monetary policy be adjusted frequently?, CEPR Discussion Paper 2074.

[15] Kydland, Finn and Edward Prescott (1977), Rules rather than discretion: The inconsistency of optimal plans, Journal of Political Economy 85(3), 473-491.

[16] Meade, Ellen E. (2002), Central bank decisions: How does one good head compare with a rule?, AICGS/DAAD working paper

[17] Meade, Ellen E. and David Stasavage (2003), Publicity of debate and the incentive to dissent: Evidence from the US Federal Reserve, mimeo.

[18] Mihov, Ilian and Anne Sibert (2002), Credibility and flexibility with monetary policy committees, CEPR Working Paper 3278.

[19] Orphanides, Athanasios (1998), Monetary policy evaluation with noisy information, Federal Reserve Board Finance and Economics Discussion Series Paper 50.

[20] Rudebusch, Glenn D. (1995), Federal Reserve interest rate targeting, rational expectations, and the term structure, Journal of Monetary Economics 35, 245-274.

[21] Sack, Brian and Volker Wieland (2000), Interest-rate smoothing and optimal monetary policy: A review of recent empirical evidence, Journal of Economics and Business 52, 205-228.

[22] Verhagen, Willem H. (2002), Interest rate stepping, interest rate smoothing and uncertainty: Some views from the literature, De Nederlandsche Bank Research Memorandum 683.