Central Bank Voting and the Incidental Parameters Problem*

Henry W. Chappell, Jr.
Department of Economics
American University of Sharjah
PO Box 26666, Sharjah
United Arab Emirates
Phone: +971-6-515-4625
Fax +971 6 515 2550
hwchappell@professorchappell.com

Rob Roy McGregor
Department of Economics
University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223 USA

Abstract

In recent years, central banks around the world have increasingly made decisions in committees and have also become increasingly transparent. Many banks now publish transcripts or summaries of meeting discussions and provide recorded votes or policy preferences associated with individual members of policymaking committees. The availability of these data promises to further our understanding of how monetary policy decisions are made, but this paper offers a cautionary note. We present an econometric model of committee decisions for Sweden's Riksbank that uses data pooled over members and meetings. We demonstrate that key parameters of our model are affected by large biases associated with the incidental parameters problem. This problem could affect other studies that use panel data to investigate the behavior of monetary policy committees. Drawing appropriate inferences about model parameters may require model-specific and data-specific Monte Carlo analyses to quantify the magnitude of biases.

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1. Introduction

Blinder (2004, 2007) has noted that central banks increasingly make policy decisions in committees. The trend toward committee decision-making has also been accompanied by increasing transparency. Many central banks publish detailed records of committee policy deliberations and the individual votes that committee members cast on policy directives. A number of studies have used these data to describe the policy preferences of individual committee members and to characterize the collective choice-making of the committees.[1] In this paper, we describe an effort to use data from the monetary policy committee (MPC) of Sweden's Riksbank for these purposes. Specifically, we estimate individual-specific Taylor rule parameters to describe the policy preferences of members of the Riksbank's MPC. We also estimate parameters that describe how preferences are aggregated within the committee to produce collective choices. Our econometric model requires the use of panel data—we pool observations over members and meetings and estimate individual fixed effects to capture differences in policy preferences across committee members.

Maximum likelihood estimates of fixed effects in panel data regressions are subject to bias associated with the incidental parameters problem.[2] This problem is potentially severe in panel data sets where the time dimension is small relative to the number of individuals. In ordinary least squares applications where fixed effects are nuisance parameters, the incidental parameters problem is typically not a cause for

[1] Examples include Besley, Meads, and Surico (2008), Chappell, Havrilesky, and McGregor (1993, 1995, 1997), Chappell and McGregor (2000), Chappell, McGregor, and Vermilyea (2008, 2012, 2014), Harris, Levine, and Spencer (2011), Harris and Spencer (2009), McGregor (1996), and Tootell (1991a, 1991b, 1996, 1999).

[2] The original treatment of the incidental parameters problem was by Neyman and Scott (1948). Lancaster (2000) surveys a half century of subsequent literature about the problem.

concern—while estimates of the fixed effects themselves are biased and inconsistent, estimates of other parameters are consistent. In our application, estimation of the fixed effects is of intrinsic interest because fixed effects characterize preference differences across committee members. Estimates of other key model parameters are related to the values of the fixed effects, so these estimates can also be biased.

Our panel from the Riksbank spans 102 meeting observations and covers 17 individuals who served on the committee. Previous work suggests that the incidental parameters problem is unlikely to be an issue in panels with these dimensions. However, our panel is unbalanced, and some individuals attended small numbers of meetings; specifically, five individuals attended 15 or fewer meetings. In addition, the model we estimate is not a standard regression specification—the dependent variable is discrete and censored, and a variety of parameter restrictions are imposed. Relatively little is known about the importance of the incidental parameters problem in such a setting.[3] Using Monte Carlo methods, we find that key model parameters are subject to large biases. Unfortunately, this problem could affect other studies that use panel data to investigate the behavior of monetary policy committees.[4] To draw appropriate inferences about model parameters, it may routinely be necessary to undertake model-specific and data-specific Monte Carlo analyses to quantify the magnitude of biases.

[3] The Monte Carlo experiments reported by Carro and Traferri (2010) indicate a severe bias in the maximum likelihood estimates for dynamic panel data ordered probit models with fixed effects. This bias is not trivial even when the time dimension is as large as 20.

[4] Examples include Besley, Meads, and Surico (2008), Chappell, Havrilesky, and McGregor (1993, 1995, 1997), Chappell and McGregor (2000), Chappell, McGregor, and Vermilyea (2008, 2012, 2014), Harris, Levine, and Spencer (2011), McGregor (1996), and Tootell (1991b, 1996).

2. Monetary Policymaking at Sweden's Riksbank

Monetary policy decisions in Sweden are made by the Riksbank's MPC. Like any committee, the MPC faces the problem of aggregating the preferences of individual committee members in order to make a decision. In practice, MPCs can operate in a variety of ways, and Blinder (2004, 2007) has developed a typology for classifying them according to their decision-making procedures. In Blinder's scheme, committees can be "individualistic," "genuinely collegial," or "autocratically collegial." In individualistic committees, each member acts independently in developing his policy preference and in voting on a policy choice. In genuinely collegial committees, members attempt to reach a consensus that reflects the views of all members of the committee. Autocratically collegial committees also reach consensus, but primarily by the deference that committee members show to the committee chairman.

Sweden's Riksbank provides an interesting case study. It is the world's oldest central bank and has become one of the most transparent.[5] After each policy meeting, it promptly reports not only its decision about the target interest rate but also the target rate preferences reported by each member of the policy committee. Thus, it provides the essential data required to investigate collective decision-making.

The Riksbank has also had a unique macroeconomic experience in the period since the global financial crisis and recession. Like many other countries, Sweden experienced a severe recession in 2008 and 2009, but its recovery was quicker and stronger than in most other countries. The target interest rate (the repo rate) reached a low

[5] Although Sweden is a member of the European Union, it has not adopted the euro, and it conducts an independent monetary policy. Under the terms of its accession treaty with the European Union, Sweden is required to join the Eurozone when it fulfills its exchange rate convergence criteria, but it has intentionally failed to fulfill those criteria, thereby avoiding adoption of the euro.

of 0.25% in July 2009 but began to rise again by April 2010. In contrast to the United States and other countries, Sweden has actively managed interest rates since 2008.

Previous studies have attempted to analyze collective decision-making by the Riksbank's MPC. Chappell, McGregor, and Vermilyea (2014) (hereafter CMV) estimated an econometric model of committee decision-making that suggested that the Governor of the Riksbank (who is also the chair of its MPC) was very powerful. In contrast, Blinder (2004) characterized the Riksbank as highly individualistic based on a subjective assessment.

In this paper, we adopt an empirical approach similar to that of CMV, but with several important changes. First, we extend the sample period. The CMV sample ended in September 2008, but we extend it to April 2014. In the years covered by the CMV sample, two changes in the Governorship coincided with inflection points in the path of interest rates. As CMV note, if changes in the Governorship closely align with policy shifts, this is likely to lead to an inference that the Governor is *causing* the policy shift. This association could have been coincidental, so our study should benefit from the extension of the sample period because there have been a number of interest rate movements since 2008 that have not been associated with changes in the Governorship.

Second, the CMV method is not appropriate to the policymaking environment that prevailed in the recession and post-recession periods. The original CMV model was developed for a policy regime in which the only choices relevant for the committee were to move a target interest rate up or down by 25 basis points. This was the norm in the CMV sample period, but that norm was quickly abandoned in response to the 2008 financial crisis. In addition, a lower bound on interest rates had become a binding constraint for the Riksbank by the middle of 2009. The Riksbank's target rate never went below 0.25%, but minutes from the policy meetings indicate that this was considered an effective lower bound at that time.[6] Our purpose in this paper is to develop and estimate a model of decision-making for the Riksbank that effectively exploits the data that have become available in the crisis and post-crisis period.

3. A Model of Voting Decisions

The Riksbank MPC has six voting members, including the Governor. Our model indexes these six positions by $i = 1,...,6$. The chairman is indicated by $i = 1$ and rank-and-file positions are represented by $i = 2,...,6$. The specific individuals occupying positions vary over time. In our sample period, 17 different individuals occupied the six voting positions. We will refer to these 17 individuals as "personalities," and we will index personalities by $j = 1,...,17.$ There were 102 meetings of the MPC in our sample that runs from January 2000 to April 2014. Meetings are indexed by $t = 1,...,102$.

We suppose that each voter in a committee meeting has a "true" preferred interest rate target for each meeting. We let R_{it}^{*} indicate the true preferred rate target for voter *i* in meeting *t*. This variable is assumed to be unobserved. However, minutes of the MPC record the interest rate favored by each member in the formal voting stage of the meeting. These recorded interest rate votes are indicated by R_{it}.

[6] In October 2014, beyond the end date of our sample, the Riksbank MPC adopted a target of 0.0% for the repo rate. As this paper is written in August 2015, the repo rate has become negative, at -0.35%. While this might suggest that 0.25% should never have been considered a lower bound, we believe that it is more appropriate to infer that the lower bound was formerly high and has since changed. In section 3 of this paper, we support our assumption with evidence drawn from the text of meeting minutes. See Chappell and McGregor (2015) for additional discussion.

If members always voted according to their true preferences, then R_{it}^{*} would always equal R_{it}; however, this need not be the case. Recorded votes reflect individual preferences, but they may also reflect pressures for consensus or special influence exerted by the committee chairman (the Governor). Specifically, we suppose that members' rates recorded in the formal vote reflect both their true preferences and the influence of their colleagues and the chairman, according to equation (1):

$$R_{it} = \omega R_{it}^{*} + \gamma R_{1t}^{*} + \lambda \left(\sum_{i=1}^{6} R_{it}^{*} \right) / 6 . \tag{1}$$

Assuming that $\omega + \gamma + \lambda = 1$, equation (1) says that a member's recorded preferred rate is a weighted average of her true preferred rate, the preferred rate of the committee chairman, and the average preferred rate across all members. A key objective of our empirical analysis is to obtain estimates of ω, γ, and λ.

Our model assumes that individual personalities have true preferred rates as specified by equation (2):

$$R_{jt}^{*} = \mathbf{X}_t \boldsymbol{\beta}_j + u_{jt} . \tag{2}$$

A personality's preferred rate in meeting *t* depends on a vector of macroeconomic indicators $\mathbf{X}_t$, on personality-specific parameters $\boldsymbol{\beta}_j$, and on a normal random error term u_{jt}. Equation (2) can be thought of as an individual's monetary policy reaction function. We will later adopt a Taylor rule specification for the reaction function in (2).

As we have noted, only six of 17 personalities vote in any given committee meeting, and interest rate preferences are observed only for voters. It is therefore necessary to map the preferences of personalities into voter positions:

$$R_{it}^{*} = \sum_{j=1}^{17} D_{ijt} R_{jt}^{*}, \text{ for } i = 1,\ldots,6 . \tag{3}$$

In equation (3), D_{ijt} is a dummy variable equal to one if position *i* was occupied by personality *j* in meeting *t*. In effect, equation (3) defines the preferred rate of voter *i* in meeting *t* to be the preference of the individual personality occupying position *i* in meeting *t*.

Substituting equations (2) and (3) into equation (1) yields

$$R_{it} = \omega \sum_{j=1}^{17} D_{ijt} \left(\mathbf{X}_t \boldsymbol{\beta}_j + u_{jt} \right) + \gamma \sum_{j=1}^{17} D_{1jt} \left(\mathbf{X}_t \boldsymbol{\beta}_1 + u_{jt} \right) + \lambda \sum_{i=1}^{6} \sum_{j=1}^{17} D_{ijt} \left(\mathbf{X}_t \boldsymbol{\beta}_j + u_{jt} \right) / 6$$

or

$$R_{it} = \omega \sum_{j=1}^{17} D_{ijt} \left(\mathbf{X}_t \boldsymbol{\beta}_j \right) + \gamma \sum_{j=1}^{17} D_{1jt} \left(\mathbf{X}_t \boldsymbol{\beta}_1 \right) + \lambda \sum_{i=1}^{6} \sum_{j=1}^{17} D_{ijt} \left(\mathbf{X}_t \boldsymbol{\beta}_j \right) / 6 + e_{it}, \tag{4}$$

where e_{it} is a composite error term. The dependent variable in (4) is the observed interest rate selection of voter *i* in meeting *t*, while the right-hand side of the equation includes interactions of macroeconomic variables and dummy variables that describe the membership of the committee. For our empirical work, (4) is an equation to be estimated with data pooled over meetings and voting members of the committee. The parameters include individual reaction function parameters $\boldsymbol{\beta}_j$ and the weighting parameters ω, γ, and λ. Since the weighting parameters sum to one, only two of the three will be estimated independently.

The key to identifying the weighting parameters in the model involves the changing composition of the committee. Power of the chairman is inferred when changes in the chairmanship are accompanied by changes in the voting patterns of rank-and-file committee members. Similarly, pressures for consensus can be detected if members respond to changes in the composition of the committee's rank-and-file membership.

4. Econometric Issues

Estimation of equation (4) is subject to several econometric complications. First, the observed interest rate choice for a voting committee member is not strictly continuous. During the entire sample period, voters always proposed rates that were multiples of 25 basis points, making the dependent variable discrete. This means that we do not actually observe the dependent variable in (4); rather, we assume that we observe that variable measured to the closest multiple of 25 basis points.

Second, in a series of six meetings beginning in July 2009, the Riksbank MPC appears to have encountered a lower bound on the repo rate.[7] It is normally believed that the lower bound on a nominal interest rate is zero.[8] The actual rate target selected by the MPC in those six meetings was 0.25%; however, minutes of the meetings make it clear that most committee members regarded 0.25% as an effective lower bound. In the July 2009 meeting, Deputy Governor Svante Öberg acknowledged that "with today's cut the repo rate has in practice reached its lower limit and that it should not be reduced more than this" (Minutes of the Executive Board's Monetary Policy Meeting, No. 3, July 1, 2009, p. 13). A majority of the committee members agreed, but there was one exception. In five meetings, committee member Lars Svensson advocated moving the repo rate to

[7] See Bernanke and Reinhart (2004), Fleming and Garbade (2004), Goodfriend (2000), McCallum (2000), Saunders (2000), Svensson (2003), and Williams (2009) for treatments of the zero lower bound on nominal interest rates.

[8] Because lenders have the option of holding currency and earning zero interest, we would not expect them to lend at rates that were lower than zero. As a practical matter, however, holding and making transactions with cash can be cumbersome and risky, and many individuals would still hold bank deposits at slightly negative interest rates (Saunders 2000). From time to time, negative rates have also been observed in repo markets (Fleming and Garbade 2004).

0.0%. For our empirical model, we will assume that a lower bound on the rate was in effect for all voters. That lower bound will be set at 0.0% for Svensson and at 0.25% for all others.

Both the discreteness of reported rates and the presence of lower boundaries suggest that equation (4) should be estimated as an interval regression with left censoring. This model has the character of ordered probit when rates exceed the bound and the character of a Tobit model for censored observations.[9] Our implementation is non-standard in that many parameter restrictions are imposed and the lower boundary on the target rate can vary across MPC members.

Additional complications arise from the use of panel data. In equation (4), composite error terms will be correlated across members within a meeting.[10] To fully and properly account for error correlations across six voters in a meeting, a multivariate discrete choice model would be required. However, as Greene and Hensher (2010, p. 299) note, "for practical reasons, the bivariate probit is more or less the dimensional limit of the applications of the multivariate ordered probit model." Most importantly, as we have noted, estimates of individual fixed effects can be subject to an "incidental

[9] Chappell, Havrilesky, and McGregor (1993, 1995, 1997), Chappell and McGregor (2000), and McGregor (1996) apply ordered probit analysis to Federal Reserve monetary policy decisions, while Harris, Levine, and Spencer (2011) and Harris and Spencer (2009) apply ordered probit analysis to Bank of England monetary policy decisions. Kato and Nishiyama (2005) and Kim and Mizen (2010) have used the Tobit model to estimate the Bank of Japan's policy reaction function, while Kiesel and Wolters (2014) have used the Tobit model to estimate the policy reaction functions of the Bank of Japan, the Federal Reserve, and the European Central Bank. The Tobit models estimated by Kim and Mizen (2010) for the Bank of Japan assumed positive threshold values at which monetary policy was effectively at the zero lower bound.

[10] This is true even if the error terms in equation (2), describing individual rate preferences, are uncorrelated across members within a meeting.

parameters" bias in a panel data estimation.[11] This is thought to be a notable problem when T is small.[12] As we later report, despite having a reasonably long time series for most individuals who served on the committee, estimates of some of our model parameters are subject to large biases.

Our approach will be to pool data over members and meetings, estimating under the (implausible) assumption that error terms are uncorrelated across members within a meeting. We will then investigate parameter biases with a Monte Carlo analysis and estimate coefficient standard errors via parametric bootstrapping.

5. Data

Equation (2) of the model specifies a monetary policy reaction function to explain individual rate preferences. The macroeconomic variables appearing in that rule also appear in equation (4), which we will estimate. We assume that (2) takes the form of a Taylor rule; specifically, preferred target interest rates depend on a measure of the output gap (the percentage deviation of actual real GDP from potential real GDP) and the deviation of inflation from its target rate. For the output gap, we have obtained a series published by Sweden's National Institute of Economic Research (NIER). For each MPC meeting, we use the first available NIER estimate of the output gap for the current quarter.[13] Inflation is measured as the observed rate of consumer price inflation over the

[11]Greene and Hensher (2010) undertake a Monte Carlo analysis to evaluate the size of the bias related to the incidental parameters problem in the context of an ordered probit model. See also the Monte Carlo analysis reported by Carro and Traferri (2010).

[12] Arellano and Hahn (2006), for example, note that in panel data applications in which the time dimension T is small relative to the cross-section dimension N, maximum likelihood estimates can be severely biased, especially in dynamic models.

[13] This series is "almost" real-time data. For meetings since 2002, this estimate has been known at the time of the meeting and is therefore real-time data. Before that, estimates were normally published shortly after meetings.

year ending in the month before the MPC meeting.[14] The Riksbank's official target rate of inflation was 2% throughout the period.[15] We also augment the Taylor rule with two lagged values of the committee's adopted repo rate target. Lagged target rates are normally included in empirical Taylor rules to account for inertia in policymaking. The dependent variable in equation (4) is the repo rate target that a voter supports in the official committee vote. We obtained voting records from the minutes of the meetings of the Riksbank's MPC. Our initial sample consisted of 102 meetings over the period from January 2000 to April 2014. Ultimately, we dropped the April 2010 meeting from our sample. The Governor (committee chairman) missed the meeting because of travel disruptions related to the eruption of the Icelandic volcano Eyjafjallajökull. Given the key role of the chairman in our model, we decided to remove all member observations associated with that meeting. In several other meetings, individuals were absent. In the end, the sample we analyze consists of 599 individual observations over 101 meetings.

In principle, it would be possible to estimate Taylor rules with coefficients that vary across all committee members for all explanatory variables. We ultimately decided to permit intercept differences across voters, while constraining coefficients on the macroeconomic variables to be the same for all. Given the limited variation in members'

[14] This measure is also "almost" real-time data. In most meetings, the current inflation measure has been available to the committee. In other cases, it has been published shortly after the meeting.

[15] Some have suggested that a measure of expected future inflation should replace historically observed inflation in the Taylor rule. For three reasons, we have chosen not to do so. First, expected future inflation is endogenous, depending on the choice of the current monetary policy setting. Second, the Riksbank's internal forecasts of inflation were calculated using three different methodologies in our sample period. Under these circumstances, it is not clear that variations in expected inflation would be comparable over different times in the sample. Finally, we note that Taylor (1993) originally proposed that inflation be measured as an average over the year preceding the decision.

voting behavior, it is probably not reasonable to attempt to estimate models that permit differences in multiple Taylor rule parameters.

6. Estimation Results

We have estimated equation (4), including Taylor rule parameters (with individual intercepts) and the key weighting parameters that indicate how members' votes are influenced by the preferences of the Governor and their other colleagues on the committee. The estimates reported in various columns of Table 1 differ according to restrictions imposed on the weighting parameters, γ, λ, and ω. In all cases, standard errors are calculated via parametric bootstrapping, as we describe in the next section of the paper.

In the first column of Table 1, we impose the conditions $\lambda = 0$ and $\gamma = 0$, so that $\omega = 1.0$. This estimation corresponds to the case in which committee voters take no account of others' preferences; the committee is perfectly individualistic. The table shows that coefficients on both inflation and the output gap are positive, as expected. Both high inflation (relative to its target) and high output (relative to potential) encourage the Riksbank to increase the interest rate target. The sum of the coefficients on the lagged target rates is high at 0.905, indicating substantial inertia in policymaking. The sign pattern for the coefficients on the lagged target rates, with the first lag positive and the second negative, is compatible with the existence of both persistence (this meeting's selection will be close to the last meeting's selection) and momentum (if the rate changed at that last meeting, it is likely to change in the same direction this meeting). Individual intercepts vary in sensible ways, given what is known about voting patterns. For example, Lars Svensson frequently pushed the committee to adopt lower rates during his tenure, and his intercept is low. Svante Öberg often favored higher rates, and his intercept is accordingly high.

We next attempted to estimate (4) while permitting γ, λ, and ω to vary freely, subject to the requirement that they sum to one. This estimation produced an unusual and implausible result—the estimate of ω, the weight members attach to their own preferences, tended to approach zero. If $\omega = 0$, individual intercepts are not (all) identified and estimation of the model is not possible. Intuitively, when $\omega = 0$, individuals disregard their own preferences in voting, and a member's votes do not provide any direct information about those preferences.[16] While it is conceivable that members would attach no weight to their own preferences, this seems implausible. In our data set, members disagree with the adopted alternative in 13.7% of all votes cast, which suggests at least modest independence.

Under the assumption that the true value of ω is greater than zero, we have re-estimated equation (4) while imposing different positive values for that parameter. The last three columns in Table 1 present the results of estimations that set ω equal to 0.10, 0.25, and 0.50. Coefficients on the lagged dependent variables and macroeconomic variables are similar across all estimations, following the patterns described earlier for column 1. Individual intercepts also continue to vary in plausible ways that are related to the frequency and direction of individual disagreements with the targets adopted by the committee. Our primary interest in these estimations is in the relative importance of the

[16] If $\omega = 0$, the voting record provides some information about individual intercepts because member's votes respond to changes in the composition of the committee. However, there are multiple linear dependencies across the dummy variables indicating personalities. For example, the dummy variables indicating personalities occupying any voter position *i* necessarily sum to one (one personality occupies that slot in each meeting). This implies that we cannot estimate all of the individual intercepts in this case.

chairman and the committee, given that we impose the requirement that individuals attach some weight to their own preferences. The results appear to be ambiguous on this point. When ω is set at 0.10 or 0.25, then values of γ and λ are similar in magnitude, implying that the chairman and the committee consensus both affect the votes of individual committee members. However, when ω is set equal to 0.50, the estimate of γ goes to 0.57, and the estimate of λ is equal to -0.07.[17] The latter results imply that deference to the Governor is strong and that deference to rank-and-file colleagues is absent.[18] These implications will be revisited after we have investigated the properties of our estimator.

7. Monte Carlo Analysis

We have investigated the properties of our estimation procedure with a Monte Carlo analysis. This analysis permits us to calculate standard errors for parameter estimates and to evaluate biases in estimation. To carry out the analysis, we first obtained parameter values by estimating the ordered probit model described by (4). Taking those estimates to be "true" parameter values, we then simulated our model, drawing random error terms as needed, to obtain 1000 sets of pseudo data. For this exercise, we assumed

[17]We can offer some conflicting insights about the plausibility of different ω values that we have imposed. First, the overall fit of the model is clearly better when ω is close to zero. Second, we can show that simulated dissent vote frequencies match the data well when ω is close to 0.10. These findings suggest that low values of ω are more plausible. Tempering this view, we see that estimated differences in individual Taylor rule intercepts tend to be more variable when ω is small. In the presence of substantial persistence in policymaking, even modest intercept differences can imply implausibly large differences across members in long-run targets for the real interest rate. This suggests that larger values of ω are more plausible.

[18] We have estimated models similar to those in Table 1 but including additional variables in the Taylor rule specification. Specifically, we have added the growth rate of real GDP in the quarter preceding the quarter of the meeting and the value of the target interest rate of the European Central Bank prevailing on the date of the meeting. Coefficients on both of these variables differ significantly from zero, but other results are little changed. For the remainder of our work, we use the original Taylor rule formulation.

that the correlation between individual Taylor rule error terms for a given meeting [in equation (2), the correlation between u_{jt} and u_{kt}, for $j \neq k$] was equal to 0.50.[19] We then estimated the model again for each of the 1000 sets of pseudo data. Coefficient standard errors (as reported in Table 1) were calculated as standard deviations of the estimates obtained over the 1000 estimations. Biases were investigated by comparing sample means for each parameter over the Monte Carlo estimations with the known true values.[20] Table 2 reports the bias ratio—the ratio of the Monte Carlo sample mean to the true value—for each parameter. If estimates are unbiased, this ratio should be very close to 1.0. Values less than 1.0 indicate biases toward zero, and values greater than 1.0 indicate biases away from zero.

Table 2 clearly indicates the presence of bias in our estimations. For some parameters, the biases are modest; for example, a large majority of the bias ratios for individual Taylor rule intercepts are between 0.90 and 1.10. Most of the outliers involve intercepts whose true values were very close to zero (so that even small biases produce large bias ratios) or correspond to individuals who attended very few meetings. Bias ratios for the macroeconomic variables included in the Taylor rule specifications are almost all between 0.80 and 1.20. The size and direction of biases vary with the values assumed for ω. Despite the existence of bias, estimates of most parameters are sufficiently accurate to be meaningful; for example, the rankings of members according to intercepts are generally robust across estimations, and signs are correct even when magnitudes are misleading.

[19] We have assumed alternative values for the error correlation with qualitatively similar results.

[20] In the Monte Carlo simulation, we imposed the requirement that the weighting parameters γ and λ be non-negative.

However, the results show a large bias in the estimation of the key weighting parameters in the model. Table 2 reveals the existence of a large downward bias for the estimate of γ (the weight accorded the Governor) and a corresponding upward bias in the estimate of λ (the weight accorded one's peers). In the last three columns of the table, the bias ratio for γ ranges from 0.51 to 0.78, implying that our estimate of the power of the Governor is much lower than the true value. Consider the case in which $\omega = 0.10$. Our estimate of γ is 0.39, and our estimate of λ is 0.51, suggesting that the weight attached to the Governor is less than that attached to the views of rank-and-file colleagues. However, if γ is subject to a 50% downward bias (the estimated bias ratio is 0.51), the true value of γ would be close to 0.80, and the true value of λ would be roughly 0.20.[21] The implication is that, once the bias is accounted for, our results show much stronger support for the dominant chairman hypothesis. Regardless of the value assumed for ω, bias-adjusted estimates indicate a large weight for the chairman relative to the remainder of the committee.

8. Circumstances Associated with Bias

The presence of notable biases in the estimation of equation (4) is somewhat surprising. The incidental parameters problem is known to be a concern in panel data sets with small *T*, but most individuals in our sample attended fairly large numbers of meetings, so we have undertaken additional Monte Carlo experiments to understand the circumstances associated with the problem.

[21] We have also run Monte Carlo simulations in which we assume that the true value of γ is 0.8. The estimated value of γ is approximately 0.40, so the 50% downward bias also holds for this case.

One important feature of our data is that the composition of the committee changes over time. Some individuals occupy voting positions for rather short periods, so the number of observations for a specific individual can be small; for example, in our sample, committee members Martin Flodén and Cecilia Skingsley each voted in only six meetings. In addition, the total number of personalities in the sample increases over time with the number of meetings. Over a long period of time, the number of individual intercepts estimated would grow approximately in proportion to the number of meetings in the sample. Another feature of our data is that disagreement is somewhat unusual—members voted against the committee choice only 13.7% of the time. This means that even though we may have a sample of 599 individual votes, the number of observations that reveal differences across members is smaller.

To begin our investigation of the bias, we evaluated our procedure with a near "ideal" data set. We simulated data for a three-voter committee, populated by eight personalities (including two different chairmen), over 1000 meetings. Personalities had varied "true" interest rate preferences determined by differing intercepts; their desired rates were also assumed to vary with a single macroeconomic variable. The coefficient on the macroeconomic variable was equal for all personalities. We further assumed that voters' reaction function error terms within meetings were correlated, with the correlation coefficient set at 0.50. Unlike our real-world data set, we have many observations for each voter in this scenario, and the preferences of voters differed enough to generate considerable disagreement in each meeting. Results of the Monte Carlo analysis are presented in Table 3. Based on 1000 simulated data sets and estimations of equation (4), we found that biases still exist, but that they are rather small.[22] Bias ratios are close to 1.0 for most parameters, including the key weighting parameters and the coefficient of the economic variable in the reaction function.

Knowing that our procedure produces acceptably accurate estimates with a near-ideal data set, we then returned to our actual data for Sweden. Table 4 presents the results of a Monte Carlo analysis based on the original data for the Riksbank, with several modifications. In creating pseudo data, we assumed greater variety in member preferences, removed the lags of the dependent variable from the Taylor rule, and removed the assumed correlation between members' equation (2) error terms. These changes all produce more preference variety in the pseudo data sets. In addition, we did not estimate separate intercepts for members for whom there were fewer than 15 observations—we merged these individuals' records with the records of those who preceded or replaced them on the committee.

Table 4 shows that with more preference variety, bias in the estimation of the key weighting variables is notably reduced, though still present. For example, the ratio of the estimated to the true value of γ is 0.89 in Table 4, compared to 0.67 in the comparable experiment reported in Table 2 (the experiment in which $\omega = 0.25$).[23] Bias in the estimation of individual intercepts is often large, however, with a positive bias for larger intercepts and a negative bias for smaller ones. The results suggest that biases are related not only to the numbers of observations but also to the variety of preferences

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[22] Standard errors reported by our procedure were very close to the standard deviations of estimates in the Monte Carlo simulations.

[23] In the Table 4 experiments, ω was estimated, not imposed. If a true value of ω is imposed, the bias in the estimation of γ is a bit smaller.

characterizing the committee members. This also suggests that if our method were applied to voting records from other central bank MPCs, the pattern of biases could be rather different, depending on specific attributes of those data.

9. Conclusions

In recent years, central banks have begun to provide detailed information that is revealed in committee deliberations and votes. These data typically take the form of unbalanced panels describing the preferences of individual MPC members over a sequence of meetings. The availability of these data offers new opportunities to learn about the policy preferences of individual committee members and to characterize the collective choice procedures by which individual preferences are aggregated. In this paper, we investigate data produced by the MPC of Sweden's Riksbank.

We ultimately find evidence to support the hypothesis that the Riksbank is an autocratically collegial committee, i.e., a committee that achieves consensus as members defer to the committee chairman. The analysis also highlights econometric hazards that cloud the analysis of committee decisions. Our work requires the estimation of models that include individual fixed effects—the fixed effects are Taylor rule intercepts that differ across individuals. As a consequence of the incidental parameters problem, estimates of fixed effects and other key model parameters are biased. In addition, a Monte Carlo analysis reveals that biases are large. This result is somewhat surprising, given that previous work has suggested that the incidental parameters problem is of limited practical importance unless the time dimension of the data set is small.

These findings have implications for future work using panel data from central bank policy committees. The use of panel data offers important benefits in terms of investigating how individuals influence one another within policy meetings. However, isolating these effects also requires estimating individual fixed effects that will be biased. In this paper, a Monte Carlo analysis permitted us to approximate the size of the bias affecting key parameter estimates. Our conclusion that the Riksbank Governor is especially powerful depends on a bias correction calibrated to our specific model and data. Unfortunately, there is no general way to avoid the bias associated with the incidental parameters problem, so future work may need to use similar methods.

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Table 1. Estimates of Equation (4)
Taylor Rule Parameters and Voting Influence Weights
Riksbank MPC Meetings from February 2000 to April 2014

Parameter	$\omega = 1.00$	$\omega = 0.10$	$\omega = 0.25$	$\omega = 0.50$
ω	1.0[a]	0.1000[a]	0.2500[a]	0.5000[a]
λ	0.0[a]	0.5061	0.3451	-0.0746
		(0.1684)	(0.1655)	(0.1343)
γ	0.0[a]	0.3939	0.4049	0.57455
		(0.1684)	(0.1655)	(0.1343)
σ_e	0.2268	0.2076	0.2110	0.2166
	(0.0106)	(0.0167)	(0.0160)	(0.0146)
$\beta_{R_{t-1}}$	1.3696	1.1231	1.1623	1.2111
	(0.0814)	(0.1267)	(0.1210)	(0.1086)
$\beta_{R_{t-2}}$	-0.4654	-0.3549	-0.3544	-0.3706
	(0.0722)	(0.1075)	(0.1012)	(0.0918)
$\beta_{\dot{P}}$	0.0339	0.0792	0.0605	0.0494
	(0.0228)	(0.0386)	(0.0326)	(0.0287)
β_{gap}	0.0636	0.0956	0.0963	0.0964
	(0.0171)	(0.0297)	(0.0141)	(0.0233)
Intercepts:				
Bäckström	0.4411	1.2604	1.0554	0.8209
	(0.1130)	(0.3776)	(0.2114)	(0.1669)
Heikensten	0.3562	0.0634	0.4465	0.4106
	(0.1046)	(0.2108)	(0.1626)	(0.1397)
Ingves	0.3283	0.7873	0.6781	0.5343
	(0.0933)	(0.2045)	(0.1441)	(0.1207)
Srejber	0.4369	1.2149	0.9201	0.7060
	(0.1030)	(0.3177)	(0.1702)	(0.1395)
Bergstrom	0.3563	0.6967	0.6289	0.5454
	(0.1031)	(0.2195)	(0.1633)	(0.1394)
Hessius	0.5045	1.5940	1.1865	0.6923
	(0.1369)	(0.7279)	(0.4319)	(0.2154)
Nyberg	0.3143	0.7596	0.6470	0.5400
	(0.0978)	(0.1897)	(0.1538)	(0.1336)
Rosenberg	0.2757	0.6131	0.5606	0.5029

	(0.0970)	(0.3667)	(0.1712)	(0.1342)
Persson	0.2953	0.1047	0.3861	0.4568
	(0.1019)	(0.3287)	(0.1774)	(0.1409)
Öberg	0.3657	1.3109	0.8571	0.6242
	(0.0952)	(0.2390)	(0.1689)	(0.1353)
Wickman-Parak	0.3164	1.3013	0.7003	0.5238
	(0.0962)	(0.3376)	(0.1839)	(0.1330)
Svensson	0.1541	-0.3155	0.0542	0.2010
	(0.0960)	(0.3409)	(0.1826)	(0.1291)
Ekholm	0.1158	-1.0484	-0.2611	0.0428
	(0.0975)	(0.4446)	(0.1792)	(0.1289)
Jochnick	0.2981	0.7376	0.4458	0.3946
	(0.1043)	(0.3838)	(0.4375)	(0.1494)
Jansson	0.2981	0.7376	0.4458	0.3946
	(0.1065)	(0.3958)	(0.2359)	(0.1488)
Flodén	0.1164	-0.4471	-0.1512	-0.0037
	(0.1295)	(0.5573)	(0.3492)	(0.2083)
Skingsley	0.2829	1.2177	0.5148	0.3294
	(0.1284)	(0.5386)	(0.3439)	(0.2105)
Log Likelihood	-776.13	-728.21	-736.90	750.55
Sample Size	599	599	599	599

[a] The estimate is restricted to the value shown.

Notes: The parameters are defined as follows: $\beta_{R_{t-1}}$ is the Taylor rule coefficient on the first lag of the target interest rate; $\beta_{R_{t-2}}$ is the Taylor rule coefficient on the second lag of the target interest rate; $\beta_{\dot{P}}$ is the Taylor rule coefficient on inflation; β_{gap} is the Taylor rule coefficient on the output gap; ω is the weight a voter attaches to his own preferred interest rate; λ is the weight a voter attaches to the average preferred interest rate of rank-and-file committee members; γ is the weight a voter attaches to the Governor's preferred interest rate; and σ_e is the standard error of the composite error term in equation (4). The remaining coefficients are individual intercepts. Standard errors are in parentheses and are estimated via parametric bootstrapping. The constraint $\omega+\lambda+\gamma=1$ is imposed. In column (4), standard errors are calculated from a Monte Carlo experiment that requires both λ and γ to be non-negative; specifically, we set $\lambda=0$ and $\gamma=0.50$.

Table 2. Bias Ratios

Parameter	$\omega = 1.0$ "True" Value	$\omega = 1.0$ Bias Ratio	$\omega = 0.10$ "True" Value	$\omega = 0.10$ Bias Ratio	$\omega = 0.25$ "True" Value	$\omega = 0.25$ Bias Ratio	$\omega = 0.50$ "True" Value	$\omega = 0.50$ Bias Ratio
ω	1.0000	------	0.1000	------	0.2500	------	0.5000	------
γ	0.0000	------	0.3939	0.5121	0.4049	0.6751	0.5000	0.7794
λ	0.0000	------	0.5061	1.3797	0.3451	1.3812	0.0000	-----
$\beta_{R_{t-1}}$	1.3696	0.9869	1.1231	0.9888	1.1623	1.0476	1.2173	0.9881
$\beta_{R_{t-2}}$	-0.4654	0.9668	-0.3549	0.9920	-0.3544	1.1307	-0.3760	0.9696
β_{gap}	0.0636	1.2039	0.0956	1.1183	0.0963	0.7348	0.0938	1.1104
$\beta_{\dot{P}}$	0.0339	1.1100	0.0792	1.1332	0.0605	0.8429	0.0492	1.0888
σ_e	0.2268	------	0.2076	------	0.2110	------	0.2166	------
Intercepts:								
Bäckström	0.4411	1.0440	1.2604	1.2419	1.0554	1.0401	0.8371	1.0824
Heikensten	0.3562	1.0609	0.6034	1.0398	0.4465	0.8076	0.4017	1.0119
Ingves	0.3283	1.0714	0.7873	1.0834	0.6781	0.9221	0.5361	1.0586
Srejber	0.4369	1.0481	1.2149	1.0469	0.9207	0.9626	0.7022	1.0298
Bergstrom	0.3563	1.0582	0.6967	1.0974	0.6289	0.9239	0.5413	1.0371
Hessius	0.5045	1.0629	1.5940	0.9522	1.1865	0.9052	0.7277	1.0633
Nyberg	0.3413	1.0544	0.7596	1.0692	0.6470	0.9108	0.5377	1.0285
Rosenberg	0.2758	1.0661	0.6131	0.8436	0.5606	0.9214	0.4908	1.0165
Persson	0.2953	1.0643	0.1047	2.2104	0.3861	0.9451	0.4461	1.0348
Öberg	0.3657	1.0602	1.3109	1.0377	0.8571	0.9205	0.6246	1.0267
Wickman-Parak	0.3164	1.0797	1.3013	1.0678	0.7003	0.8248	0.5220	1.0599
Svensson	0.1541	1.2325	-0.3155	0.4385	0.0542	4.1086	0.1990	1.2429
Ekholm	0.1158	1.2637	-1.0484	0.8509	-0.2611	1.3035	0.0443	2.2246
Jochnick	0.2981	1.1277	0.7376	1.2843	0.4458	0.8632	0.3929	1.1956
Jansson	0.2981	1.1324	0.7376	1.2812	0.4458	0.8686	0.3929	1.2031
Flodén	0.1164	1.2669	-0.4471	0.7099	-0.1512	0.9988	0.0073	11.1357
Skingsley	0.2829	1.1424	1.2177	1.1293	0.5148	1.0347	0.3403	1.2441

Table 3. Bias Analysis: "Ideal" Pseudo Data
Taylor Rule Parameters and Voting Influence Weights
Monte Carlo Analysis

Parameter	"True" Value	Monte Carlo Estimate	Bias Ratio
ω	0.40	0.4058	1.0125
λ	0.20	0.2019	1.0095
γ	0.40	0.3923	0.9801
X_1	0.50	0.4972	0.9944
Intercepts:			
Member 1	0.25	0.2640	1.0560
Member 2	0.75	0.7562	1.0083
Member 3	0.80	0.7988	0.9985
Member 4	0.20	0.1819	0.9095
Member 5	0.40	0.3852	0.9630
Member 6	0.50	0.4910	0.9820
Member 7	0.70	0.6980	0.9971
Member 8	0.25	0.2325	0.9300
Sample Size	3000		

Notes: The parameters are defined as follows: ω is the weight a voter attaches to his own preferred interest rate; λ is the weight a voter attaches to the average preferred interest rate of rank-and-file committee members; γ is the weight a voter attaches to the Governor's preferred interest rate; and X_1 is a macroeconomic variable appearing in equation (2). The remaining coefficients are individual intercepts. The constraint $\omega+\lambda+\gamma=1$ is imposed, and the estimates of ω, λ, and γ are constrained to be non-negative.

Table 4. Bias Analysis: Riksbank Pseudo Data
Taylor Rule Parameters and Voting Influence Weights
Monte Carlo Analysis

Parameter	"True" Value	Monte Carlo Estimate	Bias Ratio
ω	0.25	0.2303	0.9212
λ	0.25	0.3223	1.2892
γ	0.50	0.4474	0.8948
$\beta_{\dot{P}}$	1.25	1.2692	1.0154
β_{gap}	1.00	1.0174	1.0174
Intercepts:			
Member 1	0.50	-0.0065	0.0130
Member 2	4.00	4.2775	1.0694
Member 3	0.75	0.5405	0.7207
Member 4	3.50	3.7094	1.0598
Member 5	2.00	1.8437	0.9219
Member 6	3.00	3.0970	1.0323
Member 7	2.25	2.2214	0.9873
Member 8	1.50	1.3396	0.8931
Member 9	1.00	0.7461	0.7461
Member 10	2.75	2.7164	0.9878
Member 11	3.25	3.3228	1.0224
Member 12	1.75	1.6268	0.9296
Sample Size	599		

Notes: The parameters are defined as follows: $\beta_{\dot{P}}$ is the Taylor rule coefficient on inflation; β_{gap} is the Taylor rule coefficient on the output gap; ω is the weight a voter attaches to his own preferred interest rate; λ is the weight a voter attaches to the average preferred interest rate of rank-and-file committee members; and γ is the weight a voter attaches to the Governor's preferred interest rate. The remaining coefficients are individual intercepts. The constraint $\omega+\lambda+\gamma=1$ is imposed, and the estimates of ω, λ, and γ are constrained to be non-negative.