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Committees with supermajority voting yield commitment with flexibility

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Abstract

A fundamental problem for government is how to combine commitment to certain policies with the flexibility required to adjust them when needed. Rogoff (1985) [Rogoff, K., 1985. The optimal degree of commitment to an intermediate monetary target, Q. J. Econ. 100(4) 1169–1189] showed that a way to strike the right balance is to appoint an optimally "conservative" policy-maker. In real life, however, policy-makers also have power over decisions where optimal plans are time-consistent, so delegating to a conservative person could be undesirable. A flexible delegation device can be found in a large committee of randomly appointed members voting over policy after observing a shock. When facing dynamic inconsistency, under a single-crossing property, there exists a supermajority rule that implements the population median's optimally conservative policy-maker with certainty. Another single-crossing property guarantees that if simple majority voting is used to select the voting rule that will govern policy choice, the supermajority preferred by the median is chosen. For problems where dynamic inconsistency vanishes, the committee will choose to make decisions by simple majority, implementing median outcomes. An application to monetary policy is developed. We show that the optimal supermajority is higher when dynamic inconsistency is more severe, when preferences are more homogeneous, and when the economy is less volatile.

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1. Introduction

A tension exists between the need of governmental bodies to commit to certain policies and the need for them to retain discretion to respond to unexpected contingencies. This

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problem affects at least three crucial policy spheres: capital taxation, the protection of property rights (including, for instance, patents), and monetary policy.

In the first example, problems arise when the government wants to credibly promise low future taxes on capital in order to encourage capital accumulation, but that government is known to prefer efficient taxation. Efficiency means the government should tax the inelastic capital stock rather than elastically supplied labor. Foreseeing this, agents will not accumulate as much capital as would be socially optimal.

In the second example, the government wishes to encourage innovation by promising unfaltering protection of patents. Ex post, however, an authority that prefers competitive outcomes because of their higher allocative efficiency will prefer to erode the power of patents. This potential inconsistency would again be bad ex ante because it lessens technological progress.

In the third example, the government promises low inflation to encourage high levels of money holdings. A problem then appears when–having been believed–the authority has, ex post, incentives to betray the low inflation expectation in order to reduce unemployment. Rational agents will only expect a level of inflation that is so high that the government has no ex post incentives to exceed it. The result is high average inflation and no governmental ability to systematically alter the economy's unemployment level.

All three examples illustrate the dynamic inconsistency problem. Its solution is, in principle, trivially simple: governments should forgo the ability to alter policy plans in the future. In the language of Kydland and Prescott (1977), they should use "rules, rather than discretion." The difficulty is that this solution is prohibitively expensive: unexpected contingencies make discretion valuable. In the case of monetary policy an unexpected recessive shock can make it worthwhile to deviate from promised monetary targets to avoid large-scale unemployment.[1] Macroeconomic shocks could be too hard to capture in a clear set of rules, and then state-contingent policy rules incorporating fine-tuned monetary responses cannot be written ex ante. Therefore, discretion is necessary for flexibility. But, as discussed earlier, such discretion destroys commitment. The real problem, then, is how to combine commitment with flexibility.

Rogoff (1985) showed that a way to attain such combination is to appoint a "conservative" central banker. This is someone who cares relatively little about unemployment vis-à-vis inflation. When choosing how conservative the central banker should be, a trade-off emerges: more conservativeness will imply lower average inflation (i.e. more commitment) but also lower flexibility in response to shocks affecting employment. Rogoff showed that the optimal degree of commitment to a policy prescription is only partial, and that the optimal policy-maker is one that yields an ideal mix of commitment and flexibility.[2]

Implementing the Rogoff solution, however, can be problematic. In many instances the policy-maker may have to decide on several issues, not all of which present a dynamic inconsistency problem. Therefore, appointing a conservative policy-maker may only help

[1] On the value of stabilization policy, see Taylor (1981) and Thompson (1981), inter alia.

[2] See however Guzzo and Velasco (1999) on the case for a populist central banker, and Neut and Velasco (2004) for a setup where more flexibility is associated with more, rather than less, commitment.

matters in one policy dimension at the cost of distorting various others. For instance, one may want conservative legislators when it comes to choosing tax rates on capital, but not when it comes to deciding on social issues. Similarly, in some countries the central bank has authority not only over monetary policy but also over the regulation of the banking industry. While a business-friendly, conservative central banker may be good for inflation, it may not be so for policing commercial banks. Separating authority over different decisions across different delegates would obviously be a way out. In real life, however, decisions over various issues are concentrated under a single authority, perhaps because of important decision complementarities. This paper proposes using a committee where the decision rule is adapted to the type of issue under consideration. If one policy is subject to dynamic inconsistency, a supermajority rule can be used to induce the right conservative bias. Meanwhile, all standard decisions can be made under simple majority voting, which entails no bias.

We consider a society with a distribution of "conservativeness" types, and a randomly sampled committee replicating society's distribution of tastes. We identify a voting protocol and a single-crossing condition on policy preferences such that different majority rules function as "personal" delegation devices. That is, each majority rule transfers authority to a precise type of individual across all possible circumstances. In particular, simple majority voting will implement the outcomes preferred by the median type. Simple majority will then work as a good delegation device from the perspective of the median individual on issues in which no dynamic inconsistency is present. Issues affected by dynamic inconsistency require delegating to a more conservative type. We show that the median can optimally mix commitment and flexibility by having the committee choosing policy under a supermajority voting rule. In other words, a supermajority rule is the median's way to delegate authority to someone more conservative than himself. We focus on the median as the institutional designer for the following reason. Under an additional condition (a single-crossing property on preferences over delegates), the voting rule that emerges endogenously through simple majority voting is the rule preferred by the median. When the policy setting displays a dynamic inconsistency problem, the majority rule preferred by the median is a supermajority.

Our argument is developed in quite general form for an environment that is complicated by the presence of a stochastic shock. The key condition to deal with such complication is that the single-crossing property over policy preferences must hold for every realization of the shock. Under a well-specified voting protocol, that condition is both necessary and sufficient for voting in committees to constitute an accurate delegation device, in the sense that it will delegate authority to a desired type.

We then develop a monetary policy example to illustrate how the assumptions invoked for our general argument can be met in applications. This example shows clearly how supermajority voting rules mitigate dynamic inconsistency by introducing a partial status quo bias.[3] We show the optimal bias will, in equilibrium, depend on characteristics of the

[3] More stringent supermajorities will imply lower average deviations from a (low) target inflation rate. Similarly, one should expect higher supermajority rules to imply higher protection of property rights and lower taxation levels. In fact, this last effect is corroborated by the very little empirical evidence available on the connection between voting rules and policy outcomes. Knight (2000) shows that higher supermajority requirements in state legislatures are associated with lower tax rates across American states.

environment, like the volatility of the economy, the extent of dynamic inconsistency, and the degree of preference heterogeneity.

Although the main thrust of our argument is normative, our paper yields a theory of the prevalence of collective decision-making devices, such as assemblies and committees. Committees embody a conflict of interest that can be exploited to mix commitment with flexibility. Because of this, committees offer a flexible delegation device: supermajority voting can be used specifically on those issues that require a conservative bias, without distorting policy-making on other areas. If the committee is large and the distribution of preferences is known, even when individual types are unobservable one can use committees to delegate authority to desired types.

The plan for the paper is as follows. The next section discusses related literature. Section 3 presents the general argument and results. Section 4 presents the application to monetary policy. Section 5 concludes.

2. Related literature

This paper is at the intersection of three different strands of literature. One concerns optimal voting rules in political contexts; another one involves dynamic inconsistency, and the third relates to central bank committees. One of the earliest contributions to the first strand is Buchanan and Tullock (1962, Chapter 6), who saw voting rules as trading off different costs of collective action. Later, Caplin and Nalebuff (1988) showed that a supermajority requirement close to 64% eliminates voting cycles under certain restrictions on preferences. Alesina and Tabellini (1990) study a model where in each period the current generation votes on fiscal expenditures. Because members of the current generation do not know whether their tastes will be reflected in the expenditure decisions of future generations, they choose to run a deficit. Alesina and Tabellini establish that a balanced budget is an impossibility if simple majority is used at each point in time to make fiscal decisions. Then they suggest that the problem could be overcome "by requiring a qualified majority to abrogate the [balanced budget] rule." However, they recognize that this would reduce the flexibility to respond to unexpected events, and that "presumably, in a model with uncertainty there would be an 'optimal qualified majority' corresponding to the optimal point on the trade-off between commitment and flexibility." Our model incorporates these ingredients and demonstrates the point formally.

Supermajorities have been studied as ways of achieving various trade-offs different from that between commitment and flexibility. In Aghion et al. (2002), a supermajority rule in Congress balances two forces. One is "insulation" of the executive from "excessive" legislative opposition to beneficial reforms. The other is legislative control against abuse of power by the executive. In a related vein, Aghion and Bolton (2003) derive an optimal majority rule for trading off protection to minorities against the need to pass reforms without paying socially costly compensations to losers. Azariadis and Galasso (2002) study an overlapping generations model and show that veto powers introduce a tendency towards the elimination of dynamically inefficient equilibria. Also in the context of an overlapping generations model, Messner and Polborn (2004) show that supermajority rules endow the old with a veto power against the stronger propensity of the young to implement reforms.

The first paper to link qualified majority rules to commitment problems is, to our knowledge, Gradstein (1999). In his model, society commits to a supermajority rule in order to credibly promise low future taxation. Riboni (2003) develops an infinite horizon model where bargaining in a committee can resolve commitment problems. Our model is complementary to theirs in that it allows for a random disturbance that makes discretion valuable. The presence of a random shock is necessary to produce the trade-off between commitment and flexibility.[4]

The second strand of literature to which our paper is related considers means for mitigating dynamic inconsistency. Reputational concerns have been shown to alleviate dynamic inconsistency (see, for instance, Barro and Gordon, 1983a). Two papers (Lohmann, 1992; Walsh, 1995) have suggested solutions that rely on giving central banks incentive schemes. They show that the trade-off between commitment and flexibility can be either relaxed (Lohmann, 1992) or eliminated (Walsh, 1995). Voting in committees, by replicating delegation to individuals, only makes different points in the trade-off available to society. What is interesting is that the results presented here depend only on institutional design. No reputation concerns or incentive schemes are considered, so our results can be seen as complementary to those just mentioned.[5] Indeed, those contributions notwithstanding, the profession continues to investigate institutional responses to dynamic inconsistency (see for instance Herrendorff, 1997; Atkeson and Kehoe, 2001; Stokey, 2002; Athey et al., in press).

Lastly, this paper brings the issue of dynamic inconsistency to bear on the topic of central bank committees. Some authors have discussed the role of committees in central banking, but the focus has not been on dynamic inconsistency. For instance, Blinder (1998) claims that committees will “avoid very bad mistakes,” and Waller (2000) shows that policy boards can insulate policy from electoral volatility. Blinder and Morgan (in press) report on experiments showing that groups make better decisions than individuals.

3. The general argument

3.1. The dynamic inconsistency problem

Consider a continuum of citizens with types t, distributed in the unit interval according to some cumulative distribution function $F(\cdot)$. Suppose there is an authority that must make a

[4] The introduction of a random shock creates a distinction between the concepts of *policy* and *institution*. Commitment to an institution or rule for policy selection (as opposed to direct commitment to a policy) is needed when (i) there is a shock that will affect the relative convenience of different policies in the future and (ii) no enforceable plans contingent on the shock can be written. In the absence of such shocks, society needs not worry about choosing the right institutions. If society can commit to any decision-making procedures by writing them into a constitution, society can equally commit to the optimal ex ante policy rather than to a decision rule.

[5] Note that introducing explicit incentives is not a trivial operation when the underlying policy model is not precisely micro-founded. In the case of monetary policy, the question of how to combine money utility and the (presumably, only policy-related) loss function does not have a natural answer without a fully fledged model. Moreover, explicit incentives are not without problems. Lohmann’s mechanism relies on a conflictive relationship between the central bank and the executive. Walsh’s paper makes the remuneration of the central banker contingent on inflation. In real life both approaches may create adverse selection effects. Therefore, a combination of explicit incentives and institutional arrangements may have to be sought.

variety of policy decisions. We assume that one of those decisions is subject to a dynamic inconsistency problem, and will focus attention on that area. As we develop our model we will make reference to how things would be in the standard policy areas where time-inconsistency is absent. Suppose the type t authority wishes to maximize the policy related function,

$$S(p, t, p^{\mathrm{e}}, u),$$

where p is the policy choice, u is the value of a shock or state of nature, and p^{e} is the policy expectation held by the public (assume all variables are real valued). This policy expectation affects policy consequences (and hence the value of the function S) because policy expectations affect political and economic decisions by agents. Our formulation is analogous to that in Kydland and Prescott (1977), although we include from the outset the presence of the shock u. As in Kydland and Prescott (1977), assume interior solutions throughout.

3.2. The discretion (flexibility) regime

Consider the following timing: First, the public forms expectations. Second, the shock is realized. Third, the authority chooses policy. This timing precludes the authority from committing to any policy ex ante, so after u is realized the policy problem is to,

$$\max_p S\{p, u, p^{\mathrm{e}}, t\},$$

while taking u and p^{e} as given. The first order condition for this problem is,

$$\frac{\mathrm{d}S\{p, u, p^{\mathrm{e}}, t\}}{\mathrm{d}p} = 0. \tag{1}$$

When the maximizing value is unique, the expression in (1) defines implicitly a policy reaction function to shocks for a type t policy-maker, given the policy expectation p^{e}. The reaction function is denoted $p^{\mathrm{f}}[u|p^{\mathrm{e}},t]$, where f denotes "flexibility."

In a rational expectations equilibrium corresponding to a situation of no commitment– i.e. in the sub-game perfect Nash equilibrium of the game–the public will expect a type t authority to implement the time-consistent policy: i.e. to choose policy according to the discretionary reaction function $p^{\mathrm{f}}[u|p^{\mathrm{e}},t]$. This means that, in average, the public will expect policy $E_u p^{\mathrm{f}}[u|p^{\mathrm{e}},t]$. It follows that a rational expectations equilibrium must feature policy expectations $p^{*\mathrm{f}}$ satisfying $p^{*\mathrm{f}}=E_u p[u|p^{*\mathrm{f}},t]$, which implicitly defines a function $p^{*\mathrm{f}}(t)$, meaning that equilibrium policy expectations under discretion depend on the type of the authority.

This means the type t authority will in expectation attain payoff $E_u S\{p^{\mathrm{f}}[u|p^{*\mathrm{f}}(t),t], u,p^{*\mathrm{f}}(t),t\}$. In ex ante terms, this is not optimal for a type t authority. The ex ante optimal plan is one that selects policy contingent on the state of nature *while* taking into account that expectations respond rationally to policy plans.

3.3. The optimal state-contingent plan

Consider the following timing: First, the authority commits to a state-contingent policy rule $p[u|p^{\mathrm{e}},t]$ by writing it into the constitution. Second, the public forms expectations. Third, the shock is realized. Fourth, the authority observes the shock and selects policy according to the announced rule. The optimal rule to commit to would emerge from solving,

$$\max_p E_u S\{p, u, p^e(p), t\},$$

where expected policy is no longer taken as given. The first order condition for this problem is,

$$E_u\left(\frac{\mathrm{d}S\{p,u,p^e,t\}}{\mathrm{d}p}\right) + E_u\left(\frac{\mathrm{d}S\{p,u,p^e,t\}}{\mathrm{d}p^e}\frac{\mathrm{d}p^e}{\mathrm{d}p}\right) = 0, \quad (2)$$

which implicitly defines a policy reaction function by a type t authority, which we label $p^b[u|p^e,t]$ (where the superscript b denotes "1st best"). This policy plan adjusts policy to the shock u but also takes into account that a policy plan affects expectations (the rational expectations policy equilibrium will in this case satisfy $p^{*b}=E_u p^b[u|p^{*b},t]$). Thus, the policy rule $p^b[u|p^e,t]$ yields a higher expected payoff than the rule $p^f[u|p^e,t]$. Under discretion the costs of affecting expectations are not internalized, leading to distorted policies that are in turn fully expected.

Unfortunately, the optimal state-contingent policy plan $p^b[u|p^e,t]$ is in general not time-consistent, so it will not be implemented under discretion. In addition–and contrary to our timing assumption in this second game–such plans cannot typically be written nor enforced, so the choice facing authorities is that of forgoing commitment to preserve flexibility (then implementing policy plan $p^f[u|p^*(t),t]$), or committing to a single policy beforehand. We now explore this last possibility.

3.4. The commitment (no flexibility) regime

Assume the following timing: First, the authority commits to a single policy value p (regardless of shock realizations) by writing it into a constitution. Second, the public forms expectations. Third, the shock is realized. Fourth, the authority implements the committed policy p. For a type t, the best policy to commit to solves,

$$\max_p E_u S\{p, u, p^e = p, t\},$$

so the best committed policy must satisfy,

$$\frac{\mathrm{d}E_u S\{p,u,p^e=p,t\}}{\mathrm{d}p} = 0,$$

which implicitly characterizes a policy $p^c(t)$ for each type t (in the monetary policy application this policy is the same for all types). The rational expectation under commitment is precisely $p^{c*}=p^c(t)$. If the dynamic inconsistency problem is so severe that the discretion regime yields a lower payoff than a full commitment one, an authority of type t will choose to commit to policy $p^c(t)$. It is obvious then that this approach only solves the commitment problem at the dear price of forgoing flexibility to adjust policy to the prevailing state. Otherwise, the authority will keep discretion to be able to match policy to the shock, effectively implementing $p^{f}[u|p^{*}(t),t]$. This opposition between full commitment and full flexibility is very stark, and the real problem for governments is how to attain some combination of commitment and flexibility.

In a monetary policy model, Rogoff (1985) showed that a way to combine commitment with flexibility is to delegate decision-making to someone who is "more conservative." A person with type t will want to delegate power to another type t^{d} (where d denotes "delegate") who has a lower tendency for reoptimization. The reason is that when type t^{d} is in power the difference between the solutions to expressions (1) and (2) is smaller than when type t himself is in charge. Relative to discretion, this will trade-off some flexibility (the reaction function of type t^{d} will typically respond less swiftly to shocks) for a diminished policy bias, which will help type t's welfare through the effect on expectations.

3.5. Assumptions

Our focus is on situations where voting in committees can function as a delegation mechanism and optimal plans are time-inconsistent. Therefore, we directly assume (1) that there is a dynamic inconsistency problem in the choice of p, and (2) that, as in Rogoff's world, the function $S(\cdot)$ is such that delegation is a way of creating commitment. In particular, assuming an interior solution for the problem the median type faces when choosing an optimal delegate, we have that the median's optimal delegate will be more conservative than the median, but not totally conservative. With suitable notation precisions, these assumptions are as follows.

Assumption 1. There exists an extreme, totally conservative type (chosen to be $t=0$ with no loss of generality) who has no leaning toward reoptimization. A type $t=0$ chooses a policy p^{0} regardless of policy regime and value of the shock (i.e. $p^{f}[u|p^{e},0]=p^{b}[u|p^{e},0]=p^{c}(0)\equiv p^{0}$). For all other types $t>0$, the tendency to reoptimize makes their optimal policy rules time-inconsistent.

Assumption 2. For all types $t\in[0,1]$, there exists an ideal delegate $t^{d}(t)\in[0,1]$ that solves,

$$\max_{t^{d}} E_{u}S\{p[u[p^{*}(t^{d}),t^{d}],u,p^{*}(t^{d}),t\}, \tag{3}$$

and we have that, for the median type t_{m}, an interior solution for this problem implies $0<t^{d}(t_{m})<t_{m}$.

Assumptions 1 and 2 merely replicate standard dynamic inconsistency setups. The more challenging part is identifying conditions that make voting in committees an accurate delegation device in the presence of a stochastic shock. We now identify a condition on policy preferences that will prove both necessary and sufficient for our voting institutions to delegate authority to a single type. For every level of the shock u, we require types to be mapped into the policy space "in order." In other words, we require the Gans and Smart (1996) single-crossing property to hold for every level of the shock.

Assumption 3. (Single-crossing condition on policy preferences): For each value of the shock u, desired deviations lie either above or below p^0, and one of the following conditions holds:

(i) If desired deviations lie above p^0: if $p^0 < p' < p$, and $t' < t$; or if $p^0 < p < p'$ and $t < t'$, then $S\{p,u,p^e,t'\} \geq S\{p',u,p^e,t'\} \Rightarrow S\{p,u,p^e,t\} \geq S\{p',u,p^e,t\}$.

(ii) If desired deviations lie below p^0: if $p < p' < p^0$, and $t' < t$; or if $p' < p < p^0$ and $t < t'$, then $S\{p,u,p^e,t'\} \geq S\{p',u,p^e,t'\} \Rightarrow S\{p,u,p^e,t\} \geq S\{p',u,p^e,t\}$.

What this condition says is that, for every level of the shock, if we take two policies (where p is relatively less conservative than p' in that it represents a larger deviation from p^0) and two types (where t', being closer to $t=0$, is more conservative than t), then if the more conservative type prefers the less conservative policy, then so does the less conservative type.[6] This condition ensures that, for every level of the shock, types can be ordered in the policy space either directly (case (i)), or inversely (case (ii)), but their relative order is never scrambled. This allows us to use median voter theorem-type arguments and ensures that, given the voting mechanism we will propose, every majority rule delegates decision power to some individual type across all states of nature. This assumption is not innocuous. It simplifies the complication brought in by the presence of a shock by requiring that the policy reaction functions $p[u|p^e,t]$ for all types should either not cross each other, or do it all at the same value of the shock u (as is the case in the monetary policy example).[7]

Assumption 3 will be sufficient to prove that there exists a supermajority rule that optimally trades-off commitment and flexibility from the median's point of view. Such rule will emerge endogenously when the committee votes (under simple majority) on voting rules, if we impose a similar condition on preferences over delegates.

Assumption 4. (Single-crossing condition on delegate preferences): For every value of the shock u, if $t^d > t^{d\prime}$, and $t < t'$; or if $t^d < t^{d\prime}$ and $t > t'$, then $E_u S\{p[u|p^*(t^d),t^d],u,p^*(t^d),t\} \geq E_u S\{p[u|p^*(t^{d\prime}),t^{d\prime}],u,p^*(t^{d\prime}),t\} \Rightarrow E_u S\{p[u|p(t^d),t^d],u,p^*(t^d),t'\} \geq E_u S\{p[u|p^*(t^{d\prime}),t^{d\prime}],u,p^*(t^{d\prime}),t'\}$.

This assumption says that if we take two delegates and two types, and the relatively conservative type prefers the relatively less conservative delegate, then so does the less conservative type. In our example on monetary policy in Section 4 the preferences over

[6] The reason we allow this condition to hold in either of two ways depending on the state of nature is that for some states the preferred policy deviations may lie below the committed policy p^0, rather than above it. This makes lower policies to represent *larger*, not smaller deviations from p^0. Everything we require is that, regardless of what is the direction of desired deviations for all those who have a preference for reoptimization, higher types should prefer larger deviations in that direction than lower types.

[7] Assumption 3 can easily be seen to follow from $S(\cdot)$ satisfying *increasing differences in* (p,t): For each value of the shock u and expected policy p^e, (i) When desired deviations lie above p^0, if $p^0 < p' <$ p, and $t' < t$, then $S\{p,u,p^e,t\} - S\{p',u,p^e,t\} \geq S\{p,u,p^e,t'\} - S\{p',u,p^e,t'\}$, and, (ii) When desired deviations lie below p^0, if $p < p' < p^0$, and $t' < t$, then $S\{p,u,p^e,t\} - S\{p',u,p^e,t\} \geq S\{p,u,p^e,t'\} - S\{p',u,p^e,t'\}$. This condition simply says that more progressive types value departures away from p^0 relatively more.

both policy and delegates are single-peaked and satisfy Assumptions 3 and 4. Assumption 4 is quite reduced form, and it can easily be seen to follow from an increasing difference condition in (t^d, t) indicating that more progressive types value a change to a more progressive delegate relatively more. Deriving this condition from more primitive preference characteristics is possible. When dynamic inconsistency is absent, $S(\cdot)$ satisfying increasing differences in (p,t) implies not just Assumption 3 but also Assumption 4. When policy expectations play a role, the derivation of Assumption 4 is more complicated.[8]

3.6. Supermajority voting yields commitment with flexibility

In this section we show that there exists a voting protocol comprising the use of a supermajority rule that achieves the optimal mix of commitment and flexibility in the eyes of the median type t_m. Our proof will make clear that the use of simple majority delegates authority to the median himself. Thus, using different voting rules for selecting policy in different areas can yield the appropriate "delegate" for each. In connection with p, suppose the committee operates under the following protocol:

Institutional choice stage

Step 1: Policy p^0 is set as the status quo policy.
Step 2: Pairwise simple majority voting takes place over all possible pairs of majority rules $s \in [0,1]$ that could apply to voting over policy.

Policy choice stage

Step 3: A pairwise simple majority vote is taken over three options: sticking with the status quo policy, passing positive deviations and passing negative deviations (in case deviations are possible in just one direction, the vote is on whether to stick with the status quo or not).
Step 4: An arbitrarily small deviation x (in the direction approved in Step 3) from the status quo policy p^0 is proposed and voted on. At least s% of committee members

[8] A detailed proof is available from the author upon request. A succinct explanation should mention that the effect of having a more progressive delegate on the expected payoff of a t type can be decomposed in three parts: (i) the effect of the delegate having a predisposition for larger deviations for each u, given p^*, (ii) the direct effect of changed policy expectations, and (iii) the indirect effect that changed policy expectations have on payoffs through their impact on the delegate's preferred policy. If all these effects are nondecreasing in t, then preferences over delegates satisfy increasing differences and Assumption 4 holds. The first effect is indeed increasing in t whenever $S(\cdot)$ satisfies increasing differences in (p,t). If dynamic inconsistency is entirely driven by diverging tastes for policy rather than different tolerance for changes in policy expectations, the effect of policy expectations on payoffs is invariant in t, and the second effect will be nondecreasing too. Lastly, the payoff impact of policy changes due to altered expectations should (in average across shocks) not decrease in t. In the monetary policy example this effect in fact increases with t (which is intuitive: higher expected inflation causes a higher inflation to be chosen, which in average is valued more by less conservative types). These conditions imply Assumption 4. In standard policy problems expectations play no role. Then, effects (ii) and (iii) disappear and $S(\cdot)$ satisfying increasing differences in (p,t) is sufficient for both Assumptions 3 and 4 to hold.

must agree for it to be approved. If it fails, the process stops and the status quo prevails. If approved, p^0+x becomes the new status quo policy. A further deviation is now pitted against the new status quo policy and the process is repeated until the s% requirement fails to be met. The policy to be implemented is p^0 plus all approved deviations.

We can now state our main result,

Proposition 1. *(a) (Institutional choice): The committee selects a supermajority* $s_m \in (1/2,1)$ *that is the most preferred voting rule of the median type* t_m. *(b) (Policy choice): Under supermajority* s_m*, the committee implements policy as if type* t_m*'s most preferred delegate* $t^d(t_m)$ *were in charge.*

Proof. See Appendix A. □

This proposition establishes that supermajority voting in committees can optimally combine commitment and flexibility. This is attained because under Assumption 3 committee voting constitutes a delegation device that replicates the behavior of an individual type.[9] The voting rule determines the particular type to whom authority is passed on. This makes it possible to transfer decision-making power to the optimally conservative person. The institutional setting considered allows for the endogenous determination of the majority voting rule under which the committee shall operate. Under Assumption 4, the median type's preferred voting rule–a supermajority–prevails, so the median's ideal mix of commitment and flexibility obtains.

In the case of standard policies, under an analog of Assumption 3, Proposition 1b implies that pairwise simple majority voting will implement the median's preferred policy rule. Because dynamic inconsistency does not trouble the choice of a standard policy, each type sees himself as the ideal delegate. In the absence of dynamic inconsistency, if $S(\cdot)$ satisfies increasing differences in (p,t) Assumption 4 obtains. Hence, Proposition 1a would imply that simple majority voting over voting rules yields simple majority itself as the chosen rule. The end result is that the committee will choose to use simple majority to make standard decisions, and a supermajority to decide on matters in which optimal plans are time-inconsistent.[10] Moreover, note that when the preference types of delegates are unobservable, the committee contributes to resolving delegation uncertainty due to the law of large numbers. Thus, delegation to committees might also be useful when facing another delegation problem, namely that the type of delegates is uncertain.

[9] Note that Assumption 3 is key for committee policy making to be able to replicate the behavior of an individual type. The Proof of Proposition 1 shows Assumption 3 is a sufficient condition for that. Necessity follows from the fact that if Assumption 3 did not hold, then a given voting rule would make different types decisive under different shocks. Thus, although in average this might create some mix of commitment and flexibility, it could never create the mix that obtains from delegating to individual types.

[10] Note that, indirectly, our results yield a rationale for why supermajorities must be applied to constitutional reforms. If some policy revisions require the use of some supermajority s, then reforming the constitution of the committee must require a supermajority of at least s. Otherwise, the first supermajority requirement would be a hollow one, as coalitions smaller than s wanting to get a decision approved could reform the constitution to eliminate the requirement.

The single-crossing properties we have identified are emerging features that particular models may or may not have. One advantage is that any model can be studied in the light of these conditions to determine if supermajority voting in committees will help. One disadvantage is we do not know yet whether there is any specific model where our assumptions hold. We now show that the conditions we have identified are met in a classic model of dynamic inconsistency.

4. The monetary policy case

In this section we study a classic monetary policy model, we show that it satisfies all the assumptions in Section 3, and use it to make the logic behind the results more transparent. Also, in this section we establish further (comparative statics) results.

4.1. A basic model

An individual policy-maker is characterized by a parameter $w \in [0, \infty)$ determining how much he cares about inflation relative to unemployment. Here we focus on a single policy area where dynamic inconsistency is a problem: the choice of inflation. The objective function for a person of type w is,

$$L(w) = w\pi^2 + (y - k\bar{y})^2, \qquad k>1, \tag{4}$$

where π is the inflation rate, and $\bar{y}$ is the natural activity level in the economy.[11] The assumption $k>1$ implies that the target activity level is higher than the natural level—so k may be called the "activist" bias. This could capture distortions in the labor market that lower the natural employment level. The higher the type w is, the higher is the person's concern for inflation deviations from a target level of zero, relative to his concerns for unemployment.[12] Hence a higher w will correspond to a more conservative policy-maker. In terms of our model in the previous section, the loss function can be seen as $-S\{\cdot\}$, and each type w corresponds to a type t according to the rule $w=(1-t)/(t)$.

The Phillips curve linking inflation to the activity level is,

$$y = \bar{y} + \beta(\pi - \pi^* + u), \qquad \beta>0, \tag{5}$$

where π^* denotes the inflation expected by the public. Inflation expectations can affect output for instance when they affect nominal aspects in contracts throughout the economy. The letter u denotes a white noise exogenous supply shock that is unknown to agents at the time of forming inflation expectations. The variance of u is denoted σ^2 and its expectation is $Eu=0$. Given that the shock u introduces a source of uncertainty, the measure of

[11] We use the standard version of the model as presented by Blanchard and Fischer (1989). The quadratic formulation has been used, for instance, by Barro and Gordon (1983b), Rogoff (1985), Lohmann (1992) and Walsh (1995).

[12] All the results extend to considering a target inflation level different from zero.

economic performance is given by the expectation of (4) across realizations of u, where y is given by (5).

Suppose a person of type w is in charge of setting inflation policy. We assume that the policy-maker has the ability to choose inflation levels after observing the shock.[13] Then, given π^* and u, the policy-maker chooses π to minimize his loss function subject to (5). Thus, the inflation level chosen is,

$$\pi(u, w, \pi^*) = \frac{\beta}{w + \beta^2}[(k-1)\bar{y} + \beta(\pi^* - u)]. \tag{6}$$

To see the nature of the dynamic inconsistency in this setup, suppose agents expect zero inflation and the shock was neutral (i.e. $\pi^*=0$ and $u=0$). Then Eq. (6) says that the policy-maker will want to create positive inflation to reduce unemployment (π will be set at $((\beta)/(w+\beta^2))(k-1)\bar{y}$). In a rational expectations equilibrium, however, the inflation expected by agents (π^*) equals the mathematical expectation of inflation, $E\pi(u,w,\pi^*)=(\beta)/(w+\beta^2)[(k-1)\bar{y}+\beta\pi^*]$, so expected inflation is,

$$\pi^*(w) = \frac{\beta}{w}(k-1)\bar{y}. \tag{7}$$

Given this expectation from agents, the actual ex post inflation under a type w policy-maker will be (substituting (7) into (6)),

$$\pi(u, w) = \frac{\beta}{w}(k-1)\bar{y} - \frac{\beta^2}{w + \beta^2}u. \tag{8}$$

This is the familiar result that a policy-maker will respond to shocks by inflating more when a deeper recession strikes. The extent of the response, however, will depend on how conservative the policy-maker is. A more conservative policy-maker will respond relatively less to the shock u (note that the absolute value of the slope $-(\beta^2)/(w+\beta^2)$ is decreasing in w). In the limit, an infinitely conservative person does not react to shocks at all. A less sensitive stabilization response is the bad thing about a more conservative policy-maker. The good thing is that average inflation in a rational expectations equilibrium is lower. This is given by $(\beta)/(w)(k-1)\bar{y}$, and we can see that an infinitely conservative person always yields zero inflation. Think of a policy-maker with some positive finite type, w'. A consequence of dynamic inconsistency is that this policy-maker obtains an average inflation that is positive and thus too high by his own standards. This is

[13] The assumption that the authority can directly choose the inflation rate, although frequent, is unrealistic (see Barro and Gordon, 1983b who use this assumption and discuss some alternatives). In reality the authority controls instruments affecting the rate of money growth, which impacts on interest rates and then on inflation. If the connection between money growth and inflation is monotonic and stable, then the assumption is innocuous. A more realistic possibility is that the connection between money growth and inflation depends on stochastic elements. If these elements can be learned by the authority before making decisions, then the model captures what transpires after such learning. If inflation is uncertain conditional on the choice of money growth, then the authority will set money growth to steer expected inflation in the way our model characterizes inflation. Although realized inflation may not equal the intended one, in average it will.

a consequence of keeping flexibility to respond to shocks when it is not possible to commit to a shock-contingent policy rule.[14]

We show now that–starting from a situation of total discretion–the policy-maker is ready to trade some flexibility for a diminished average inflation. That is to say, a policy-maker of type w' would like to delegate policy to a more conservative person, although not to an infinitely conservative one. To see this, note that the expected value of the loss function of a type w' when a type w is in charge of setting policy is,

$$EL[w, w'] = w' E\pi(u, w)^2 + E\{(1-k)\bar{y} + \beta[\pi(u, w) - \pi^*(w) + u]\}^2.$$

Using (8) and (7), one gets,

$$EL[w, w'] = [(1-k)\bar{y}]^2 + w'\left[\frac{\beta(k-1)\bar{y}}{w}\right]^2 + (\beta^2 w' + w^2)\left(\frac{\beta}{w+\beta^2}\right)^2 \sigma^2.$$

This expression has a unique (finite) minimum $w^{\mathrm{d}} > w'$ (where, again, the superscript d stands for "delegate"). This is Rogoff's (1985) result on the optimally conservative central banker: a person of type w' would like to have a more conservative person of type w^{d} setting policy. The proposition due to Rogoff holds for any type $w' \in (0, \infty)$. But how conservative the optimal central banker is depends on how conservative the type w' is himself. Because the cross partial $(\mathrm{d}E_u L[w,w'])/(\mathrm{d}w\mathrm{d}w')$ is negative (and the loss function is to be minimized) we know that the function $w^{\mathrm{d}}(w')$ has a positive slope. This means that the more conservative a type w' individual is, the more conservative his ideal central banker $w^{\mathrm{d}}(w')$ will be. It also means that preferences over delegates satisfy increasing differences in (w^{d},w), which implies that Assumption 4 is satisfied (we discuss the satisfaction of Assumption 3 later).

When dynamic inconsistency becomes arbitrarily severe (k tends to infinity) or flexibility becomes irrelevant (σ tends to zero) the median wants to delegate to an infinitely conservative policymaker that yields zero inflation. When dynamic inconsistency tends to vanish (k tends to 1) or flexibility becomes all important (σ goes to infinity), the median would rather delegate to himself (these statements are implied by our Proof of Proposition 3 later on). Delegating to a conservative central banker is not the only way to mitigate dynamic inconsistency, however. Besides the fact that reputation and incentives can play a role, direct bounds on the authority's discretion can be used. Athey et al. (in press) characterize the optimal limits on discretion in a dynamic mechanism design setup (see also Holmstrom, 1984; and Armstrong, 1994 on optimal bounds on discretion). The optimal structure of limits on discretion is a history-independent cap on inflation. This arrangement yields a different policy function relative to a conservative delegate. Under a cap, policy responds with full flexibility provided the shock is such that the cap is not binding. When shocks get recessive enough, policy hits the cap and becomes fully rigid. An optimal delegate yields suboptimal flexibility during fairly good times, but avoids total rigidity during bad times. This suggests that delegating to a conservative type may offer more of a chance for the system to survive very recessive events. The limiting behavior under caps is similar to that under delegation. When dynamic inconsistency becomes

[14] If this were possible, a policy-maker of type w would like to commit to a reaction rule that has the slope of $\pi(u,w)$ but yields zero inflation in average.

arbitrarily severe, the optimal cap arrangement mandates permanent zero inflation. When dynamic inconsistency tends to vanish, the optimal arrangement tends to an arbitrarily high cap that does not constrain behavior.

4.2. Dynamic inconsistency in a monetary policy committee

Suppose policy-makers have their types drawn from a distribution function $F(w)$ with associated density $f(w)$ and support in $[0,\infty)$.[15] The distribution $F(w)$ is common knowledge. To save on notation, assume this distribution also describes the composition of the (for simplicity, infinitely large) monetary policy committee, which has been randomly sampled from the population. We abstract from any cost considerations associated to committee members (e.g. wages), and focus on the policy consequences of committee decision-making. The median individual has type w^{m}. The point of this subsection is to show that, in a monetary policy committee choosing inflation through simple majority voting, the median type will be decisive. Thus, he will be subject to the same intertemporal inconsistency he would face when setting policy on his own.

Suppose a level u of the shock has just been realized. Also assume some level of inflation expectations $\pi^* \geq 0$ by the public. A policy-maker of type w then would like to implement an inflation level $\pi\ (u,w,\pi^*)$ as defined by Eq. (6). This expression comes straight from the first order condition of a policy-maker with type w choosing inflation given a pair (u,π^*). Preferences are single peaked.[16] The peak for each type w lies precisely at $\pi(u,w,\pi^*)$, meaning the bliss inflation level for each type w lies generally at a different point. Fig. 1 shows plots of the function $\pi(u,w,\pi^*)$ against u, corresponding to different types w.

Given a shock level u and some inflation expectation π^*, the distribution of types $F(w)$ induces a distribution $G(\pi|\pi^*,u)$ in the space of most preferred inflation levels. (The expression $G(\pi|\pi^*,u)$ indicates the fraction of people that, given π^* and u, have a preferred level of inflation deviation which is closer to zero than π is.) For, say, a shock of zero, the function $g(\pi|\pi^*,0)$ describes the density of intersections between the vertical axis in Fig. 1 and a continuum of functions $\pi(u,w,\pi^*)$ indicating the bliss inflation level for varying types w. For instance, a type such as w^{m} will want an inflation level such as $\pi\ (0,w^{\mathrm{m}},\pi^*)$ in the figure, while types lower than w^{m} will want even higher inflation levels. The distribution function $F(\cdot)$ tells us how frequent these intersections are as we move along the π axis, so the distribution of preferred inflation levels satisfies $G[\pi\ (u,w,\pi^*)|\pi^*,u]=1-F(w)$.

Note that for a shock level equal to $\pi^*+((k-1)\bar{y})/(\beta)$, all types prefer an inflation level of zero (see Eq. (6)). Hence, the distribution of most preferred inflation levels across types is actually degenerate in this case. For shocks lower than $\pi^*+((k-1)\bar{y})/(\beta)$, the more conservative people are, the less inflation they want. For shocks higher than

[15] Waller (1992) shows how different attitudes towards monetary policy can emerge even when people have the same intrinsic preferences. All that is required is that they conduct their transactions in markets with varying vulnerability to shocks. This will induce different personal trade-offs between unemployment and inflation.

[16] To check single peakedness, note that the second order condition for the problem of choosing inflation $(2w+2\beta^2>0)$ tells us the loss function is convex (hence the loss function has a unique minimum).

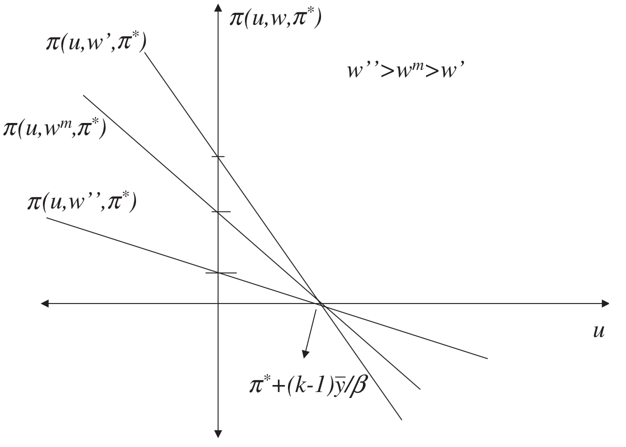

Fig. 1. Preferred inflation levels for different types.

$\pi^*+((k-1)\bar{y})/(\beta)$, the more conservative people are, the less *deflation* they want. More conservative people always prefer lower deviations from zero inflation in either direction.

4.2.1. Committee policy-making under simple majority voting

Suppose policy is chosen under simple majority voting over pairs of inflation levels, after committee members have observed the shock. There is a Condorcet winner whenever preferences satisfy the Gans-Smart single-crossing condition: the bliss policy of the median type. It is easy to see, using Eq. (6), that for shocks below $\pi^*+((\mathrm{k}-1)\bar{y})/(\beta)$ Assumption 3i is met, while for shocks above $\pi^*+((\mathrm{k}-1)\bar{y})/(\beta)$ Assumption 3ii is met. Therefore, the Condorcet winner is indeed given by the preferred inflation of the median type, given by $\pi(u,w^{\mathrm{m}},\pi^*)$.[17] Thus, the rationally expected inflation is given by (7): $\pi^*(w^{\mathrm{m}})=(\beta/w^{\mathrm{m}})(k-1)\bar{y}$. As a result, actual inflation is $\pi(u,w^{\mathrm{m}})=(\beta)/(w^{\mathrm{m}})(k-1)\bar{y}-((\beta^2)/(\mathrm{w}^{\mathrm{m}}+\beta^2))u$. The committee behaves exactly as if its median member were in charge. However, we know that the median person would like the committee to set policy as if a more conservative person than himself were choosing policy.

4.3. Supermajority voting on inflation

In this section we show how voting procedures involving a specific majority requirement can be chosen to make the committee behave as if a single central banker

[17] This is easy to check. From the optimization of any given type w, we know that the loss function varies monotonically away from the 'peak' $\pi(u,w,\pi^*)$. This implies that if a type w prefers an inflation level π to another level $\pi'>\pi$ ($<\pi$), then all types $w'>w$ (<w) also will. Thus, any pairwise comparison induces a splitting of the set of types in two convex sets: one for all those that prefer one inflation level, and another for all those who prefer the other level. The option preferred by the median type leaves exactly 50% of the types at each side, so it beats every other option.

of type $w^{d}(w^{m})$ were in charge (to save space we will write $w_{m}^{d} \equiv w^{d}(w^{m})$). This gives the median type the mix of commitment and flexibility that is best for him. We focus on the median type in this subsection for the following reason. In the next subsection we show that when society uses simple majority to vote on majority rules, the one that is chosen is the rule preferred by the median person. So we devote the current section to characterize the median's preferred voting rule.

Now consider the following procedure to be written into the constitution of the central bank:

Step 1: Previous to the realization of the shock, a target inflation level of zero is announced as the status quo policy, together with a supermajority requirement $s_{m} \equiv F[w_{m}^{d}] > (1/2)$.

Step 2: The committee takes a simple majority vote on the agenda. Three possibilities are feasible: sticking with the status quo, treating deflation variations from the status quo, or treating inflation variations.

Step 3: A supermajority vote is taken to decide whether to stick with the zero status quo inflation or to move inflation by x percentage points away from zero (where x is some arbitrary incremental unit we can think to be very small). The sign of x depends on the decision made at stage 2: it will be positive iff the shock is below $\pi^{*}(w_{m}^{d}) + ((k-1)\bar{y})/(\beta)$, and negative otherwise. If a supermajority approves the change, the new level becomes the status quo and a new supermajority voting is taken on whether to stick with the new status quo or to move inflation by another x percentage points. The process is repeated until a supermajority fails to support a new change. The resulting inflation level is implemented (i.e. the sum of all the x variations approved).

Given this voting protocol, we obtain,

Proposition 2. *Under the procedure above, the monetary policy committee implements inflation levels just as if the median type's optimally conservative central banker w_{m}^{d} were setting policy.*

Proof. See Appendix A. □

The last proposition tells us that there exists a supermajority rule that makes the monetary policy committee behave exactly like the median's optimal delegate. It is easy to check that the majority rule that achieves this must be a supermajority. We know that $w_{m}^{d} > w_{m}$ and $F[w_{m}] = (1/2)$, so $s_{m} \equiv F[w_{m}^{d}] > (1/2)$.

4.3.1. Discussion and comparative statics

We now relate the median's optimal supermajority to characteristics of the underlying policy trade-off.

Proposition 3. *The optimal supermajority s_{m} is (a) smaller when the volatility of the environment is larger (i.e. when σ, the dispersion of the shock, is larger); and (b) larger when the activist bias k is larger.*

Proof. See Appendix A. □

The proof in Appendix A contains the formalities of the comparative statics exercise involved. The intuition for this result is direct. When the variance of shocks is large, ex post flexibility is very valuable vis-à-vis credibility. Therefore, anyone prefers an optimal central banker who is less conservative than otherwise. The way to attain a committee that behaves like an optimal central banker that is less conservative is by requiring a smaller supermajority to overturn the status quo. On the other hand, the higher the target activity level is above the natural one (i.e. the further k is from 1) the higher the inflationary temptation is. This will justify having the committee emulating a more conservative central banker. And the way to attain this is to impose a larger supermajority rule. When either the variance of the shock goes to infinity or k goes to 1 eliminating the inflationary bias, the median member does not want to lose any flexibility. In this case the type of the optimal central banker $w_{\mathrm{m}}^{\mathrm{d}}$ tends to the median w^{m}, and the limit value of the supermajority is 1/2, i.e. simple majority. The median would like to delegate to himself the power to make decisions that do not pose a dynamic inconsistency problem, and hence a committee using simple majority will do as a delegation device.

Going to the other extreme, the supermajority requirement tends to unanimity only when conditions are such that the optimal central banker should be infinitely conservative (for instance when $\sigma=0$ or k goes to infinity). Unanimity is equivalent to full commitment to a rule of zero inflation.

The optimal supermajority can also be shown to depend on the degree of heterogeneity of preferences in society.

Proposition 4. *The optimal supermajority s_m is smaller when preferences in society are more heterogeneous (as measured by a median preserving spread of the distribution $F(\cdot)$).*

Proof. See Appendix A. □

The intuition for this result is as follows. The median person wants the committee to behave as if a type $w_{\mathrm{m}}^{\mathrm{d}}$ individual were setting policy. This requires making the latter individual decisive. How far the latter is from the median type in the space w is independent from the distribution $F(\cdot)$. But what does depend on this distribution is the fraction of members that are placed between the median and $w_{\mathrm{m}}^{\mathrm{d}}$. That fraction will be relatively high when the distribution is quite concentrated around the median—i.e. when preferences are quite homogeneous. Then the supermajority rule needed to make a type $w_{\mathrm{m}}^{\mathrm{d}}$ individual decisive is large. When the distribution is very disperse around the median, the opposite holds. An empirically relevant example of the distribution $F(\cdot)$ is the Lognormal, in which a single parameter can be altered to yield different spreads about the median.

4.4. Endogenous decision rules

In the previous sections we have focused on the case in which the median type, or a planner with his views, has the power to design institutions single-handedly. The key institution of choice is the supermajority rule to be used to approve inflation deviations from the status quo. What majority rule will emerge if it is up to the whole committee (or society, described by the same distribution of types) to decide on it through simple majority voting?

The answer is in the following,

Proposition 5. *Pairwise simple majority voting over all possible majority rules $s \in [0,1]$ will select the majority rule preferred by the median person: s_m.*

Proof. See Appendix A. □

The proof to this proposition shows that the majority rule preferred by the median type beats all others under a pairwise majority contest. The key element is that each voting rule delegates authority to a well-defined individual, and preferences over individual delegates satisfy Assumption 4 in Section 3. This makes the median's preferred delegate–and by extension his preferred majority rule–a Condorcet winner. For issues involving dynamic inconsistency, the median will impose the use of a supermajority, and for issues involving standard properties he will impose simple majority rule.

Suppose the decision rule s is the content of the central bank's constitution. The last proposition tells us that the endogenous democratic constitution will be equivalent to that which would be written by a constitutionalist with the preferences of the median person. A constitutionalist, however, is not strictly necessary. Supermajority rules can be the outcome of a collective decision under simple majority voting (on endogenous institutions, see also and Aghion and Bolton, 2003; Alesina et al., 2004; Barbera and Jackson, 2000; Messner and Polborn, 2004).

4.5. Discussion

Our model of voting in monetary policy committees plays a normative role: it advises a way to organize decision-making if one wants to use committees to delegate power to a conservative type. It also has some positive potential. Central banks like the Bank of England, the European Central Bank, and the Federal Open Market Commission in the Federal Reserve of the United States set policy through committees. Although voting relies in theory on simple majority rule, in practice committees function under a norm of agreement that makes them strive for consensus. This is the case in the FOMC, where dissenting votes are not common, and it is also the case in the European Central Bank. One interpretation is that striving for consensus will, to the extent that full unanimity is not always achieved, yield outcomes similar to those under supermajority voting.

The typical sequence of action in a monetary policy committee meeting (such as the FOMC or the Bank of England) is as follows. First, committee members meet and review evidence brought in by staff economists. The latter report both on real activity and financial developments. One way to interpret this evidence review process is that committee members are trying to form an opinion on how policy instruments (like the quantity of money) will impact interest rates and inflation, and on how a particular instrument stimulus will affect activity levels. In other words, they try to know what a "neutral" choice of instrument is, to serve as target. The second thing committee members do is discussing how close or far from neutral policy should be.[18] This second task ends with members taking a vote. The voting protocol used in the paper can be seen as a highly stylized representation of real central bank proceedings based on such two steps. The problem of identifying the neutral choice of instrument is simplified by assuming that such choice is constant and equal to zero. This presumably captures a situation in which staff economists "reveal" the neutral level to the committee. The protocol then focuses on the second aspect, which is the conflict over the extent to which policy should depart from neutral. This conflict comes to light after staff have offered their advice, when members of the committee express their own reading of prevailing circumstances and speculate on likely prospects. At this stage the burden of proof tends to lie with those who propose a very activist or very accommodating policy stance. In the light of discussion, in the FOMC the Chairman ends up putting forward a motion which simply takes interest rates to a particular level. In the Bank of England, the Deputy Governor proposes a motion that may pit two or even three policy options against each other, which may or may not include the existing policy.[19]

The process of agenda formation just described appears less structured than in our protocol, where sequential deviations from neutral policy are considered. One may still interpret such process as being determined by an underlying protocol, where the disagreement policy could be the target level, or alternatively the preexisting policy (our protocol would exactly capture real behavior in the first case but not in the second, which we discuss below). Once it becomes clear what the protocol would yield, the motion put forward simply expresses the common understanding of what equilibrium policy will be. An alternative interpretation is that the Chairman of the committee proposes the best policy he/she can get away with, subject to the prevailing approval norm. This process is captured by our model: our protocol yields the same outcome as one in which an agenda setter that is less conservative than the optimal delegate proposes the most progressive policy that the supermajority type will accept given the target policy. In fact, our model implies that a median type would want to surround himself with committee members, chair the committee so as to set the agenda, but constrain himself by imposing a supermajority or consensus norm. For instance, in the Bank of Canada power was given to a Governor who in turn devolved authority to a committee containing another four members.

4.5.1. Will all voting protocols work?

One relevant question is whether supermajority rules will mix commitment and flexibility regardless of the voting protocol used. This is not the case. Consider for instance

[18] There is evidence of monetary policy members making this distinction between learning what is neutral policy and how far from neutral policy should be. For example, Ms. Minehan, President of the Federal Reserve of Boston, participating at the FOMC meeting on February 2 1999, stated that "Arguably, monetary policy is stimulative, given the available liquidity in markets and the reduction in real interest rates brought about by the 75 basis points of easing in the fall. The question we have to ask is whether we really want to stimulate the economy right now or whether it might be prudent to bring policy closer to neutral, recognizing how difficult it might be to measure where neutral is." Minutes available at the FOMC's website. http://www.federalreserve.gov/FOMC.

[19] Private communication with Christopher Allsopp, former member of the Monetary Policy Committee of the Bank of England.

the following mechanism, relying on a zero inflation status quo and a supermajority requirement $s>(1/2)$. Suppose that after the shock is observed, a supermajority vote is taken to decide whether to stick with the zero status quo inflation or not. The status quo is overturned if and only if a measure of at least s votes this way. If the status quo is overturned, a new inflation level is chosen by pairwise simple majority voting over all possible inflation pairs. Under this protocol, if $s>F(2w^{\mathrm{m}}+\beta^2)$, the implemented inflation is zero regardless of the shock. If $s\leq F(2w^{\mathrm{m}}+\beta^2)$, the implemented inflation is the one preferred by the median member, regardless of the shock. To see this, note that there exists a type $w^i\equiv 2w^{\mathrm{m}}+\beta^2$ that is always indifferent between zero inflation and the preferred inflation of the median member $\pi(u,w^{\mathrm{m}})$.[20] It is easy to see that a more conservative type than w^i would strictly prefer zero inflation to the median's preferred level, while a less conservative one would hold the opposite preference. Because when overturned the status quo will be replaced by the inflation level the median member likes best, anyone more conservative than w^i would support the status quo while anyone less conservative than w^i would want to overturn it. Thus, if $s>F(2w^{\mathrm{m}}+\beta^2)$, the fraction of those voting against the status quo ($F(2w^{\mathrm{m}}+\beta^2)$) is lower than that required for overturning it, and the status quo inflation is implemented regardless of the shock. If the opposite inequality holds, the status quo is overturned, leading to the selection of $\pi\ (u,w^{\mathrm{m}})$ regardless of the shock.

Another relevant question arises in dynamic setups. Can supermajority rules mix commitment with flexibility if the status quo policy is not a given target but the last implemented policy? A full characterization of policy under such regime should integrate voting protocols where the status quo is history-dependent (as in Riboni, 2003 and Riboni and Ruge-Murcia, 2005) with a stochastic, rational expectations environment, as in this paper. This is a complex enterprise that lies beyond the scope of this paper. It is however possible to offer some guidance as to what the relevant forces at play are. To keep things as simple as possible, consider a model with two periods in which the monetary policy game is played. Shocks are i.i.d and their distribution symmetric around zero. Suppose the shock in the first period is such that an inflationary response is desired (which is the average occurrence). Under supermajority voting a lower inflationary reaction will take place than under simple majority. When a shock is realized in period 2, three things may happen. If the shock is even more recessive, further inflation will be called for, and the supermajority requirement will again restrain inflationary tendencies. If the shock goes strongly the opposite way, a deflationary response will follow, and the supermajority requirement will again exert a restraining influence over policy variation. The third case, when the new shock belongs to an intermediate interval, contains two subcases. For relatively low shocks in this intermediate interval supermajority voting will induce policy inertia, because no large enough coalition in favor of lower inflation will form to satisfy the supermajority requirement. For larger shocks in this intermediate category, a supermajority will be formed around the type that is a mirror image of the median's optimally conservative central banker. (I.e. if the optimally conservative central banker is at two thirds of the distribution over types, for the shocks we are discussing the decisive type will be the one standing at one third of the distribution.) This is a very progressive type, so for some

[20] The reader can check that type w^i satisfies $L[u,w^i,0]=L[u,w^i,\pi(u,w^{\mathrm{m}})]$ for every u. Then one can solve for w^i.

shocks the policy response will tend to be quite inflationary. In other words, for a subset of future shocks there will be a switch to an undesired bias. Supermajority voting will then entail a trade-off: lower inflationary bias today versus a mix of effects tomorrow: lower inflationary bias for some shocks, policy inertia and an inflationary bias for other shocks. Given this, the policy preferences of all types should be different in the first period, as they know that any policy they implement today will not only constitute a response to today's shock, but with some probability also influence tomorrow's policy. In this setup the median may still want to introduce a supermajority. This can be seen by making a limiting argument. Suppose that all types more progressive than the median are arbitrarily close to the median (in the limit, the type distribution has mass 1/2 at the median's position. In this case, a supermajority may imply policy inertia in the future, but inflation will never be higher than the median would have chosen it himself. Thus, supermajorities do introduce an unambiguous and permanent force towards less inflation, which dominates the initial loss of flexibility when departing from simple majority. As a result, supermajorities can well arise to mix commitment with flexibility when the status quo policy is history-dependent.

An important qualification is that due to the inertial and bias-switching effects the system will behave differently from a simple repetition of the current model with a constant status quo policy. In particular, a supermajority no longer delegates authority to a single type over all periods and across all shock realizations. An important implication of this discussion is that the relatively informal process of agenda formation in real central banks may deserve closer scrutiny, as their status quo policy is unclear. If the motions voted upon emerge to consider deviations from the estimated neutral level, real central banks under consensus norms may be mixing commitment and flexibility in a reasonable way. To the extent to which they simply choose deviations relative to the previous policy, they may be introducing undesirable biases and policy inertia. Thus, variations in the degree of monetary policy smoothing may be tracked to variations in the underlying status quo policy options used by committees.

5. Conclusion

This paper offers a theory of committees and of supermajority rules in a setup where voting institutions are endogenously determined. In our simple model, when voting institutions are chosen through simple majority voting, the median individual imposes his will, so he can be seen as the effective institutional designer. If the median individual finds himself in an environment in which optimal policy is time-inconsistent, he will want to transfer decision-making power to someone with diverging tastes. When the delegate has to make other decisions on which the median would want to keep reflected his own tastes, the median person will find trouble with the direct delegation approach. A way to overcome this problem is to appoint a committee. Then the voting rule applying to each type of decision can be chosen carefully to transfer decisiveness precisely to the person who should make decisions in each policy area. For issues where dynamic inconsistency is present, the median will prefer a supermajority rule as a way to balance commitment and flexibility. For standard issues where the temptation to reoptimize is absent, the median can empower himself by means of a simple majority rule. Thus our paper offers a rationale for committees as a flexible delegation device, which differs from the conventional rationale associated with Condorcet's Jury Theorems.[21]

In Section 3 we identify conditions under which voting rules will function effectively as delegation mechanisms in a stochastic environment, and establish our results. We show that supermajorities work by exploiting the conflict of interests present within a group of people with heterogeneous preferences. What supermajority is best depends on the fundamentals of the policy-making problem. In Section 4 we study a monetary policy application, and we show that very volatile environments make flexibility very valuable. This calls for low supermajorities, so as to make policy reoptimization easier. A large inflationary bias makes commitment relatively more valuable, so this will call for more stringent qualified majorities. Finally, more heterogeneous preferences will be associated with lower supermajority requirements.

This paper abstracts from the use of alternative means to limit the reoptimization bias, such as placing bounds on discretion or offering incentive schemes. As stated in Introduction, incentives can do better than the voting procedures studied here. Certainly a pending issue for future research is to investigate how well voting does vis-a-vis bounds on discretion and how far can voting procedures go to completely eliminate the trade-off between commitment and flexibility.

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Appendix A

Proof of Proposition 1. We first prove part (b). Focus on Step 4. In general all types $t>0$ will prefer some degree of deviation from type 0's bliss policy p^0. Assume deviations were allowed in Step 3 in a direction that, given the shock level, is the correct direction (we later show this is true), and that some majority rule s is being used to vote over policy. Then an s% majority voting is taken on a small policy deviation of size x. From Assumption 3, if x is very small, a very large fraction of types will prefer it to the status quo and it will be approved. This approval of small and cumulative deviations is repeated until the bliss policy of type t_s (which satisfies $1-F(t_s)=s$) is reached. Any further increments will not have the vote of that type, and the majority of s% will fail, thus stopping the policy

[21] For an analysis of optimal committees and voting rules in relation with Condorcet Jury Theorems, see, for instance, Grofman et al. (1983), Young (1988), Feddersen and Pesendorfer (1997), Persico (2004), and Cai (2001).

selection process at $p^{f}[u|p^{*f}(t_s),t_s]$. Now move backwards to Step 3. Assumption 3 guarantees that all types agree on what direction deviations should take. Assuming that $s>(1/2)$ (we later show this is correct), the median type and all those with higher types will prefer to approve deviations in the correct direction through simple majority voting, knowing that in Step 4 policy will be moved to a point that lies closer to their preferred policy levels than p^0. Hence, a type t^{d} is made decisive by a voting rule s satisfying $1-F(t^{d})=s$. Thus, if the median wants the committee to behave like his optimal delegate with type $t^{d}(t_{m})$, he should impose a majority rule $s_{m}=1-F[t^{d}(t_{m})]$. From Assumption 2 we know that $0<t^{d}(t_{m})<t_{m}$, implying $s_{m}=1-F[t^{d}(t_{m})]\in((1/2),1)$, i.e. s_{m} is a supermajority.

Part (a): We move back to the institutional choice stage and show that under pairwise simple majority voting over majority rules, the supermajority s_{m} beats any other majority rule. There are two situations to consider. Assume that (a) the median prefers, ex post, to see policy implemented by type 1 rather than by type 0. This means that in Step 3, no matter how low the rule s for selecting policy is, the median and all less conservative types prefer to vote against the status quo and in favor of deviating in the right direction. Thus, in Step 2 every type t has a preferred majority rule $s(t)\in[0,1]$: that which makes decisive his own optimal delegate $t^{d}(t)\in[0,1]$. This means that the single-crossing property applying to the space of optimal delegates (Assumption 4) applies to the space of optimal majority rules, and the majority rule preferred by the median type will be the Condorcet winner. Alternatively, assume that (b) the median prefers, ex post, type 0's bliss policy rather than type 1's. This means that for a low enough "submajority" rule $\underline{s}<(1/2)$ for policy selection in Step 4, the median and more conservative types will vote to stick with the status quo in Step 3. This makes all rules $s\leq\underline{s}$ effectively equivalent to unanimity rule. Thus, s_{m} will beat any $s\leq\underline{s}$ with the votes of the median and all less conservative types, while the single-crossing argument used above guarantees that s_{m} is the Condorcet winner in $(\underline{s},1]$. □

Proof of Proposition 2. Focus first on Step 2. Suppose that, in line with the proposition being true, expected inflation is $\pi^{*}(w_{m}^{d})=((\beta)/(w_{m}^{d}))(k-1)\bar{y}$. For every possible shock, preferences are aligned on whether the agenda should allow for inflation or deflation deviations from the status quo: if $u>(<)\pi^{*}(w_{m}^{d})+((k-1)\bar{y})/(\beta)$ all types will desire deflation (inflation)—albeit to different degrees. (We disregard the case when u is exactly $\pi^{*}(w_{m}^{d})+((k-1)\bar{y})/(\beta)$.) This does not mean that the decision will be unanimous, though. Very conservative types may prefer to set the agenda to include only deflation when they know the rest of types would go on to approve high inflation levels. However, simple majority voting is incompatible with these strategic incentives disrupting the agenda. For any $u<\pi^{*}(w_{m}^{d})+((k-1)\bar{y})/(\beta)$, the median and all less conservative types will vote for the agenda to focus on inflation, and they will support deflation otherwise. The agenda emerging in Step 2 can only be the correct one. Now focus on Step 3. Suppose–with no loss of generality–that the shock has been of a recessive kind, so that the agenda prescribes inflationary changes to be considered. Given the pair $(u,\pi^{*}(w_{m}^{d}))$, the distribution of preferred inflation levels is as in Fig. 2 below.

Voting begins and a first positive change of x% is proposed. All individuals with preferred inflation levels lying to the right of x would prefer an inflation level of x better than zero. If x is sufficiently small, then it certainly lies to the left of $\pi[u,w_{m}^{d},\pi^{*}(w_{m}^{d})]$, so

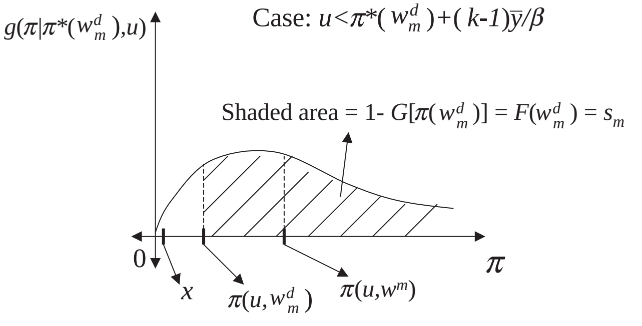

Fig. 2. A distribution of preferred inflation levels.

the type $w_{\rm m}^{\rm d}$ individual and all those less conservative than him (making up for a fraction $s_{\rm m}$ of the committee) will approve the change and make x the new status quo level. A new addition of x percentage points will be treated analogously, and this will go on until the status quo level is exactly $\pi[u,w_{\rm m}^{\rm d},\pi^*(w_{\rm m}^{\rm d})]$, or very close to it.[22] When this point is reached, the type $w_{\rm m}^{\rm d}$ individual will refuse to lend his vote to approve any further changes that would take inflation beyond $\pi[u,w_{\rm m}^{\rm d},\pi^*(w_{\rm m}^{\rm d})]$. Thus, for new changes taking inflation beyond this value, the supermajority requirement will fail to be met, and the implemented inflation is $\pi[u,w_{\rm m}^{\rm d},\pi^*(w_{\rm m}^{\rm d})]$. □

Proof of Proposition 3. We need to establish that $s_{\rm m}$ is decreasing in σ and increasing in k. Given that $s_{\rm m}=F[w_{\rm m}^{\rm d}]$, we know that $s_{\rm m}$ is increasing in $w_{\rm m}^{\rm d}$. So we only need to establish that (a) $w_{\rm m}^{\rm d}$ is decreasing in σ (i.e. when shocks have a larger variance the type w' individual prefers a less conservative central banker), and (b) $w_{\rm m}^{\rm d}$ is increasing in k. Part (a) follows from the cross partial $({\rm d}E_uL[w,w',\sigma])/({\rm d}w{\rm d}\sigma)$ being positive (the objective function is to be minimized):

$$\left.\frac{{\rm d}E_uL[w,w',\sigma]}{{\rm d}w{\rm d}\sigma}\right|_{w=w_m^{\rm d}}=\left.\frac{4\sigma\beta^4(w-w')}{\left(w+\beta^2\right)^3}\right|_{w=w_m^{\rm d}}>0.$$

Part (b) follows from the cross partial $({\rm d}E_uL[w,w',k])/({\rm d}w{\rm d}k)$ being negative:

$$\frac{{\rm d}E_uL[w,w',k]}{{\rm d}w{\rm d}k}=-\frac{4w'\beta^2(k-1)\bar{y}^2}{w^3}<0. \quad \square$$

Proof of Proposition 4. Imagine we apply a median preserving spread to distribution $F(\cdot)$, so that we obtain a new–more disperse–distribution $F^+(\cdot)$, such that $F^+(w^{\rm m})=(1/2)$, and $F^+(w)<F(w)$ for all $w>w^{\rm m}$. In a society described by $F(\cdot)$ the supermajority is $s_{\rm m}=F[w_{\rm m}^{\rm d}]$. Given $w_{\rm m}^{\rm d}>w^{\rm m}$, in a society described by $F^+(\cdot)$ the supermajority must be $s_{\rm m}^+=F^+(w_{\rm m}^{\rm d})<F(w_{\rm m}^{\rm d})=s_{\rm m}$. □

[22] We can assume that in the last round a variation of the exact amount is treated so that the final inflation is precisely $\pi[u,w_{\rm m}^{\rm d},\pi^*(w_{\rm m}^{\rm d})]$. Otherwise we can assume x to be arbitrarily small so that after arbitrarily many voting rounds the status quo inflation is arbitrarily close to $\pi[u,w_{\rm m}^{\rm d},\pi^*(w_{\rm m}^{\rm d})]$.

Proof of Proposition 5. The supermajority rule s_{m} makes decisive a type $w_{\mathrm{m}}^{\mathrm{d}}$ individual, so the implemented inflation under such rule is $\pi(u,w_{\mathrm{m}}^{\mathrm{d}})$. Preferences over ideal central bankers are single peaked and satisfy the single-crossing condition. This implies that the supermajority s_{m} beats any higher and any lower majority rules. To see this, note that all supermajority rules above s_{m} will make decisive people more conservative than $w_{\mathrm{m}}^{\mathrm{d}}$. It follows that all types $w' \leq w^{\mathrm{m}}$ will prefer the supermajority rule s_{m} to any higher one. Showing that s_{m} will beat all "submajority" rules in [0,(1/2)] is slightly more involved. Suppose first that the median is happier, ex post, if type $w=0$ sets policy rather than a type arbitrarily close to infinity. In this case, any majority rule $s \in [0,s_{\mathrm{m}})$ delegates to an individual with type $w(s)=F^{-1}(s)<w_{\mathrm{m}}^{\mathrm{d}}$. This type $w(s)$ would implement inflation deviations that are farther from zero than the median's optimal central banker. Thus, the single-peakedness of preferences in the w space means that all types $w' \geq w^{\mathrm{m}}$, preferring central bankers of type equal or higher than $w_{\mathrm{m}}^{\mathrm{d}}$, will prefer the supermajority rule s_{m} to any lower rules. Things are tricky if the median prefers, ex post, to have policy set by a type arbitrarily close to infinity rather than by type 0. This implies that there exists some majority $\underline{s} \in [0,(1/2)$ which transfers decisiveness to a type that is so biased toward inflation that the median type (and all more conservative types) would prefer to stick with the status quo in Step 2 of the voting protocol. In such case, all rules $s \leq \underline{s}$ would be equivalent to the unanimity rule, in that the status quo would prevail. But even in this case the median and all less conservative types will support s_{m} over any rule in $[0,\underline{s})$.

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