



ELSEVIER

Journal of Public Economics 76 (2000) 295–306

JOURNAL OF
PUBLIC
ECONOMICS

www.elsevier.nl/locate/econbase

Credibility may require discretion, not rules

Tyler Cowen^a, Amihai Glazer^{b,*}, Katarina Zajc^a

^a*Department of Economics, George Mason University, Fairfax, VA 22030, USA*

^b*Department of Economics, University of California, Irvine, CA 92697, USA*

Received 1 September 1997; received in revised form 1 October 1998; accepted 1 March 1999

Abstract

We reexamine the common argument that rules produce greater credibility than discretion. Rules limit the actions of agents, restricting observations of the agents' preferences or types. In a second-best world, where rules cannot be everlasting, a regime of discretion in some periods may produce superior credibility and dominate a regime of rules. © 2000 Elsevier Science S.A. All rights reserved.

Keywords: Rules; Discretion; Credibility; Regulation

JEL classification: D78; D82; L51

1. Introduction

Allowing agents discretion in their actions may be the only way to learn the agent's type. For that reason, an organization which gives an agent discretion in some period allows others to learn about what the agent is likely to do in the future, and may therefore increase his effectiveness. Of course, if the organization could prescribe the agent's action in all periods, then information about the agent's preferences or type is irrelevant. But suppose the organization faces a second-best problem, where an agent's actions cannot be prescribed in each and every period.

*Corresponding author. Tel.: +1-949-824-5974; fax: +1-949-824-2182.

E-mail address: aglazer@uci.edu (A. Glazer)

Then, as this papers shows, discretion, by revealing information about agents, can increase the long-run predictability and credibility of policy.¹

Credibility, in this sense of long-run predictability, is critical to the success of policy in many areas, ranging from monetary policy to patent policy to tax incentives. Anti-inflationary policies, for instance, will work only if individuals believe government will continue to fight inflation (Sargent and Wallace, 1981; Sargent, 1982; Barro and Gordon, 1983; Rodrik, 1989). When monetary policy is not credible, inflationary expectations will remain high, and deflationary policy may cause output to decline. Furthermore, expectations of future inflation can make it impossible to stabilize the value of money in current periods. Credibility problems also appear in tax policy, regulation, and the theory of incentives. Though government may provide tax incentives to encourage the allocation of resources in a particular direction, individuals who believe the tax incentives will be discontinued will be reluctant to commit resources in the desired direction. Similarly, subsidies, privileges, and penalties will be ineffective if individuals think the threats or promises will likely be voided.²

Relevant experience is found with the Clean Air Amendments of 1970, 1977 and 1990 which required firms to produce automobiles with lower emissions. Meeting these requirements called for costly research and development, redesign of cars, and investment in factories to produce such new equipment as catalytic converters (see White, 1982). Credibility was also imperfect in enforcing fuel economy standards for automobiles. Following the energy crisis of 1973, Congress adopted the Energy Policy and Conservation Act, which mandated minimum corporate average fuel economy standards for all new light-duty passenger vehicles sold in the United States. The standards mandated by the 1975 Act were repeatedly relaxed: standards for the 1986 model year were relaxed to 26 mpg in October 1985; standards for the 1987 and 1988 model years were relaxed to 26 mpg in October 1986; standards for the 1989 model year were relaxed to 26.5 mpg in September 1988.

More generally, credibility issues arise whenever the government faces different *ex ante* and *ex post* constraints, and when the *ex ante* solution is not a first-best policy (Persson, 1988).

Our analysis follows this literature in supposing that credibility of policy is important. We claim, however, that under some circumstances credibility increases when agents are more likely to have discretion. The conclusion arises from a simple principle—it is hard to discover information about officials bound by rules.

¹In contrast, other researchers focused on government's incentives to keep its promises. For example, rules may constrain a government that would pursue its own interests rather than the general welfare (Brennan and Buchanan, 1985; Cukierman and Meltzer, 1986). Rules may prevent governments from acting incorrectly on imperfect information (Friedman, 1968). Rules may address problems of time inconsistency (Kyland and Prescott, 1977).

²Fischer (1980) demonstrates the pervasiveness of credibility problems when government cannot use lump-sum taxation. Government has an incentive to encourage a capital investment, for instance, and then confiscate that capital *ex post*.

If the rule is ever removed or relaxed, uncertainty about future policy may be greater than if discretion had previously prevailed. In contrast, discretion generates information about the determinants of government policy, such as the types of bureaucrats in power, the preferences of voters, or the influence of special interest groups.

If policy is always set by known rules, then information about types of agents or about political preferences is irrelevant. But ironclad, eternal, rules are rare or non-existent. Our analysis instead applies when rules cannot be everlasting. In other words, we consider a second-best problem where the rule under consideration is eventually unsustainable or imperfect, or allows some discretion on some aspect of policy. We compare different stringencies of rules, where stringency is defined as the probability that a rule is in force. We show that policy may be less effective the more likely rules are in force. Social welfare may be higher if in some periods discretion substitutes for rules. Alternatively, our argument can be interpreted to say that the credibility-enhancing benefits of rules may require an unrealistic total removal of governmental discretion.

Treating the stringency of rules as variable and imperfect accords with common sense empiricism. No rule allows for absolute precommitment, nor would absolute precommitment be desirable, even if possible. Sovereign political authority, by its nature, is little constrained by external forces. “Sovereign is he who decides on the exception,” wrote Schmitt (1985, p. 5) [1922] to start a political treatise. Government, even if partially bound by constraints, always holds some ineradicable discretionary power. External forces which constrain governments may themselves hold the power to break rules. The Supreme Court, for instance, may constrain the president or Congress, but only by holding discretionary power itself.³

Policy impermanence is difficult to avoid. Voters and revolutions throw out incumbents, politicians die in office, constitutions are amended or reinterpreted, and technologies of enforcement or of avoidance improve. A Carnegie Council study of legal, political, and social institutions found that few survive for very long. Only four European institutions (other than universities) from 1530 are still around today.⁴

Our examination of how discretion reveals information about the agent is broadly related to studies of the ratchet effect in regulation (see Laffont and Tirole (1993, chapter 9) and references therein). They consider a regulator (principal) who is unsure about the costs of the regulated firm (agent), and who cannot commit to the price he will allow in later periods. A firm which produces at a low

³Bodin (1992) [1576], the sixteenth-century French political theorist, emphasized the impossibility of pure precommitment and the inevitable discretionary nature of government. See also Schmitt (1985), as cited above.

⁴The four are the Catholic Church, the Lutheran Church, the parliament of Iceland, and the parliament of the Isle of Man. Interestingly, sixty-two universities survived that same length of time (Damrosch, 1995, p. 18).

cost today thus fears that the regulator will infer that low costs are not hard to achieve, and will later offer a demanding incentive scheme. The authors show if the agent can be one of only two types and if the discount factor is small, then the optimal first-period contract separates the two types, but that for a large discount factor the optimum is close but never equal to the pooling equilibrium.

Our paper, too, asks whether the principal wants agents to reveal their types in the first period. But our analysis differs in three regards. First, in our model each agent wishes to reveal his type, if possible. Second, we do not suppose that the principal aims to extract the maximum surplus from the agent. Third, we allow the principal to prescribe what the agent should do in the immediate period (albeit not forever). Models of dynamic incentives postulate a more persistent difference between the interests of principal and agent.

The literature otherwise shows little direct parallel to our argument. Petit (1995) mentions in passing the essential idea. Giavazzi and Pagano (1988) argue that even temporary rules are likely to improve credibility, but they do not consider the effects analyzed in our paper. Backus and Driffill (1985) and Vickers (1986), drawing on the game-theoretic analysis of Kreps and Wilson (1982), illustrate how central banks may signal reputations for credibility under discretion. They do not, however, consider whether discretion is superior in this respect to rules. Drazen and Masson (1994) consider situations where rules may reduce future credibility by creating persistent costs through time. For instance, a government which resists inflating in the current period may increase long-run unemployment and thereby increase pressure on future policy makers to inflate. Long-run credibility may decline. Using a different approach, Drazen and Masson support our conclusion that necessarily impermanent rules should sometimes end sooner rather than later. Our analysis, however, focuses on the revelation of information about future policy and does not assume that the costs of current rules persist or increase over time. Rogoff (1990) notes that political business cycles may send signals about agent quality and therefore create superior outcomes, but he focuses on how political business cycles may be generated, rather than on the benefits of rules versus discretion. Waller and Walsh (1996) consider optimal term length for central bankers, emphasizing the tradeoff between the costs of surprises (associated with short terms) and the lock-in effect (associated with long terms). They do not consider our point, and thus do not consider how short terms can generate better information about future policy.

2. Assumptions

2.1. Agents

Consider two types of agents, *a* and *b*. The prior probability that a type-*a* agent holds power is α ; the prior probability that a type-*b* agent holds power is $1 - \alpha$. A

particular agent, of unchanging type, holds power for the length of the time horizon we consider. It is easiest to think of the agent as the person who implements policy, with firms or other market participants uncertain about his preferences. But the agent can also be the person who appoints another person to power. For example, the president of the United States may be considered an agent who appoints the Chairman of the Federal Reserve Board or appoints the Administrator of the Environmental Protection Agency. Once appointed, the preferences of such appointees may be clear. What may be unknown is the type of person a president will appoint in the future. Even if the preferences of the agent are known, his response to pressures by special interest groups, the ways the bureaucracy under him will use any discretion it has, or the interpretation courts will place on rules issued, may all be subject to uncertainty. Experience of policy under discretion may provide information about future policy that is otherwise not obtainable. Or in terms of our model, discretion reveals agents' types.⁵ In short, under rules, observers cannot distinguish between the types of agents: the policies adopted are identical. Under discretion, however, the agent's action gives information about his type.

The model can be given a related interpretation. Suppose firms know the types of different agents, but are uncertain about some other aspect of the state of nature. Then the policy adopted by an agent of a particular type reveals information about the state of nature, and thus about the policy likely to be adopted by that agent or by a different agent. For example, suppose President Nixon got national security data showing that improved relations with China would benefit the United States. Given his antipathy to Communists, if he thought the data compelling then they must be overwhelming. So future presidents will also maintain diplomatic relations with China.

2.2. *Effectiveness of policy*

We view the goal of discretion or rules as making policy more credible and thus more effective. We suppose policy is effective only when the type of investment firms make matches the policy government adopts. Consider environmental policy to make cars emit less pollutants. Many policies are possible: encouragement of electric cars, of cars running on natural gas, more rigid smog checks, reduction of travel, etc. If, say, government will require firms to produce electric cars and firms anticipate that, then policy will be effective. But if instead firms invest to produce

⁵Cukierman and Meltzer (1986) consider the possibility that even a good agent may wish to hide his type to reap later benefits from a policy surprise. We assume, in contrast, that the policymaker's type becomes known after the first discretionary action, or at least that market participants improve their information about the policymaker's type. Similarly, Canzoneri (1985) models agents who estimate the type of a discretionary policy maker, albeit with noise. See also Barro (1986).

electric cars and government imposes a policy of smog checks, policy will be ineffective.⁶

2.3. Investment by firms

Policy i will be effective in period t only if just at the beginning of that period firms made an investment of type i .⁷ In turn, a firm profits from an investment of type i only if policy in the coming period is of that type. We postulate that with no investment the return is zero. An investment has a fixed cost, K , which returns $V > K$ when the investment matches the type of policy. Otherwise the investment returns zero. Firms will undertake a costly investment only if they are sufficiently sure about what policy will be in the coming period. An investment can be made at the beginning of each period, which can generate a return in that period.

2.4. Regimes

In any period the agent will be bound by rules with probability r and will enjoy discretion with probability $1 - r$; these probabilities are common knowledge. The regime may change, and may be imperfectly anticipated, because a court may void a law setting up a rules regime, because Congress may change the law governing a regulatory agency, because the International Monetary Fund which imposed the rules may change its policy, and so on.

Under a regime of rules the agent follows a predetermined policy, which we take to be a . Under discretion the agent follows the policy of his type.

The first-best solution is a regime of rules in each period. We suppose that is impossible, so that r is constrained to be less than 1, and ask what is the socially optimal value of r . We shall show that within a range the effectiveness of policy can decrease in r .

3. Results

By our assumptions, policy can be effective only if it is anticipated. Note first that $r = 1$ in all periods generates perfect information. And $r = 0$ in period 1 generates perfect information about the agent's policy in period 2 were he given

⁶The idea is similar to job matching which appears in labor economics: what matters beyond the quality of a worker is how well his abilities match those required by the job. See Jovanovic (1979).

⁷For work on investments, see Milliman and Prince (1989) and Jung et al. (1996), who examine the incentives of firms to invest in new technology under different regulatory methods. Laffont and Tirole (1996) show that simple markets for pollution permits reduce incentives for innovation, and propose that options to pollute are a better policy. Requate (1995) considers output markets and shows that permits allow for partial adoption of new technologies while taxes do not.

discretion in period 2. We thus have one, extreme, example in which a high probability of discretion in period 1 may make policy in period 2 effective.

More formally, let π_a be the probability at the beginning of the period that the agent is of type a ; without loss of generality, let $\pi_a > 1/2$. Then a firm will invest in that period if and only if $V\pi_a > K$, or if $\pi_a > K/V$. With no prior information in period 1, the probability that the agent will take action a is $\pi_a = r + (1 - r)\alpha$. So no investment will occur in period 1 if and only if $r + (1 - r)\alpha < K/V$, or

$$r < \frac{K - \alpha V}{V(1 - \alpha)}. \tag{1}$$

The problem we analyze is interesting only if this inequality holds,⁸ which we henceforth assume.

Now consider a firm’s decision in period 2. Suppose it observed the agent take action a in period 1. To compare rules and discretion, we distinguish two cases. The firm either does or does not know whether rules were in effect in period 1. If the firm does know, and rules were in effect, then the posterior probability is the same as the prior probability.

If the firm knows that the agent had discretion and that he took action a , then the firm knows for sure the agent’s type is a . That is, for values of $r < \frac{K - \alpha V}{V(1 - \alpha)}$, policy will be most effective if $r = 0$. The agent’s action in period 1 perfectly reveals the agent’s type, and therefore induces investment in period 2.

Suppose next that the firm does not know whether rules were in effect in period 1, and suppose again that the agent took action a in period 1. Then the posterior probability that the agent’s type is a is given by Bayes’ Theorem: $\text{pr}(\text{type} = a | \text{action} = a) = \frac{\text{pr}(\text{action} = a | \text{type} = a)\text{pr}(\text{type} = a)}{\text{pr}(\text{action} = a)}$. We know that $\text{pr}(\text{action} = a | \text{type} = a) = 1$, and that $\text{pr}(\text{type} = a) = \alpha$, yielding the probability at the beginning of period 1 that $\text{pr}(\text{action} = a) = r + (1 - r)\alpha$. Thus,

$$\text{pr}(\text{type} = a | \text{action} = a) = \frac{\alpha}{r + (1 - r)\alpha}. \tag{2}$$

The probability that policy will be a in period 2 given that the action was a in period 1 is therefore

$$r + (1 - r)\frac{\alpha}{r + (1 - r)\alpha} > r. \tag{3}$$

We also find that

$$\frac{d\left(r + (1 - r)\frac{\alpha}{r + (1 - r)\alpha}\right)}{dr} = -\frac{(1 - \alpha)(\alpha(r - 1)^2 - r^2)}{(r + \alpha - \alpha r)^2}. \tag{4}$$

⁸If the inequality fails to hold, information about the agent’s type is irrelevant.

For sufficiently small α , the derivative is negative, so that an increase in r reduces the posterior probability that an agent who took action a in period 1 will take action a in period 2. In short, for values of r constrained to be less than $\frac{K - \alpha V}{V(1 - \alpha)}$, a reduction in r can increase the expected profitability of investment a in period 2.

When the prior probability is low that the agent's type is a , an observation that he took action a is highly informative. That is, the derivative with respect to α of the left-hand side of (3) is $(r - 1) \frac{r}{(r + \alpha - \alpha r)^2} < 0$. Thus, for a given r , firms may not invest when α is high, but may invest when α is low. Discretion may therefore be especially worthwhile when the probability of having a good agent (defined as a type- a agent) is small, suggesting a qualification to traditional analyses of governmental constraints. Advocates of rules typically argue that government officials are corrupt, lazy, untalented, or defective in other ways. Such observations are supposed to strengthen the case for rules. We suggest that sometimes the opposite result holds. Discretion may be superior precisely when most agents are bad, because it thereby allows a good agent to reveal his type, with consequent high social benefits. Or seen differently, when uncertainty does not much hinder good outcomes (i.e., when most potential agents are good), the value of information is lower and the potential long-run credibility benefits of discretion become correspondingly weaker.

We supposed so far that firms will invest only if they expect policy a to be adopted with sufficiently high probability. But if investment is profitable when it matches policy, investment may also be profitable when firms believe policy b will be adopted with sufficiently high probability. Under these conditions, the benefits of discretion in period 1 increase. To take the extreme case, if $r = 0$ in both periods, then policy in period 1 perfectly predicts policy in period 2. Regardless of policy in period 1, firms will therefore invest in period 2.

More generally, recall that by assumption in any period with rules policy is a . Therefore, if in period 1 the policy was b , firms know that the regime was one of discretion, that the agent's type is b , and that he will adopt policy b under a discretion regime in period 2. And if $r < 1 - K/V$, the firm will find it profitable to make investment b after observing action b in period 1. Now for $K/V > 1/(2 - \alpha)$, the value of $1 - K/V$ is less than the value of $\frac{K - \alpha V}{V(1 - \alpha)}$. Thus, a reduction in r can not only make investment profitable after an observation of action a , but can also make it profitable after observation of action b . That strengthens the possible benefits of discretion.

4. Applications

Though we focused on the issue of rules, many of the arguments apply to other attempts to shape the behavior of agents. To the extent that principals or policy

makers succeed in shaping the behavior of that agent, whether through rules or through incentives, they cause less information to be revealed about the agent's type. Principals are less well informed about how that agent will behave if left to his own devices.

Our critique of rules, in modified form, also applies to the use of high-powered incentives within firms and governments. High-powered incentives cannot be used to control all behavior, just as rules cannot last forever. A principal may therefore avoid using high-powered incentives in some periods, allowing him to learn the agent's type. In using lower-powered incentives, the principal learns what to expect from various agents when they act without constraint. That information may help sort agents into their proper roles, or may increase the planning abilities of the principal. For these reasons, our argument may help explain why firms or governments may avoid high-powered incentives.

Our analysis may apply not only to the stringency of rules, but also to differing regimes of pure discretion. The benefits of information revelation under discretion suggest a new argument for frequent turnover of politicians. Under full discretion, frequent turnover can generate better information about the preferences of the electorate or the strengths of various political pressures. Turnover can generate information about the likely course of future policy and strengthen rather than weaken credibility. We have in mind a government where policy is determined by a combination of voters, special interest group pressures, and the personal preferences of ruling politicians. Individuals or firms observe the resulting current policies and draw inferences about the course of future policy. In other words, individuals try to predict the future political equilibria.

The frequent turnover of officials can generate information about long-run political equilibria. When one person holds office for a long time, firms do not know whether the observed equilibrium is attributable to the power and preferences of that ruler, or whether the observed equilibrium represents a natural balance of power that will outlast that ruler's tenure. Once that agent's tenure ends, planning costs may be very high. Were one person to be chairman of the Federal Reserve Bank for long, U.S. monetary policy could face a crisis of confidence when the new chairman stepped in. Investors would not know what monetary policy to expect. Was money tight because the former chairman forced that policy, or was money tight because anti-inflationary groups control the Fed? When new chairmen are more frequently appointed, investors can better estimate the idiosyncratic contribution of particular agents to the overall outcome. Investors can then predict inflation rates with greater accuracy. Similarly, peace between Egypt and Israel became credible after President Sadat was assassinated and his successor, President Mubarak, abided by the agreement. And by serving only two terms as president, George Washington demonstrated that the stability of the federal government did not depend on him.

The Augustan reign during the Roman empire illustrates the potential costs of politicians who hold office for too long. Augustus reigned from 44 B.C. to 14

A.D., a tenure of 58 years. Augustus is considered a benevolent and efficient emperor. More than any single other ruler, he restored order to the empire and created the Roman imperial system. Yet the reign of Augustus also brought long-run costs. Augustus built a political equilibrium that centered fundamentally around his personal power and prestige. Augustus was aware of the problem of succession he had created, and tried in vain to ensure that stability would survive his reign. Once Augustus died, however, political chaos broke out. Having lived under Augustus for so long, citizens did not know which political forces would prevail after him. Successive emperors lacked Augustus's talents and therefore turned into tyrants (e.g., Caligula) or found themselves buffeted by unstable political currents (e.g., Claudius).⁹

Our argument therefore illustrates a parallel between the costs of dictatorships and the costs of rules. A dictator, even if efficient and benevolent, cannot control his own succession. His credibility may be high during his regime, but the presence of dictatorship generates uncertainty about later policy choices. Other political interest groups could not establish a readily observable balance of power. Rules face a similar problem of succession, as discussed above. Once the rule is gone, individuals may not know what to expect.

5. Conclusion

We found two counterintuitive results. First, discretion in some periods may increase credibility of policy in future periods beyond what a regime of rules can. Second, the benefits of discretion may be especially large when the agent is initially expected to be bad.

These results show that the concept of credibility is more complex than usually realized. Economists sometimes think of credibility as the likelihood that government will keep its promises or maintain a policy in a given period. We focused on a broader, intertemporal, property of credibility—the need to signal the agent's type. These two properties of credibility need not always be neatly packaged. That is, the presence of governmental rules in earlier periods can increase the difficulty of signaling government policy for the more distant future. For this reason, a desire to increase the credibility of policy does not always argue for policy rules and against discretion. The case for discretion is stronger than previously believed.

6. Notation

K Cost of investment

⁹For an introduction to the reign of Augustus, see, for instance, Earl (1968).

r	Probability that regime is of rules
V	Return from investment which matches policy
π_a	Posterior probability that agent's type is a
α	Prior probability that agent's type is a

Acknowledgements

We are grateful for comments by the editor, anonymous referees, James Buchanan, Penelope Cowen, Michelle Garfinkel, Daniel Sutter, Alex Tabarrok, and seminar participants at the University of California-Riverside, the University of Regensburg, and the George Mason University Brown Bag.

References

- Backus, D., Driffill, J., 1985. Rational expectations and policy credibility following a change in regime. *Review of Economic Studies*, April 52 (2), 211–221.
- Barro, R.J., 1986. Reputation in a monetary model with incomplete information. *Journal of Monetary Economics* 17 (1), 3–20.
- Barro, R.J., Gordon, D.B., 1983. Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics* 12 (1), 101–121.
- Bodin, J., 1992. *On Sovereignty: Four Chapters From Six Books on the Commonwealth*, Cambridge University Press, Cambridge, [1576].
- Brennan, G., Buchanan, J.M., 1985. *The Reason of Rules: Constitutional Political Economy*, Cambridge University Press, Cambridge.
- Canzoneri, M., 1985. Monetary policy games and the role of private information. *American Economic Review* 75 (5), 1056–1070.
- Cukierman, A., Meltzer, A.H., 1986. A positive theory of discretionary policy, the cost of democratic government and the benefits of a constitution. *Economic Inquiry* 24 (3), 367–388.
- Damrosch, D., 1995. *We Scholars: Changing the Culture of the University*, Harvard University Press, Cambridge, MA.
- Drazen, A., Masson, P.R., 1994. Credibility of policies versus credibility of policymakers. *Quarterly Journal of Economics* 109 (3), 735–754.
- Earl, D., 1968. *The Age of Augustus*, Crown Publishers, New York.
- Fischer, S., 1980. Dynamic inconsistency, cooperation and the benevolent dissembling government. *Journal of Economic Dynamics and Control* 2 (1), 93–107.
- Friedman, M., 1968. The role of monetary policy. *American Economic Review* 58 (1), 1–17.
- Giavazzi, F., Pagano, M., 1988. The advantage of tying one's hands: EMS discipline and central bank credibility. *European Economic Review* 32 (5), 1055–1075.
- Jovanovic, B., 1979. Job matching and the theory of turnover. *Journal of Political Economy* 87 (5), 972–990.
- Jung, C., Krutilla, K., Boyd, R., 1996. Incentives for advanced pollution abatement technology at the industry level: An evaluation of policy alternatives. *Journal of Environmental Economics and Management* 30 (1), 95–111.
- Kreps, D., Wilson, R., 1982. Reputation and imperfect information. *Journal of Economic Theory* 27 (2), 253–279.

- Kydland, F.E., Prescott, E.C., 1977. Rules rather than discretion: the inconsistency of optimal plans. *Journal of Political Economy* 85 (3), 473–491.
- Laffont, J.-J., Tirole, J., 1993. *A Theory of Incentives in Procurement and Regulation*, The MIT Press, Cambridge, MA.
- Laffont, J.-J., Tirole, J., 1996. Pollution permits and environmental innovation. *Journal of Public Economics* 62 (1–2), 85–125.
- Milliman, S.R., Prince, R., 1989. Firm incentives to promote technological change in pollution control. *Journal of Environmental Economics and Management* 17 (3), 247–265.
- Persson, T., 1988. Credibility of macroeconomic policy: An introduction and a broad survey. *European Economic Review* 32 (2–3), 519–532.
- Petit, P., 1995. The cunning of trust. *Philosophy and Public Affairs* 24 (3), 202–225.
- Requate, T., 1995. Incentives to adopt new technologies under different pollution-control policies. *International Tax and Public Finance* 2 (2), 295–317.
- Rodrik, D., 1989. Promises, promises: Credible policy reform via signaling. *The Economic Journal* 99 (397), 756–772.
- Rogoff, K., 1990. Equilibrium political budget cycles. *American Economic Review* 80 (1), 21–36.
- Sargent, T.J., 1982. The ends of four big inflations. In: Hall, Robert (Ed.), *Inflation: Causes and Effects*, University of Chicago Press, Chicago.
- Sargent, T.J., Wallace, N., 1981. Some unpleasant monetarist arithmetic. *Federal Reserve Bank of Minneapolis Quarterly Review* 5 (3), 158–190.
- Schmitt, C., 1985. *Political Theology: Four Chapters on the Concept of Sovereignty*, MIT Press, Cambridge, MA, [1922].
- Vickers, J., 1986. Signalling in a model of monetary policy with incomplete information. *Oxford Economic Papers* 38 (3), 443–455.
- Waller, C.J., Walsh, C.E., 1996. Central-Bank independence, economic behavior, and optimal term lengths. *American Economic Review* 86 (5), 1139–1153.
- White, L.J., 1982. *The Regulation of Air Pollutant Emissions from Motor Vehicles*, American Enterprise Institute, Washington.