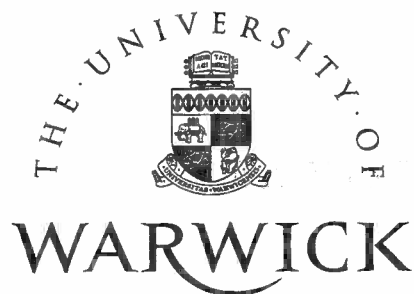


EUROSCLEROSIS, EUROCHICKEN AND THE OUTLOOK
FOR EMU

Marcus Miller

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EMU

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Eurosclerosis, Eurochicken and the Outlook for EMU*

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Abstract

Europe is rushing headlong into monetary union armed with preconditions reflecting mistrust among would-be partners rather than what is needed for a successful common currency. Current negotiations on the future structure and policy of EMU, in particular, seem to resemble a game of "Chicken"! It is surely unlikely that this will produce the sort of monetary policy needed to mitigate the effects of Eurosclerosis. It is suggested, therefore, that willingness to initiate labour market reforms would be a far more effective criterion for membership than the current Maastricht conditions.

1 Introduction

The issue of delegating of monetary policy from government to central bank is high on the political agenda in Europe. Both France and the UK have recently given more autonomy to their central banks (CBs) and The Treaty of European Union (1992) require EU countries joining a European Monetary Union to collectively delegate their monetary policy to a

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European central bank (ECB), whose primary objective will be price stability. What kind of monetary policy are we to expect from the ECB? Will it be like that practised in the USA, for example, where Mr Greenspan runs a fairly active stabilisation policy; or will it be more like a return to the Gold Standard? These are the issues we focus on here.

As a preliminary we recall some conclusions from an earlier paper, Lockwood *et al* (1996), where Rogoff's (1995) model of delegation to a "conservative" central bank was extended to allow the latter to build a reputation for low inflation. Since the longer-run view taken by a central bank, relative to the finance minister, means that it will be more concerned to protect its reputation, this implies that it has a comparative advantage in implementing monetary policy ; for unlike the ministry of finance, it can respond actively to supply-side shocks without raising fears that this activism will be used to stimulate the economy beyond its non- inflationary equilibrium. In this case it is the central bank's concern for reputation and not its conservative bias that checks inflationary expectations. With sufficiently good reputation, indeed, a central bank will in principle be able to implement the governments own first-best stabilisation policy.

One can apply this idea to see how the conduct of policy might differ on either side of the Atlantic. One observes that there is considerable nominal rigidity in the USA, substantially more than in Europe. On Rogoff's reasoning this should lead to a greater conservative bias in America — because the government there needs to offset a perceived greater temptation to spring monetary surprises. But there is little evidence of a more pronounced conservative bias in US monetary policy. On the contrary, the Fed seems to conduct a fairly active stabilisation policy as already noted. That it can do this without stimulating inflation expectations could be because, in the USA, reputation (the "Greenspan effect") is acting as an effective substitute for Rogoff's "conservative bias".

One can only speculate about future European monetary policy because the ECB is not yet in business. But a striking feature of current negotiations on EMU is the lack of trust between Northern and Southern states. This has led to increased restrictions on the freedom of governments to use fiscal policy (the Stability Pact) — and it looks set to lead to fairly conservative monetary policy. In the next section, where we use game theory ideas to analyse current and future EMU negotiations, we find that they resemble the game of "Chicken": North and South have different agendas and a breakdown of negotiations has

avoided largely because of Chancellor Kohl's warning that failure to proceed with EMU will imperil peace in Europe.

One cannot discuss stabilisation policy in Europe without acknowledging the marked persistence in European unemployment. If this persistence is due to insider power, the first-best policy would surely be to change the structure of the labour market — this was Mrs Thatcher's objective in the UK. But if this is not done — and there does not seem to be much stomach in Europe for labour market reform along Anglo-Saxon lines — then the next best policy is to increase stabilisation as the persistence increases.

Delegating to a central bank without reputation in the manner discussed by Rogoff involves choosing a more conservative delegate the more persistent is unemployment — the opposite of what is socially efficient (the reason for this is that, absent reputational factors, the incentive to cheat rises faster than the incentive to stabilise as persistence increases). To avoid this there needs to be a central bank which people trust to practise active stabilisation. Reputational factors or state contingent contracts can help to achieve this.

But the lack of trust between North and South combined with the lack of willingness to reform labour markets suggests, however, that Europe may get the worst of both worlds, inflexible labour markets and rigid monetary policy. This is one reason why countries like the UK prefer to wait and see before making any irreversible commitment.

Finally, we note that for many countries the economic incentive to delay joining EMU appears to be offset by the desire to signal commitment to Europe; i.e., joining EMU is a costly but positive signal. We conclude that there must surely be better signals of caring for Europe than being willing to sign up prematurely to an institutional structure born of mistrust.

2 Some Strategic Aspects of the EMU Negotiations

In discussing the prospects of a mini currency union, Paul de Grauwe (1996) draws attention to the scope for strategic behaviour in 1998, when the decision to allow individual countries into EMU is made by a qualified majority of *all* EU countries. For, at that point, three or four countries would be capable of forming a blocking minority. So there is wide scope

for coalition building by the “losers” in the Maastricht game (where he defines “losers” as those member countries whom the EMI judges to have failed the Maastricht test).

De Grauwe notes, however, that the official losers would have a strong legal basis to claim that Belgium, Holland and Austria should be failed on the Debt/GNP criterion; so letting them proceed actually involves relaxing the criteria. If one of the criteria is relaxed, why not others? So (they might argue) why not have a Maxi EMU? The answer is that those pressing for a Mini EMU might rather postpone things, Germany in particular.

In what follows, these strategic aspects are illustrated using an explicit pay off matrix for Northern and Southern member states. We find that, in the absence of trust, participants seem to face a Prisoner’s Dilemma which could lead to postponement. (This is de Grauwes conclusion, and he recommends various steps to help secure agreement.)

A notable feature of negotiations, however, has been the sombre view of Chancellor Kohl that failure to agree on EMU will threaten the peace of Europe in the 21st century. Taking account of such a dire punishment for failing to agree converts the game into one of Chicken, where North and South each press for their preferred grouping (Mini and Maxi respectively) but are willing to compromise with some probability to avoid postponement.

		North	
		Mini	Compromise
South	Maxi	EMS 4, 8	7, 7
	Compromise	2, 10	4.5, 8.5

Table 1: EMU Negotiations as a Prisoners’ Dilemma.

First (in the absence of Kohl’s disaster scenario) the payoff matrix could look something like Table 1, where the first entry in each cell is the payoff to the South, the second to the North, and the actions open to each group are either to press for their preferred type of Union or to compromise. These payoffs are also illustrated graphically in Figure 1, with gains to the South on the horizontal axis. The point labelled EMS represents the perceived payoffs *before* the move to EMU. The major benefits are assigned to the North, who it was argued were gaining too much of the benefits (Germany in particular). The payoffs from

moving to a broad based EMU are indicated by the point MC where the sum of the payoff has gone up, and their distribution has been equalised. This outcome (widely thought to represent French intentions in pressing for a broad based EMU) appears as the top right cell of Table 1. The payoffs when the membership is limited to a Mini currency union are shown by point CM, corresponding to the bottom left cell of Table 1, where the inner core gains and the distribution of benefits is more unequal than in the EMS. The point labelled CC is the result of a compromise (which is an average of CM and MC) and appears as the bottom right cell of Table 1. Assuming that, in the absence of any compromise, the outcome will be a postponement with pay offs corresponding to those of the EMS (i.e., “back to square one”), we can enter the coordinates of EMS into the top left cell.

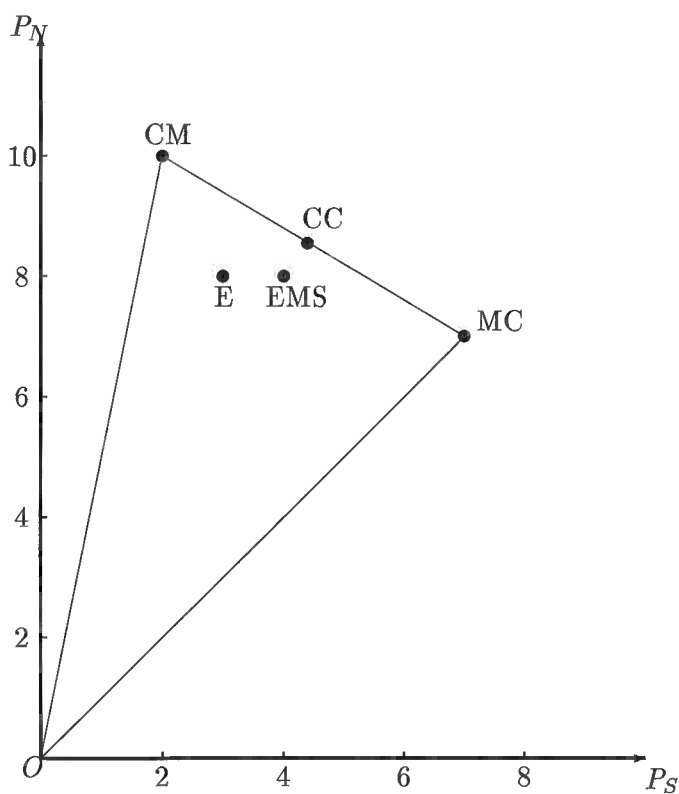


Figure 1: Possible payoffs in EMU negotiations.

What is the equilibrium of the game? It is evident that, of the two “coordinated” solutions, CC and EMS, the mutual compromise dominates a return to the EMS. But each group is tempted to defect from such a mutual compromise. Indeed it turns out that the strategy of playing Maxi is better for the South whatever the North chooses; likewise playing Mini is the dominant strategy for the North. It is in short a game of Prisoners’ Dilemma and the Nash equilibrium is one of no agreement.

Consider, now the idea of punishing heavily such a failure to agree — which is where Chancellor Kohl’s threat comes in. Let this be represented by payoffs of zero to both players as shown in the top left cell of Table 2, where other payoffs remain unchanged.

		North	
		Mini (n)	Compromise ($1 - n$)
South	Maxi (s)	“Disaster” 0, 0	7, 7
	Compromise ($1 - s$)	2, 10	4.5, 8.5

Table 2: How Kohl’s disaster scenario changes the nature of the game.

Note that postponement is no longer the unique pure strategy Nash equilibrium of the game. Indeed there are two pure strategy equilibria, CM and MC, either a Mini or Maxi currency union. How do the players tell which equilibrium will occur in what has become a game of “Chicken”? They cannot, but the best prediction in Chicken is perhaps the mixed strategy equilibrium. So with s denoting the probability of South playing Maxi and n that of North playing Mini we find the mixed strategy Nash equilibrium (with South choosing s so as to maximise its expected payoff, taking n as given, and vice versa). For the numbers in Table 2, the equilibrium values for s and n turn out to be 0.18 and 0.56 respectively, i.e., North is likely to press harder than the South for its preferred solution. The equilibrium outcome could now be any of the four entries in the pay off matrix, with probabilities depending on s and n . Most likely is a Mini currency union (with probability 0.46), followed by a mutual compromise (0.36). A postponement is no longer at all likely (probability 0.10); nor is a Maxi union (0.08). The expected payoffs to the players are

shown at the point E in the figure.

This analysis suggests that Kohl's sombre threat is keeping the show on the road by giving a high probability to a Mini currency union.

3 Labour markets and monetary policy — the choices facing Europe

Before attempting to analyse things in any detail, let us begin with a very broad-brush characterisation of labour markets and of monetary policy, illustrating various possible combinations and indicating where Europe seems to be heading. At one end of the spectrum, labour markets can be quick to clear with flexible wages and a mobile labour force: at the other, due possibly to the power of insiders they may be slow to adjust with persistent unemployment. Monetary policy can, in turn, be tied rigidly to an anti-inflationary target, or alternatively conducted so as to help stabilise the economy as much as possible without raising inflation expectations.

		Labour Market	
		Flexible	Rigid
Monetary Policy	Flexible	USA	Germany
	Rigid	UK ↑	France, EMU

Table 3: Monetary policy and labour markets: four cases and some examples.

The possibilities are shown in Table 3, where we have tried to place the US, UK, France and Germany in appropriate boxes. We begin with the least contentious. In the top left is the USA with flexible labour markets and monetary policy conducted with a fair degree of discretion (*à la* Greenspan). In the bottom right is France with rigid labour markets and inflexible monetary policy. It seems clear that Germany labour markets are pretty inflexible; but the Bundesbank has a reputation for conducting very sensible monetary policy (fully accommodating the first-round impact of oil price shocks on inflation, for example, and overriding monetary targets where velocity shocks are present). So Germany appears top left. What about the UK? After Mrs. Thatcher's efforts to reduce strike activity and union

power (with provisions for the balloting of union members before taking strike action, and a tightening of the laws governing on picketing, for example), UK labour markets are much more flexible: and the newly elected Labour administration shows no stomach for reversing her reforms. Mrs. Thatcher also adopted monetary targets which were widely criticised as being too rigid (not least by the Bundesbank). But these targets were dropped and, after spending two years in the ERM, Britain has adopted inflation targets (currently $2.5\% \pm 1\%$) It was widely reported that the example of the Fed was instrumental in persuading the Labour administration to give the Bank of England operational independence in using interest rates to pursue these targets. So the UK is put bottom left with an arrow heading to top left!

Where is Europe heading in its plans for EMU? Given the lack of stomach for Thatcher-like reforms in France and Germany, one presumes that a fairly high degree of labour market inflexibility will continue, so EMU will be in the right hand column. What about the conduct of monetary policy? Despite the fact that the Bundesbank was the model for the Maastricht Treaty, it is widely expected that the new European Central Bank (ECB) will act in a non-discretionary fashion at least to begin with; so EMU is put with France in the lower right. If this is the appropriate classification it is hardly an attractive prospect for Europe already saddled with high unemployment.

Why should Europe be heading this way? There are, of course, practical forces pushing for ever closer integration in all its forms. But the current rush for monetary integration seems to be under pinned by a mistaken assumption and undermined by international mistrust. The mistaken assumption is that creating a common currency for Europe will *ipso facto* make Europe a competitive economy like the US, without having to make painful changes in the operation of labour markets. The mistrust arises from the fact that countries being required to cede sovereignty to a relatively unaccountable European Central Bank (ECB) which does not yet exist are faced with something of a “Prisoners’ Dilemma” as we have discussed above. There are gains to be had in pooling sovereignty but they depend on shared views and values. But Germany does not trust its Southern neighbours to conduct appropriate monetary policy so it is doing its best to tighten up the Treaty and reduce policy discretion. Meanwhile other would-be EMU members — unhappy at this prospect — are seeking ways to avoid the consequent narrowing of policy options. As a result, the chances of seeing in Europe, the sort of discretionary policy currently practised in the US

seems increasingly remote.

4 Issues in the Delegation of Monetary Policy

4.1 Reputation as a substitute for conservatism

To substantiate this broad-brush treatment, we pursue the idea of monetary policy delegation explored in Rogoff (1995). In that classic paper the author showed that the “time consistency” problem facing the government can be mitigated by delegation to an anti-inflationary (“conservative”) Central Banker. In choosing the Central Banker, however, society faces a trade-off between controlling inflation and stabilising the economy against supply side shocks: and Rogoff showed that the optimal delegate should be *more* anti-inflationary than society as a whole; but not be “*too* conservative”. In recent papers Lockwood, Miller and Zhang, hereafter LMZ, have extended Rogoff’s model in two ways — first to allow for the Central Bank to differ from the government not just in its anti-inflationary preferences but also in its degree of farsightedness (see also Fratianni and Huang (1995)); second, to allow for unemployment to persist, following a first order autoregressive process. Together these two extensions allow us to give some analytical handle on the very broad issues sketched above.

If the Central Bank is more far-sighted than the government this provides another reason for delegating, namely to locate policy decisions with an agent who takes a longer view. If, in particular, the longer horizon of the delegate means that policy making is treated as a repeated game then he or she will be much less tempted to manipulate the economy for short run gain. This can be modelled by assuming, as in Barro and Gordon (1983), that the private sector effectively “punish” such behaviour with a “trigger strategy” of raising their inflation expectations whenever targets are not met. It is as if the Central Bank loses its reputation when it is found not to deliver on its targets. In these circumstances it turns out that it may no longer be necessary to delegate to a conservative. Reputation acts as a substitute for conservatism.

The basic assumptions of LMZ (1996) and the symbols used below are given in Appendix A. The results referred to above are not derived there: but they can be illustrated

with the aid of Figure 2. The parameter ϕ appearing on the vertical axis of the upper panel is a measure of expected inflation. On the vertical axis of the lower panel is plotted the parameter, λ_b the “inflation aversion” of the Central Banker.

The variable s plotted on the horizontal axis measures the extent to which the policy-maker stabilises employment in face of supply shocks. Setting $s = 1$, for example, would mean supply shocks are fully accommodated i.e., fully reflected in the price level, while $s = 0$ implies no accommodation what so ever. The choice of s reveals the preferences of the policymaker (as indicated by the upward sloping schedule in the lower panel) and the schedule OA shows how the “time consistent” rate of inflation varies with s . Thus an ultraconservative policymaker ($s = 0$) generates expectations of price stability ($\phi = 0$).

The preferences of the government are shown by the iso-cost contours centred on the point F which is the “bliss point” where inflation expectations are zero and the stabilisation coefficient s is socially optimal i.e., $s = 1 - \lambda$. Rogoff’s optimal conservative Central Banker is found by minimising costs along the schedule OA (see point R , where the iso-cost contour is tangent to OA).

The effect of reputation is to lower the schedule OA , to $ODBC$ for instance. Minimising costs in this case is achieved at point D . The inflation aversion of the Central Banker chosen in this way is shown as λ_b^* in the figure. As D lies to the southeast of R , this implies that there is more stabilisation (i.e., less conservatism) without any increase in inflation expectations. This illustrates how reputation can act as a substitute for conservatism. In next section this diagrammatic treatment is used to examine the role of inflation targets.

4.2 Two views of inflation targets

Consider first the idea of Svensson (1997) where he proposes that the inflation target given to a Central Bank should enter its objective function (so inflation is penalised in terms of its deviation from the target) and shows that such targets can substitute for the “conservative” weight on inflation suggested by Rogoff. Note that in the context of the simple model being discussed here, Herrendorf and Lockwood (1997) have shown that such inflation targets are equivalent to the explicit contracts proposed by Walsh (1995), and have desirable property that they reduce inflation expectations to zero without affecting the coefficient of

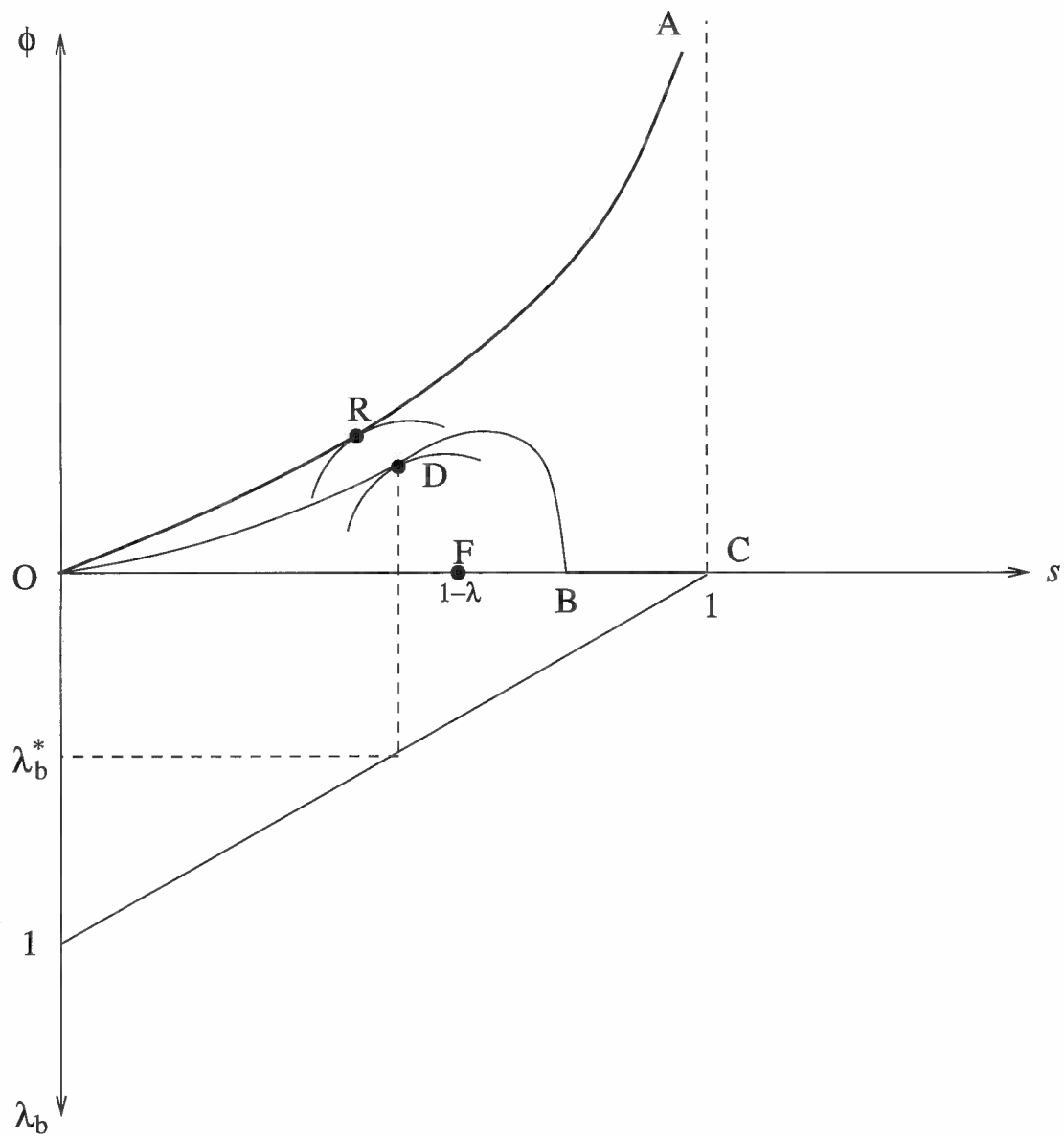


Figure 2: Delegation with and without reputation.

stabilisation. So they dominate Rogoff's conservative Central Banker.

With the aid of Figure 3 we can illustrate Svensson's proposal as follows. As the inflation targets Svensson proposes are simply the negative of the time consistency bias, they are shown in the figure by the schedule OT which is the mirror image of the schedule OA already described in Figure 2. The optimal target recommended by Svensson for this case is the negative quantity FT associated with the optimal coefficient of stabilisation (labelled F in the figure). There are two obvious objections to Svensson's proposal. First is the puzzle of why the targets should enter the objective function of the Central Bank in a way which is logically equivalent to contracts. Intermediate targets have no legal status: so why would they modify behaviour just as if they did? The second puzzle is why such negative targets will be credible when it is obvious that they will on average be missed. (The targets are always negative while the expected inflation is zero.)

Consider instead how such targets might operate in the context of delegation to a far-sighted Central Bank which sticks to its target because the public will "punish" it otherwise. One common objection in this case is that the general public could not in practice coordinate their punishment. But publicly announced targets provide an answer to this objection. Violation of the targets is the common knowledge signal for punishment. This is one of the reasons suggested by John Driffill (1994) for inflation targets in Canada. He wrote:

One possibility is that they focus attention on one particular outcome which would have been one of many possible outcomes of the game without announcements. For example, in the monetary policy game analysed by Barro and Gordon there are many equilibria with different inflation rates... In this kind of world, inflation targets might focus attention on one outcome, and solve the coordination problem. Perhaps this is what has been going on in Canada.

If this is the rationale, it is vital that the Central Bank should not persistently exceed the announced targets. So how should they be chosen? Two cases are considered in Figure 3. First is the case where the Central Bank discounts the future so little that the locus OA is dragged down to the dotted line OFC . Since the Central Bank can implement optimal stabilisation with zero inflation in this case, the target should be zero. But note that it should have a range around it to allow for the stabilisation of supply side shocks. (Without

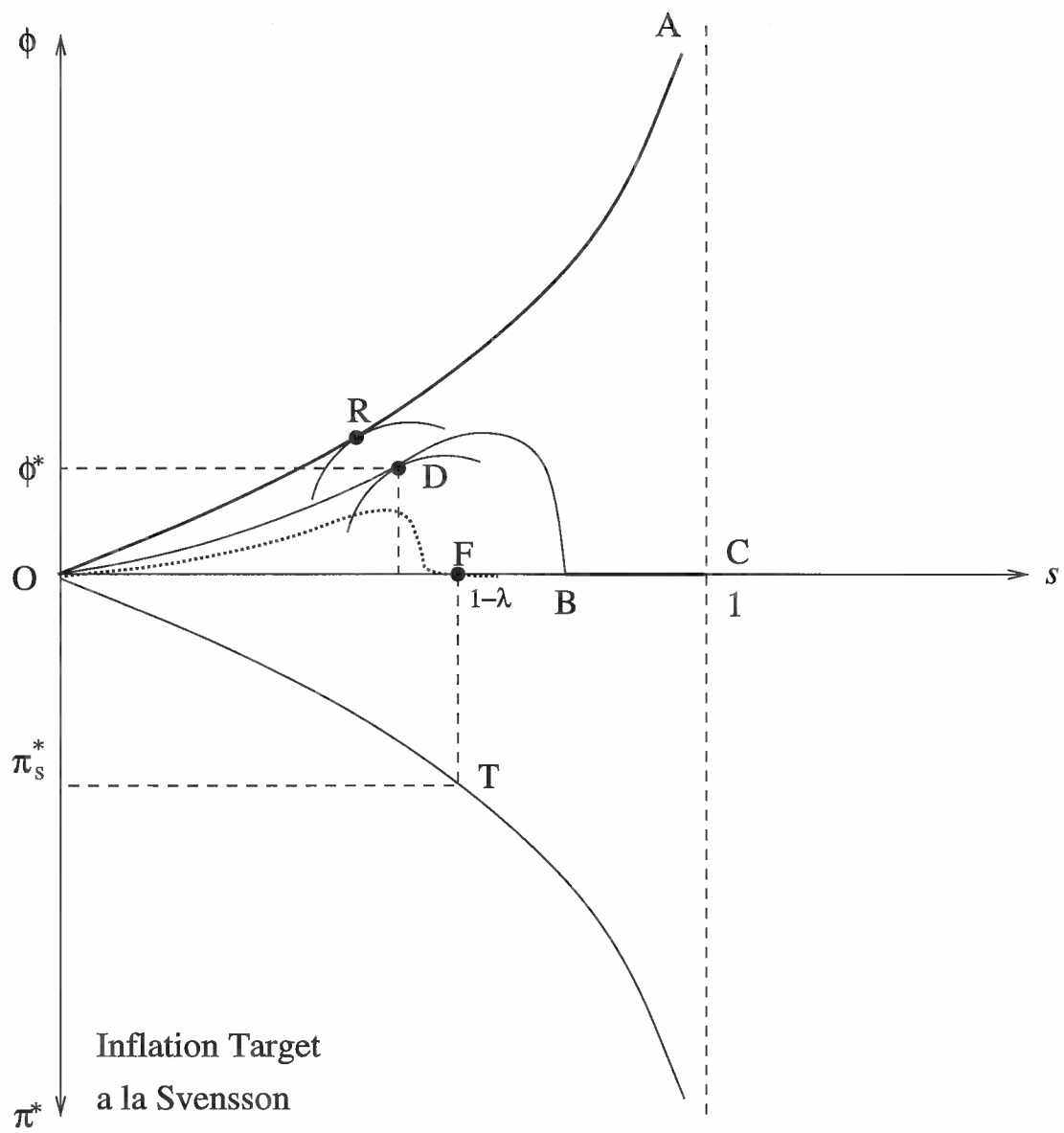


Figure 3: Delegation with and without reputation.

such a range the Central Bank would be forced to act as an ultra-conservative.) The other, more plausible, case already considered in Figure 2 is where the Central Bank has a comparative advantage over the Government in implementing monetary policy but not sufficient to reach first best. In that case the target would be at the level ϕ^* shown in the figure, with a band around it whose width will depend on the range of supply shocks and the coefficient s used in responding to them.

5 Delegation of Monetary Policy

Because of “insider” power or the costs of adjusting employment, unemployment may prove persistent. How does this affect expected inflation and the delegation decision?

Let persistence be represented by ρ , the degree of first order autocorrelation in the unemployment. As discussed further in Appendix B, higher ρ calls for *increased* stabilisation as social optimum, i.e., $s_\rho^* > s^*$ where s^* is the stabilisation coefficient without persistence. On the other hand, higher ρ increases temptation to engineer surprise inflation, i.e., the time consistency problem becomes much more severe with persistence. Rogoff’s solution can be used to counter this time consistency problem but we find that the degree of conservatism increases with ρ (assuming the Central Bank is more far sighted than the government) leading to less rather than more stabilisation as unemployment becomes more persistent.

Can reputation help to reduce conservatism and increase stabilisation in this dynamic setting? As Lockwood and Jensen (1996) have shown, that trigger strategies can in principle, as in the static case, achieve socially efficient stabilisation without increasing inflation expectations.

Table 4 shows the stabilisation coefficients achievable by efficient delegation with and without reputation provides the summary of our results. As shown at the foot of column 1 Rogoff conservative Central Banker stabilises less than socially desirable, i.e., $s < s^*$. But so long as the delegate is sufficiently forward looking one can with reputation achieve first best as shown at the top of column 1. If unemployment persists delegation without reputation involves more conservative Central Bank and less stabilisation as shown at the foot of column 2. But once again the first best can be achieved as shown at the top right corner

in Table 4.

		Unemployment	
		No Persistence $\rho = 0$	High Persistence $0 < \rho < 1$
Monetary Delegation	CB with Reputation	First Best $s = s^*$	First Best $s = s_\rho^*$
	CB without Reputation	Rogoff's conservative $s < s^*$	Even more conservative $s < s^* < s_\rho^*$

Table 4: Stabilisation, reputation and unemployment persistence.

Finally it should be pointed out the structure of Table 4 is designed to match that of Table 3, providing the latter with some analytical support. It is of course a gross exaggeration to suggest that Central Banks with reputation can typically achieve first best as implied by Table 4 and persistence is never strictly zero. But with these provisos one could treat column 1 as broadly corresponding to the Anglo-American economies, with the US at the head and the UK at the foot. Countries that have not reformed their labour markets can be associated with column 2 where Germany would come at the head of the column and France at the foot. The substantial persistence of unemployment in the EU combined with the lack of trust in the ECB suggest that the best forecast of stabilisation policy in the EMU will also be that shown at the foot of column 2.

6 Conclusion

In the paper on “Investment and Hysteresis” Avinash Dixit (1992) tells a cautionary tale which may be relevant here. “Once upon a time in New York City there lived an Assistant Professor of Finance. He and his ‘spouse equivalent’ had separate rent-controlled apartments. Their relationship progressed to the point when the woman suggested that they should keep one of the apartments and give up the other. He explained to her the importance of keeping options alive: it was unlikely that they would split up, but give a positive probability, and so on. She took this badly and ended the relationship.” The moral of the

story, Dixit explains, is that the man had misunderstood the situation for it “was not a decision problem under uncertainty, but a signalling game. The woman was unsure how highly he valued her and it was precisely his willingness to undertake the costly irreversible action of giving up the apartment that had value as a signal.”

Perhaps, after all, this is what is going on in Europe. Countries are being asked to rush into irreversible actions in order to signal their commitment to an integrated Europe; with those who choose to wait being condemned as uncaring Europhobes.

Does this mean that all European countries who want further economic (and political) integration should throw the value of waiting to the winds and rush into a premature EMU? Surely not. It implies instead that we should design a better signalling game! Why not, for example, ask countries to initiate the kind of labour market reforms that would make them good candidates for a common currency area? This will take longer than the current Maastricht time table envisages. So it would involve stopping the clock on EMU while the criteria are effectively redefined. But the signals required would be far more likely to lead to a well functioning currency area than those of the current Maastricht treaty.

Appendices

A Central Banks and Reputation: Lockwood *et al* (1996)

A.1 The model

The economy evolves over an infinite number of time periods $t = 0, 1, 2, \dots, \infty$. At time zero, the government appoints a Central Banker (CB) who is then responsible for monetary policy at $t = 1$ onwards. At every $t = 1, 2, \dots$, inflation, the real wage, employment, and output are determined by the decisions of the CB and a trade-union or other wage-setter. Within a period the order of events is as follows; first the wage-setter sets the log of the nominal wage, w_t , in order to achieve an employment target, \bar{l} , given rational expectations about the price level; then an i.i.d. labour demand shock, ϵ_t , occurs, with¹ $E_t \epsilon_t = 0$, $E_t \epsilon_t^2 = \sigma^2$. Having observed the shock, the CB chooses the price-level, p_t , or equivalently the rate of inflation, π_t . Finally, the log of employment is determined by labour demand, $l_t = p_t - w_t - \epsilon_t$.

It is well-known that once the CB is appointed, the CB and wage-setter can be thought of playing a repeated game with the following structure. First, the stage-game strategy of the bank is an *inflation rule* mapping every shock ϵ_t into a choice of inflation level, π_t , while the strategy for the wage-setter is a choice of subjective expectation of inflation π_t^e before ϵ_t is realised. Second, unemployment varies around a fixed rate, u_n , according to the inflation surprises and labour demand shocks, i.e.,

$$u_t = u_n - \beta(\pi_t - \pi_t^e) + \epsilon_t, \quad (\text{A1})$$

where $u_n = n - \bar{l}$, n is the log of the labour force and β is the response of unemployment to inflation surprises, usually called the coefficient of *nominal wage rigidity* (NWR). This is an important parameter in our analysis, and it is believed that β differs widely between the EU and the US. Stage-game expected losses for the two players are;

$$E_t[(1 - \lambda_b)u_t^2 + \lambda_b \pi_t^2] \quad \lambda_b \in [0, 1] \quad (\text{central bank}) \quad (\text{A2})$$

$$E_t[(\pi_t^e - \pi_t)^2] \quad (\text{wage-setter}) \quad (\text{A3})$$

The second follows from the assumption of rational expectations on the part of the wage-setter. The parameter λ_b measures the CB's degree of aversion to inflation, and we assume that it is this parameter that the government chooses at time zero. The CB discounts the future at $\delta_b > 0$.

¹ E_t denotes the expectation taken conditional on all inflation values and outputs over periods $\tau = 1, \dots, t - 1$.

It remains to specify the preferences of the government. The government's per period expected loss is

$$E_t[(1 - \lambda)u_t^2 + \lambda\pi_t^2] \quad \lambda \in (0, 1) \text{ (government)} \quad (\text{A4})$$

Note that this will differ from the CB's loss function if $\lambda \neq \lambda_b$, i.e., there is a difference in inflation aversion. Another difference can arise from discounting. The government discounts the future at some $\delta > 0$. We assume that

(A1) *the government is more myopic than the CB: $0 < \delta \leq \delta_b < 1$.*

The two-stage model set out above can be solved backwards. Once appointed, the CB "builds a reputation" with the wage-setter. So, we need to find the trigger-strategy, or reputation equilibrium, at this stage. The reputation equilibrium condition then imposes a constraint on the government's action at the first stage, when the government chooses a central bank "type", λ_b , to minimise its expected discounted losses subject to this incentive constraint. So, the first step is to solve for the reputation equilibrium in the game between CB and wage-setter. As a preliminary step, we solve for the stage-game Nash equilibrium in the game between CB and wage-setter, which Barro and Gordon call the discretionary equilibrium (DE).

A.2 Discretionary equilibrium

To solve for the DE, we first derive the reaction functions of the two players. The CB chooses π_t to minimise (A2) subject to (A1) and π_t^e fixed, and similarly the wage-setter chooses π_t^e to minimise (A3) subject to $E_t\pi_t$ fixed. This gives two first order conditions $-(1 - \lambda_b)\beta u_t + \lambda_b\pi_t = 0$, all ϵ_t , and $\pi_t^e - E_t\pi_t = 0$ which can be solved to yield the DE inflation level,

$$\pi_t = \frac{1 - \lambda_b}{\lambda_b}\beta u_n + \frac{\beta(1 - \lambda_b)}{\lambda_b + \beta^2(1 - \lambda_b)}\epsilon_t. \quad (\text{A5})$$

This can be thought of as a linear inflation rule of the form $\pi_t = \phi u_n + s\epsilon_t$, where

$$\phi^n = \frac{1 - \lambda_b}{\lambda_b}\beta, \quad s^n = \frac{\beta(1 - \lambda_b)}{\lambda_b + \beta^2(1 - \lambda_b)}, \quad (\text{A6})$$

using the superscript n to denote the Nash equilibrium. To interpret the rule (A6), note that if the CB would *precommit* to a rule (ϕ, s) before π_t^e were set, it would choose $\phi_b = 0$, $s_b = \beta(1 - \lambda_b)/(\lambda_b + \beta^2(1 - \lambda_b))$, i.e. zero expected inflation but optimal stabilisation. So, it is clear from (A5) and (A6) that the discretionary equilibrium exhibits an "inflationary bias", i.e., expected inflation is positive, as $\phi^n > 0$, but also that stabilisation is the same as in the precommitment case.

B Delegation with Unemployment Persistence: Lockwood *et al* (1994)

As Alogoskoufis and Manning (1988) have argued, unemployment persistence can arise from two sources; (i) from the dynamics in the wage or employment targets of the monopoly wage-setter; or, alternatively, (ii) from costs of adjusting employment for firms. All these sources of dynamics give rise to an unemployment equation similar to the following form;

$$u_t = (1 - \rho)u_n + \rho u_{t-1} - \beta(\pi_t - \pi_t^e) + \epsilon_t. \quad (\text{B1})$$

Note that ρ is the degree of persistence of unemployment; when $\rho = 1$, there is hysteresis in unemployment, and when $\rho = 0$, we are back to the static model. Next, u_n is the “long-run natural rate” of unemployment (i.e., $Eu_t \rightarrow u_n$ as $t \rightarrow \infty$ if $\rho < 1$); we assume $u_n > 0$. We now try to identify informally what effects persistence may have on the delegation decision.

Consider the case where the monetary authority (be it CB or government) *cannot* build a reputation, i.e., where the interaction between CB and wage-setter is modelled as a discretionary equilibrium (DE). In this setting, there are *two* potential differences from the static case which can easily be explained. First, if the CB cares about the future, i.e., $\delta_b > 0$, s/he faces a genuinely intertemporal problem at stage 2, as a 1% inflation surprise at t will not only reduce current unemployment by 1% at t , but also future (expected) employment by $\rho\%$ at $t + 1$, $\rho^2\%$ at $t + 2$ etc. This implies that a CB of a given degree of aversion to inflation, λ_b , will inflate *more* in the dynamic case, as the marginal (present-value) benefit of inflation has risen, but the marginal cost is unchanged relative to the static case. This implies in turn that the government must appoint a *more conservative* central banker to achieve a given level of inflation.

On the other hand, there is a second effect which goes the other way. If $\rho > 0$ in (B1), the unemployment effects of a temporary adverse shock to labour demand will persist, and the present-value cost of the shock will be larger than in the static case ($\rho = 0$). So the incentive to inflate to offset the shock is higher if $\rho > 0$. This suggests that the government will desire more stabilisation, and hence *less conservative* CB.

Numerical simulations in Lockwood *et al* (1994) for plausible parameter values (i.e., when δ_b is large relative to δ) suggest that the first effect dominates: so increasing persistence tends to increase conservatism.

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