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An Economic Defence of the
Maastricht Criteria

BERNHARD WINKLER



European University Institute, Florence

**EUROPEAN UNIVERSITY INSTITUTE, FLORENCE**

ECONOMICS DEPARTMENT

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BERNHARD WINKLER



**BADIA FIESOLANA, SAN DOMENICO (FI)**

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European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

# *REPUTATION FOR EMU*

## *An Economic Defence of the Maastricht Criteria**

**Bernhard Winkler**
European University Institute
Badia Fiesolana
I-50016 San Domenico (Firenze)
E-mail: winkler@datacomm.iue.it

*"L'Europe se fera par la monnaie ou ne se fera pas"*
JACQUES RUEFF 1950

**ABSTRACT**

This paper presents a two-period model of a monetary policy game with incomplete information in order to analyze reputational incentives in the run-up to European Monetary Union. The Maastricht criteria are characterized as a simple threshold contract that selects countries for EMU membership contingent on their inflation performance. It is suggested that the Maastricht criteria have an important role to play in two ways. They may confer commitment to policy prior to EMU and they may induce preference revelation of policymakers.

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## 1. INTRODUCTION

### *Policy: The Passage to EMU*

EMU, Economic and Monetary Union as the centrepiece of the Maastricht Treaty, is arguably Europe's most ambitious project since the Treaty of Rome. It is also the most contentious and it may yet turn out to be the "bird that does not fly". Whether and when EMU will get off the ground is in the final analysis chiefly a question of political will. However, it also depends on whether the Maastricht process succeeds sufficiently in providing incentives and in aligning and coordinating interests that differ across countries. This paper examines how countries' behaviour in the transition to EMU is affected by the convergence criteria adopted at Maastricht. We also suggest a novel interpretation of the criteria themselves which highlights their role as an information revelation mechanism. The model presented, in particular, can be seen to capture a distinctive "German view" on EMU which has not yet found resonance in the wider academic debate on the subject.

In order to explain the Maastricht criteria we depart from most of the existing literature in five ways. First, our work links the long-run performance of EMU to counries' behaviour in the transition period, rather than looking at both issues separately. This requires a multi-period analysis where the Maastricht criteria provide the intertemporal link between policy performance before and after EMU has been established. Second, we place conflicts of interest between participating countries at the centre of analysis, rather than adopting a single country or pan-European perspective. This means we must draw on game theoretic analysis. Third, we dispute the claim that the Maastricht entry conditions "have little to do with economics" (De Grauwe 1994) but primarily to do with preserving Germany's hegemonic position in European monetary policy. Therefore we take the Maastricht treaty seriously as a contractual device that affects *economic* outcomes. Fourth, we take issue with the "naive credibility" literature which prescribes central bank independence or exchange rate commitments as the cure-all. Instead, we suggest that a credible, low inflation EMU must be supported by a sound institutional set-up *and* must be rooted in public preferences *and* still must earn a lot of its reputation the hard way. This motivates our use of the Barro-Gordon (1983a) model to capture time inconsistency problems both before *and* within EMU. Fifth, the Maastricht treaty represents a regime shift which is likely to compound strategic uncertainty; hence the presence of incomplete information, which we require for a meaningful model of reputation.

The policy relevance of our work is immediate. After the virtual collapse of the European Exchange Rate Mechanism (ERM) the original Maastricht transition

strategy based on the gradual hardening of the exchange rate constraint is obsolete. Thus the convergence criteria remain as the only institutional device with potential commitment properties that is left. From the start they have also been heavily criticized as the main (and harmful) obstacle to EMU. The debate surrounding the sense and the interpretation of the criteria will intensify further in the run-up to the 1997 and (or) 1999 deadlines for EMU. After the Schäuble-Lamers proposal of a hard core Europe, launched in september of 1994, the related controversy about multi-speed approaches to EMU has come out into the open. This makes it all the more important to understand why the criteria were put into place and how their presence affects countries' behaviour as well as market expectations. The recurrent speculative onslaughts on the weaker European currencies and bond markets are a case in point.

### *The Maastricht Criteria - A Tale of Chicken*

The Maastricht Treaty stipulates that stage three of EMU comes into effect in 1997 if a majority of EU member states satisfies the convergence criteria listed below in the 12 month period preceeding initiation of EMU. Otherwise monetary union would start automatically in 1999 with whichever countries by then satisfy the criteria. The decision as to which countries can be judged to fulfil the criteria is taken by majority vote.

*THE MAASTRICHT CRITERIA:*

1. *CPI inflation not exceed the inflation rates of the three best performers by more than 1.5%*
2. *Long term interest rates no more than 2% above those of the three best price performers*
3. *Exchange rates stable within their normal bands, no devaluation on own initiative for two years*
4. *Budget deficit no larger than 3% of GDP*
5. *Public debt no larger than 60% of GDP*

Both the fiscal criteria have qualifiers attached which may allow for a liberal interpretation. The exchange rate criterion is now widely regarded as being applicable to the new wider bands of the ERM, which allow 15% deviations on either side of the central parity.

The criteria have been attacked by economists as being arbitrary and misguided (especially the fiscal conditions[1]) as well as being superfluous or worse self-defeating (primarily the nominal criteria[2]). Without reviewing the arguments advanced in detail the view taken in this paper is that much of the criticism is misplaced, because it ignores the most important functions of the criteria.

In general, if the criteria are to make sense they must provide a linkage between behaviour in stage two, prior to EMU, and stage three performance once EMU has been achieved. A first place to look for a rationale of the Maastricht condition would be the *theory of optimum currency areas* (OCA). However, it is quite obvious that the criteria have very little to do with the factors identified by OCA theory[3]. There is nothing about wage and price flexibility, factor mobility, fiscal co-insurance, trade openness, product diversification and the like. While concerns about real economic convergence may well be valid in their own right it is not the kind of convergence that Maastricht is all about. A second place to look is the more recently fashionable *credibility literature*[4]. This at least points in the right direction, credibility is indeed the crucial concern in the Maastricht game and the one that is reflected in the (predominantly nominal) convergence criteria. However, as for example emphasized by De Grauwe (1994), here we run into a straightforward paradox. For future reference we shall christen it the "credibility paradox". If the main benefit of EMU comes from increased credibility with respect to what could be achieved by national policymakers, then making entry to EMU conditional on curing the very ills that only the regime shift to EMU itself can mend is self-defeating. However, this reasoning disregards the possibility that the criteria themselves carry credibility and confer commitment. Then the paradox ceases to be one once two naive underlying assumptions are removed. The first is that somehow EMU miraculously solves all credibility problems, the second is that there are no conflicts of interests across countries. Relaxing the first acknowledges that central bank independence is no panacea, that credibility does not come entirely for free but must be earned. This paper starts from the premise

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[1] Buiter (1992) calls them a "triumph of dogma over economic reasoning"; see also Buiter, Corsetti and Roubini (1992). To Barrell, Sefton and in't Veld (1993) it is "not clear why such definite criteria have been set". Corsetti and Roubini (1992) point out that more flexible rules together with credible sanctions would be preferable. Alesina and Perotti (1994) highlight the political economy of the deficit bias which the criteria can be seen to address. Aizenman (1994) offers tentative support for limits on public debt to discipline fiscal policy in currency unions.

[2] See De Grauwe (1992) for an early discussion.

[3] See Eichengreen (1993), Tavlas (1993) and Bofinger (1994) for recent overviews.

[4] See Persson (1988) and Blackburn and Christensen (1989) for easy introductions. The reader must wait until section 3 for precise definitions of credibility and reputation. For now let both simply denote the policymaker's ability to keep inflation expectations and inflation low.

that making the European Central Bank independent is only a partial solution. Relaxing the second recognizes that there is a clear conflict of interest between those countries that (may) hope to gain credibility and those countries that fear that they may lose credibility from EMU[5].

Relaxing the naive commitment and the naive harmony assumptions successively the "credibility paradox" turns into a *chicken-and-egg* problem and into a *game of chicken* respectively. The first means that convergence is needed to establish EMU's reputation but at the same time EMU's reputation is needed to induce convergence. The second means, each of the two parties wants the other to commit first, i.e. the low-credibility countries wants the promise and the benefit of EMU-commitment to facilitate convergence, the high credibility countries want prior evidence of convergence to insure sufficient EMU reputation. The presumption of this paper is that the Maastricht criteria must be seen against the horizon of this two way chicken problem. The criteria are a compromise resulting from conflict over who should pay for EMU's reputation[6]. Despite this conflict, the game is not zero-sum, however, and there are benefits from not chickening out of the Maastricht equilibrium. This paper argues that the criteria can provide a bridge over which reputation can travel across time and across countries and it interprets them as a mechanism to build reputation for EMU.

The two chicken tales of EMU sketched above give the background to the present paper but our main emphasis is on one aspect that is novel to the academic debate over EMU. This paper argues that the Maastricht criteria may serve a supremely important role even if they have nothing at all to do with convergence of economic variables, be they real or nominal. The behaviour that the Maastricht criteria seem designed to induce then may well be intrinsically worthless, even positively harmful, inflicting pain and damage that appears unnecessary, illogical and irrational. Can this "masochism paradox" be resolved just like the "credibility paradox"? Yes, if we introduce a third interpretation of the Maastricht criteria on top of the two already discussed, namely the reputation value (for convergence) and the convergence incentive (for reputation). This third

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[5] Thus our work is close in spirit to Alesina and Grilli (1993), where performance of EMU depends on membership. They have no role for the Maastricht criteria, however. The role of conflict has been stressed by De Grauwe (1993), but only as a political problem, and not spelt out formally.

[6] The clearest manifestation of both the conflict and the compromise found is the ingenious Maastricht paradox of making transition to EMU both time- and state-contingent simultaneously. On the one hand, there is a deadline (1999) for automatic EMU. This increases adjustment pressure on low credibility candidates. On the other hand, the conditionality of the Maastricht criteria satisfies the reputation concerns of the high credibility countries.

aspect of the criteria concerns the informational value of the behaviour they induce. The sole linkage we require for this informational story to run is some continuity of policymaker preferences over time. If preferences determine EMU performance then behaviour in the run-up to EMU becomes important for the information it reveals on country preferences if not for anything else. In this indirect but important way the Maastricht criteria can help to build reputation for EMU not by testing for economic convergence but for convergence of preferences[7].

It is the view taken in this paper that convergence of policy preferences is of the single most importance for the future stability of EMU, the probability that EMU happens at all and the composition of its membership. It is also the view very deeply engrained in the German thinking on EMU in which a sufficiently diffused and sufficiently deeply rooted "stability culture" across Europe, consensus on economic policy and a strong political union are taken as preconditions for the pooling of monetary sovereignty[8]. In a narrow interpretation "stability culture" just means the degree of inflation aversion and the fiercely contested fiscal criteria do not appear immediately relevant. However, once we dispense with the "monetarist fallacy" that inflation is a function of central bank policy only, the stability orientation of all economic policy actors[9] (particularly fiscal authorities and wage setters) including the wider public become important. In such a world all the criteria[10] can be seen to test for stability culture across economic actors. Thus, even without any of the criteria being directly relevant for

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[7] This is a different idea from Artis' (1994) defence of the hard-EMS as a "proving ground" quasi EMU. Instead it captures the notion expressed by Bundesbank president Tietmeyer (1994) that in the convergence stage countries "must demonstrate how serious they are in their efforts to lay sound foundations for further monetary integration". For Bundesbank board member Prof. Issing (1994) "even a discussion of a relaxation of the convergence criteria must give rise to suspicion among those who have distrusted anti-inflationary manifestations in respect of EMU from the very outset". Collins and Giavazzi (1992) present evidence that attitudes towards inflation had converged in the EMS.

[8] Hence the Bundesbank's characterization of EMU as an "irrevocable solidarity union" (Tietmeyer 1995).

[9] If these other players act strategically we get more games of chicken. Sargent-Wallace (1981) drawing on the intertemporal budget constraint linking monetary and fiscal policy is an implicit example, but they *assume* that fiscal authorities can precommit rather than making the chicken problem explicit.

[10] The arguable exception is the criterion on debt, which as a stock variable reflects not *current* but the history of past credibility. However, the stock of debt affects *future* credibility via the incentive to surprise inflate it away.

EMU performance they serve a crucial role as auxiliary indicators with regard to the central concern of the drafters of the Maastricht criteria over price stability.

In summary, we can interprete the role of the Maastricht criteria in the context of the "holy trinity of reputation", i.e. commitment, (convergence) effort and preferences. In reality, and arguably even in theory, the three aspects of reputation, while distinct, are at the same time inseparably one. To give an illustration, the famed reputation of the Bundesbank is a joint product of institutional autonomy (commitment/delegation), continuous effort to hold its own in the various chicken games[11] and finally the deeply rooted inflation aversion of the German public, itself a product of the history of two hyperinflations in Germany this century. To make the holy trinity whole all three elements are indispensable.

### *Of Theory and Contracts*

We have motivated our choice of modelling strategy starting from the practical policy debate surrounding the Maastricht criteria which this paper seeks to understand. However, the model can be of interest and be justified independently of the particular application to EMU that we present. Its potential theoretical value derives from the exploration of the interaction of the different elements of the holy trinity. The main theoretical innovation is to look at reputation and contracts together and not as separate answers to credibility problems.

The credibility literature has identified the problem of time inconsistency of optimal plans which is a pervasive feature of policymaking and everyday life alike. It basically means that there is an incentive to deviate from an ex-ante optimal plan once another player has made a move. In the Barro-Gordon example a zero inflation promise is not credible (time-consistent), because, given that the public believes the promise, the government has the ex-post incentive to exploit the surprise Phillips curve trade-off. As a consequence, a rational public will set expectations such that this ex-post incentive vanishes. To overcome problems of opportunistic behaviour society has developed a wide array of institutions such as constitutions, laws, norms, values, morals (in declining order of formality). Economic theory has only considered a subset of these institutions, namely contracts and reputational mechanisms in repeated interaction. With contracts the problem of credibility is shifted from the optimal policy itself on to the question of what makes the contract credible, and some external enforcement mechanism

[11] To keep its reputation the Bundesbank repeatedly had to inflict recession on the German economy to punish players attempting to contest its leadership role.

must then be invoked. Thus commitment remains exogenous. In *reputation models* credibility still remains fundamentally exogenous because it is synonimous with the particular game theoretic equilibrium refinement that the modeller chooses to adopt. In complete information "reputation" games, e.g. Barro-Gordon (1983b) or Canzoneri (1985), multiplicity of equilibria is endemic which renders credibility vacuous and arbitrary. We therefore dismiss this branch of the literature as providing an inadequate representation of reputation. With incomplete information the problem is only ameliorated incompletely, but equilibrium refinements at least can here be given some economic interpretation. Incomplete information models from the oligopoly literature were first applied to monetary policy games by Backus and Driffill (1985) and Vickers (1986); both can be seen as special cases of our own model.

Variants of the *contract solution* to credibility problems have been offered by Rogoff (1985), who advocates delegation of policy to conservative central bankers, and Lohmann (1992) among others. However, they take a particular contract form as given and thus ignore the interesting question of contract choice. Persson and Tabellini (1994) have recently recognized that the problem can be couched in terms of optimal mechanism design. Yet, moving to a generalized optimal contracting environment give us problems at the opposite extreme: lack of institutional content and relevance. Moreover, in their discussion the distinctive contributions of reputation and contracts in enforcing the optimal policy become confused. Therefore our paper proposes what we regard as the only possible way out of this dilemma, i.e. to consider simple contracts and institutions that are observable in real economic environments. Institutional design is the crucial question for EMU both for the transition and for long-run performance. Unlike most optimal contracts derived in economics journals, however, observable "real" optimal contracts will always be simple, incomplete and often implicit. The Maastricht treaty, and the convergence criteria in particular, constitute such a contract. Also for this reason many of the economists' criticisms of the criteria are misplaced. They have attacked the criteria for being "imperfectly perfect". We shall argue that they may be "perfectly imperfect".

## 2. THE MODEL

The model has two parts. First, the contracting stage where the convergence criteria are set and second a two period reputation game with the treaty provisions taken as given. From backward induction we will discuss the latter stage first. Period one of the reputation game corresponds to stage two of the Maastricht process, period two to stage three, when a single currency may be established.

For each period policymakers' utilities are given by the standard Barro-Gordon objective function in equations (1) and (2) below. Utility is decreasing in the deviation of inflation from the optimal inflation rate (here set to zero) but increasing in surprise inflation. In each period the policymaker who sets the actual inflation rate $\pi$ (taking expectations as given) plays against an atomistic public who form inflation expectations $\pi^e$ at the beginning of the period. In the one shot game imposing rational expectations ($\pi^e = \pi$) yields an equilibrium inflation rate equal to the preference parameter $b_i$. This gives a utility which is lower than if the policymaker could commit ex ante to zero inflation. As we shall see later, in a two period game reputational incentives may sustain inflation rates in the first period that differ from the one-shot equilibrium. The linearity of the surprise inflation term in equation (1) means that the one-shot equilibrium inflation is a dominant strategy, independent of expected inflation, and will always obtain in period two of the reputation game.

For the purpose of the model we divide Europe into two groups of countries, those whose low (here: zero) preference parameters $b_i$ are public knowledge and those with private information. We call the former group the Principal (P) and the latter the Agent (A). The latter can be either high (H) or low (L) inflation countries depending on the weight $b_i$ in equation (1) and we shall call them weak and strong respectively. The prior probabilities over the two types are $\lambda$ for the strong (L) type and (1-$\lambda$) for the weak. The belief $\lambda$ that the policymaker strong is our measure of reputation[12]. Beliefs will be updated in the light of first period play.

$$U_t^i(A) = -\frac{1}{2}\pi_t^2 + b_i(\pi_t - \pi_t^e), \quad i = L,H \quad with\ b_H > b_L \geq 0, \quad t = 1,2 \tag{1}$$

$$U_t^i(P) = -\frac{1}{2}\pi_t^2 \qquad t = 1,2 \tag{2}$$

We model the convergence criteria as a threshhold contract (here: on inflation) which makes entry into EMU conditional on the Agent's period one performance. Thus the Maastricht contract $f$ in equation (3) is a mapping from (the Agent's) first period inflation rate into a two-valued set denoting entry ($f$ = 1), if it does not exceed the threshhold, and exclusion ($f$ = 0) otherwise.

$$f: \ \pi_1 \Rightarrow \ \{0,1\}, \qquad f(\pi_1) = \begin{cases} 0 & \forall\, \pi_1 > \tilde{\pi} \\ 1 & \forall\, \pi_1 \leq \tilde{\pi} \end{cases} \tag{3}$$

[12] Note that "reputation" here is not identical to "credibility". The latter denotes the probability that a low inflation policy will be played. Thus it depends on beliefs *and* on the equilibrium strategies.

If the Agent satisfies the Maastricht criteria EMU will be established and second period utility, for both Principal and Agent, will be given by equation (4). Otherwise second period payoffs are still given by equations (1) and (2). EMU is characterized by two parameters: first, the common fixed (net) benefits of EMU, mainly transactions cost savings, which we denote as $T$[13]. Second, the relative weights of the two groups of countries in the common objective function, $\gamma$, is the weight of the Principal's preferences. In a literal interpretation the weights simply reflect the voting power of the two groups of countries in the council of the European central bank. Thus a high $\gamma$ implies a small "hard core" EMU that excludes many of the uncertain candidates. In addition, $\gamma$ can be understood as a delegation parameter, i.e. the extent to which the ECB is a Rogoff (1985) conservative central bank. Then $\gamma$ may be a proxy for the degree of central bank independence or the degree to which the ECB can solve the credibility problem either by virtue of a superior institutional setup or more hawkish preferences.

$$U_2^i(f=1) \quad = \quad (1-\gamma)\,U_t^i(A) + \gamma\,U_t^i(P) + T, \qquad 0 \le \gamma \le 1 \tag{4}$$

Equation (5) gives the total utility, applying the discount factor $\delta$ to the second period payoff. Other than just expressing countries' time preference $\delta$ may also vary with the likelihood that EMU is perceived to happen and the date at which EMU is predicted to come about.

$$U_i(f) \quad = \quad U_1^i \quad + \quad \delta\,U_2^i(f), \qquad 0 \le \delta \le 1, \qquad i = H, L \tag{5}$$

This concludes the discussion of players' *payoff functions*. Note that, of course, the Principal is not a player in the reputation game, since his preferences are public knowledge. He is only concerned with his period two payoff which is affected by the contract $f$ and the EMU parameters $\gamma$ and $T$. Therefore henceforth by policymaker we mean the policymaker in the Agent countries. The *Policymaker's strategy* $s_i$, for each type, prescribes a pair of inflation rates $\pi_t^i$, one for each period. The public, which we can think of as the international financial markets, is assumed to form expectations rationally[14]. The *public's strategy* $e$ is a pair of expected inflation rates $\pi_t^e$ for the two periods, where the second period expectation will be contingent on the inflation rate observed in the

[13] In general, of course the non-credibility costs and benefits of EMU that are captured by $T$ will differ across countries and between the Principal and the Agent in particular. This can be easily accommodated in the model. The key assumption we do make is that $T$ is independent of type.

[14] If we wanted to make the public's objectives explicit, the standard way is to have it minimize expectational error.

first period. This means that the prior beliefs $\lambda$ and $(1-\lambda)$ will be updated in the light of any information revealed by first period play.

The solution concept applied to the reputation game thus characterized is Perfect Bayesian (Nash) Equilibrium. In incomplete information games equilibrium is a function of beliefs as well as strategies. Refinements of Nash equilibrium, here, therefore aim to rule out "unreasonable" beliefs much in the same spirit as subgame perfection restricts "non-credible" actions in full information games.

DEFINITION 1: An equilibrium is a pair $(s_i, e)$ such that

(i) policies $s_i$ are optimal given equilibrium expectations $e*$ and given type.
(ii) expectations are optimal given equilibrium policies $s_i*$ and given beliefs.
(iii) posterior beliefs are obtained from the priors and observed policy according to Bayes' rule where it applies.

The final requirement tries to capture some notion of sequential rationality, but note that the restriction is very weak in that it only applies along the equilibrium path of play. Hence typically a continuum of equilibria is admissible depending on different assumptions on out-of-equilibrium beliefs. Furthermore, two classes of equilibria can be distinguished. In *separating equilibria* first period policies differ between the strong and the weak policymaker. Hence their type is fully revealed and payoffs in the second period are those of the one-shot game. In *pooling equilibria* both types choose the same first period inflation rate, thus no information is revealed and prior beliefs are not updated. We discard the possibility of mixed strategy (semi-separating) equilibria which arises if players are allowed to randomize over their pure strategies as implausible for the policy context. In order to reduce the multiplicity problem Definition 1 can be strengthened by adding the following further restrictions:

(iv) strategies $s_i$ that are dominated are not admitted in equilibrium.
(v) strategies $s_i$ that are equilibrium dominated in the spirit of Cho and Kreps (1987) are not admitted to support equilibrium.

For sections three and four we draw on requirement (iv) as well as assume a particular simple and plausible structure of off-equilibrium beliefs in order to single out one candidate separating and one candidate pooling equilibrium only. This concludes discussion of the reputation game.

Finally, we turn to the contracting stage. The Maastricht Treaty in general and the convergence criteria in particular are clearly the result of a complex bargaining process. We have already pre-empted the simplifying assumption that we choose to adopt in this paper by naming the group of "hard-core" countries as the

Principal. This means that they are endowed with all the bargaining power and can make a take-it-or-leave-it offer with regard to the Maastricht criteria. This appears a realistic approximation of how the criteria were actually inserted into the treaty by the Dutch presidency with support from Germany[15]. The Principal is concerned about period two utility, i.e. about which type of country joins EMU. For any pair of inflation rates $\pi_1^i$ *taken as given*, three types of contracts can be distinguished. First, for all contracts $f_1$ the threshhold inflation rate, as defined in equation (3), blocks EMU (keeps both types out). Second, "conditional" contracts $f_2$ admit the strong type into EMU. Here two cases must be distinguised. Under separation both types play different first period inflation rates and the conditionality "bites". However, if both types play an identical first period inflation (pooling) conditionality does not bite. Then, inviting the strong into EMU will also attract the weak. Third, under "unconditional EMU" $f_3$ both types enter.

$$f_j(\pi_1) = \begin{cases} f_1 \ \forall \ f \ \textit{with} \ \tilde{\pi} < \pi_1^L & \text{"no EMU"} \\ f_2 \ \forall \ f \begin{Bmatrix} \textit{with} \ \pi_1^L \le \tilde{\pi} < \pi_1^H \ \textit{under separation} \\ \textit{with} \ \pi_1^L = \pi_1^H = \tilde{\pi} \ \ \textit{under pooling} \end{Bmatrix} & \text{"conditional EMU"} \\ f_3 \ \forall \ f \ \textit{with} \ \tilde{\pi} > \pi_1^H & \text{"unconditional EMU"} \end{cases} \quad (6)$$

In equation (6) the Agents' first period inflation rates $\pi_1^i$ are parametric. In general they will depend on the contract and on the equilibrium that obtains. Since the Principal's only concern is about the type of country that might join EMU, we simplify and only consider one particular contract for each case. Namely we set the threshhold inflation rates for $f_1$ and $f_3$ equal to $-\infty$ and $\infty$ respectively, and for $f_2$ equal to the respective *equilibrium* inflation rate of the strong type. For the model of section four $\tilde{\pi} = 0$ under contract $f_2$ for both the separating and the pooling case.

What is important for EMU in this model (and in reality) is that countries' preferences, their degree of inflation aversion, are *not contractible*, even if revealed ex post. Thus the Maastricht criteria can only be based on observable inflation performance, entry cannot be made type-contingent. Thus, even if the Principal knew the Agent's preferences perfectly he could not make use of this information directly but would have to devise convergence criteria to circumvent this non-contractibility, which could then be thought of as some sort of political non-discrimination constraint. Incomplete information complicates the task of the

[15] See Garrett (1993) and Sandholtz (1993) on the politics of EMU. Alternatively, we could assume that the criteria were drafted to optimize the Agent's utility subject to the Principal's participation constraint or pan-European welfare as some weighted average.

Maastricht criteria. With preferences known the criteria would simply serve as an exclusion device, an entry barrier to EMU to prevent weak countries from wanting to join. With incomplete information, the effects the criteria have on reputational incentives and on information revelation in stage two of EMU are an additional factor.

## 3. THE PRINCIPAL'S PROBLEM

In drafting the Maastricht criteria, here determining the threshhold inflation rate prescribed by the contract *f*, the Principal's only concern is with his (expected) period two payoff. It will be zero in the absence of EMU, from equation (2) and given by equation (4) otherwise. Recall that his contract choice, as described in equation (6), is between conditional and unconditional EMU or blocking it altogether. If EMU is conditional, the Principal runs the risk either of EMU not coming about (in separating equilibrium) or of joining up with the weak type (in pooling), both with probability (1-λ). We call the first event "hard EMU", the second "soft EMU".

no EMU(*nE*): $U_2(P) = 0 \qquad for\ "no\ EMU"\ (f_1)$

hard EMU(*hE*): (7)

$$EU_2(P) = \lambda\left[-(1-\gamma)^2 b_L^2/2 + T\right] \quad for\ "conditional\ separating\ EMU"\ (f_2^S)$$

soft EMU(*sE*):

$$EU_2(P) = -\lambda(1-\gamma)^2 b_L^2/2 - (1-\lambda)(1-\gamma)^2 b_H^2/2 + T \begin{cases} for\ "cond.\ pooling\ EMU"\ (f_2^P) \\ for\ "uncond.\ EMU"\ (f_3) \end{cases}$$

Comparing these three payoffs we can establish four possible preference rankings and it is most convenient to express the three critical points that divide these regions in terms of *T*.

$$\begin{aligned} &U_2(nE) \le U_2(hE) \quad \forall T \ge T_1, && T_1 = (1-\gamma)^2 b_L^2/2 && if\ (f_2^S)\ exists \\ &U_2(hE) \le U_2(sE) \quad \forall T \ge T_2, && T_2 = (1-\gamma)^2 b_H^2/2 && if\ (f_2^S)\ exists \\ &U_2(nE) \le U_2(sE) \quad \forall T \ge T_3, && T_3 = (1-\gamma)^2\left[\lambda b_L^2 + (1-\lambda) b_H^2\right]/2 \end{aligned} \tag{8}$$

From the above we can establish that $T_1 \leq T_3 \leq T_2$. The first thing to note is that contracting for a conditional hard EMU, if possible, expands the range of $T$ for which the Principal will sign the Maastricht Treaty. Empirically, given that the convergence criteria are included in the treaty, we can rule out that the Principal's $T$ is larger than $T_2$. This is also reflected, for example, in German officials' repeated insistence that a "stable currency is more important than a single currency". However, if pooling equilibrium obtains, the Principal's screening efforts are frustrated and then he must either let both types in or must refuse to sign the treaty. Given that the treaty has been signed, this suggests that $T$ is large enough to risk conditional pooled entry $T \geq T_3$, but not large enough to offer unconditional entry. Thus the critical threshhold inflation rate for $f_2$ is set such as just to let in the strong type in a separating equilibrium. If no such equilibrium exists, the threshhold is set to just let in both types on the pooling equilibrium.

It is also obvious from equation (7) that the Principal's utility is always increasing in his weight $\gamma$ in EMU. All else equal, he will prefer a small EMU or, in the alternative interpretation, will try to maximize conservatism and independence of the European Central Bank. However, if we consider $\gamma$ a choice variable at the contracting stage (in addition to the threshhold inflation rate prescribed by $f$) we must also take into account the effect $\gamma$ has on preference revelation in the reputation game. To examine this question and to understand why and under which circumstances the Agent may want to sign the Maastricht treaty we turn to the analysis of the reputation game next. Note that the Principal's problem simplifies for the special case considered in the next section, where the strong Agent shares the Principal's preferences ($b_L$=0). Then "hard EMU" is always preferred to "no EMU" as long as $T$ is positive and thus $T_1$=0.

## 4. MIMICKING

### *Equilibria*

Both for this section and the next the first step in looking for equilibria is to isolate one single plausible candidate equilibrium for the separating and the pooling case respectively. This is achieved by invoking requirement (iv) from section two, which eliminates dominated strategies. For the strong type[16] this implies that under pooling she will always play her one-shot optimum and under separation will play the inflation rate which separates her at least cost. For the

[16] To aid discussion we make the natural assumption that the strong type is feminine and the weak is masculine.

weak type this means that for pooling he must imitate the strong's one shot inflation in the first period and that he will play his one-shot optimum in the separating case. Recall that in the second period both types play their one-shot inflation, independent of expectations. Restricting attention to undominated strategies also means each player will only consider a single (most profitable) possible deviation strategy ($D$) from equilibrium. In separating equilibrium the strong type may consider deviating to her one-shot optimum (if that differs from equilibrium inflation) and the weak type may want to mimick the strong in the first period. In pooling equilibrium, the strong considers deviating to a first period inflation that would separate her, the weak may want to revert to his one-shot optimum. We have ruled out that the threshhold contract devised by the Principal interferes with these uniqueness properties given our earlier assumptions on $f_j$. Thus for existence of equilibrium in the reputation game, separating (S) or pooling (P), it suffices to show that the following *incentive compatibility contraints* are satisfied for both types.

$$V_i^k(f_j) = U_i^k(f_j) - U_i^D(f_j) \geq 0, \qquad k = S,P \quad i = L,H \quad j = 1,2,3 \tag{9}$$

Equilibrium conditions for each pooling and separating will differ depending on the contracts $f_j$, which are taken as given for the reputation game. Finally, for each equilibrium we must specify the structure of out-of-equilibrium beliefs that support equilibrium.

This section considers the special case where the strong type's weight on surprise inflation in equation (1) is zero, just like the Principal's. Thus she always plays zero inflation and her incentive compatibility constraints in equation (9) are always satisfied[17]. We only need to consider the weak type's reputational incentives. We are ready to propose the following equilibria:

[17] Note that this is always true for $T$=0. For positive $T$ there may be a range of values for which signalling behaviour can become profitable. Then the game becomes as in section five. For now we rule out such values of $T$.

PROPOSITION 1: The reputation game, with $b_L$=0, has a *separating equilibrium* with[18]

$$\pi_1^L = \pi_2^L = 0, \qquad \pi_1^H = \pi_2^H = b_H$$

$$\pi_1^e = (1-\lambda)b_H, \qquad \pi_2^e = \begin{cases} 0 & \text{if } \pi_1 \le 0 \\ b_H & \text{if } \pi_1 > 0 \end{cases}$$

iff

$$\begin{cases} \delta \le \dfrac{1}{2} & \text{for } f_j(\pi_1) = f_1 \\ \delta \le \dfrac{1}{2(1 + T/b_H^2 - \gamma^2/2)} & \text{for } f_j(\pi_1) = f_2 \\ \delta \le \dfrac{1}{2(1-\gamma)} & \text{for } f_j(\pi_1) = f_3 \end{cases}$$

*Proof*: see APPENDIX A

It is easy to show that the weak type's "excess payoff" from not deviating $V_H^S$, as defined in equation (9), is decreasing in the discount factor δ in all cases. The intuition is straightforward. A larger δ makes the future gains from mimicking more attractive relative to the first period losses. For a small δ it is more profitable to reap the benefits from surprise inflation in the first period. How do the two possible Maastricht contracts affect the sustainability of separating equilibrium? For the conditional contract $f_2$ the two components of EMU work in opposite directions. Delegation (γ) encourages separation, because the weak type can only reap a fraction of the benefits of surprise inflation once he joins EMU. The benefits $T$ of EMU, on the other hand, undermine separating equilibrium. The latter effect obviously disappears if EMU is unconditional ($f_3$) and in fact the effect from delegation will be stronger than under $f_2$. For γ≥1/2 separating equilibrium will even exist for all values of δ. The reason is that delegation has two opposing effects on the weak country. It is beneficial because it lowers the inflationary bias in period two but it also entails a loss in that it diminishes the ability to surprise inflate. As we see from contract $f_2$ the latter effect dominates the former. Under the Maastricht criteria, for a given $T$, the higher γ, i.e. the smaller EMU or the more conservative/independent the ECB, the more will weak

[18] Note that we are cavalier about second period expectations. They here only concern the Agent's contribution, i.e. when $f$=0 , not the Principal's nor the effect of the particular contract. The impact of the latter two, of course, is known for sure and the correct inflation expectations can be worked out from equation (4) for $f$=1.

countries be tempted to ignore the criteria and stay out. Multi-speed Europe makes self-selection more likely.

PROPOSITION 2: The reputation game, with $b_L$=0, has a *pooling equilibrium* with

$$\pi_1^L = \pi_2^L = 0, \qquad \pi_1^H = 0, \quad \pi_2^H = b_H$$

$$\pi_1^e = 0, \qquad \pi_2^e = \begin{cases} 0 & \text{if } \pi_1 < 0 \\ (1-\lambda)b_H & \text{if } \pi_1 = 0 \\ b_H & \text{if } \pi_1 > 0 \end{cases}$$

iff

$$\begin{cases} \delta \geq \dfrac{1}{2\lambda} & \text{for } f_j(\pi_1) = f_1 \\ \delta \geq \dfrac{1}{2\left[\gamma(1-\gamma/2) + \lambda(1-\gamma) + T/b_H^2)\right]} & \text{for } f_j(\pi_1) = f_2 \\ \delta \geq \dfrac{1}{2\lambda(1-\gamma)} & \text{for } f_j(\pi_1) = f_3 \end{cases}$$

*Proof*: see APPENDIX B

Here, the weak type's "excess payoff" from not deviating from pooling equilibrium $V_H^P$ is increasing in the discount factor δ in all cases. Again, a larger δ makes the future gains from mimicking more attractive relative to the first period losses. For pooling equilibrium the prior reputation of the players becomes important. The higher the initial reputation (probability of being strong) λ, the more attractive it becomes for a weak country to masquerade as strong in the Maastricht game. The impact of the Maastricht contract now will depend also on prior reputation. For the conditional contract $f_2$ the delegation effect (γ) is now ambiguous as we can see from equation (10).

$$\frac{\partial V_H^P(f_2^P)}{\partial \gamma} = \delta(1-\lambda-\gamma), \quad \frac{\partial V_H^P}{\partial \gamma} \geq 0 \quad \text{if } \gamma \leq \tilde{\gamma} = (1-\lambda), \quad i.e. \lambda \leq \tilde{\lambda}(1-\gamma) \quad (10)$$

The prior reputation now acts like a weight on the benefits of surprise inflation which in turn are increasingly impeded with greater γ. For a weak country with a bad reputation increasing delegation in EMU (or a small hard-core EMU) makes EMU and thus pooling equilibrium more attractive. This may explain the enthusiasm with which countries like Italy and Spain pushed for EMU and their eagerness to join even a conservative EMU. With little reputation to exploit, the

benefits of delegation in terms of a lower inflation bias become the dominant factor. The reverse argument suggests that weak countries mimicking as strong and enjoying a high (undeserved) reputation would be deterred by the prospect of a hard/conservative or multi-speed EMU. If there was remaining doubt that (high reputation) France may still be a weak country, the very fact that it accepted central bank independence and was and is ready to join even a small EMU thus signals that these doubts are unfounded. We will come back to these considerations when we consider participation constraints at the contracting stage. Increasing $T$, the net benefits from EMU, of course, makes pooling more likely. However, $T$ may also be negative for countries like the UK and Denmark, leading to separation rather than pooling if they are weak, and making an opt-out necessary if they are strong. If EMU is offered unconditionally ($f_3$) delegation will always make pooling less attractive for the weak countries to the point of ruling it out altogether, depending on the values of $\lambda$ and $\delta$.

### *Welfare and Participation*

We have discussed the equilibrium outcomes given the three possible Maastricht contracts. We have also discussed the Principal's motivation in the contract stage, i.e. the time when the treaty was negotiated and signed. This leaves us to complete the analysis by checking the Agent's participation constraints. At the contract stage we assume that the Agent can block or veto the Maastricht treaty or negotiate an opt-out. For now we assume that his reservation utility is then that obtained in the reputation game without the treaty, which is equivalent to contract $f_1$. This ignores the important possibility that in rejecting or accepting contract offers information is revealed to the public. Then the reservation payoff could well be given by the full information solution instead. This opens the possibility that the Maastricht treaty may have been signed by weak countries only to avoid to be recognized as weak, starting from a pooling situation during the latter-day hard-EMS. Discarding this possibility for the moment, we require for participation that the Agent is no worse off under the two possible EMU configurations ($f_2$, $f_3$) than if EMU does not happen ($f_1$). To check this, we examine how adding the contracts affects utility within the same equilibrium (equation (12)) and across equilibria[19] (equation (13)), since the range of parameters for which separating and pooling equilibria exist varies with $f_j$, as

[19] We do not consider mixed strategy equilibria explicitly, but since these are by definition a probability combination of the two pure strategy equilibrium payoffs the welfare analysis should go through regardless.

we have seen. It is useful first to compare welfare across the two equilibria for the same contract (equation (11)).

$$W_i(f_j) = U_i^S(f_j) - U_i^P(f_j) \qquad i = L,H \quad j = 1,2,3 \tag{11}$$

$$P_i^k(f_j) = U_i^k(f_j) - U_i^k(f_1) \geq 0, \qquad k = S,P \quad i = L,H \quad j = 2,3 \tag{12}$$

$$Q_i(f_{j,l}) = U_i^S(f_j) - U_i^P(f_l), \qquad k = S,P \quad i = L,H \quad j,l = 1,2,3 \quad j \neq l \tag{13}$$

These are a lot of cases to check and some of them turn out to be trivial. We summarize some of our results in the following propositions refering to these three comparisons respectively.

PROPOSITION 3: Comparing payoffs for the same contract for the H-type we find:

(i) For all parameter values that sustain pooling equilibrium, the resulting payoff is always preferred to the payoff obtained in separating equilibrium.

(ii) The same statement under (i) does not hold for separating equilibrium with respect to pooling equilibrium.

(iii) The "marginal" Agent, whose parameters just sustain separating equilibrium, but not pooling would strictly prefer to be in pooling equilibrium (for $\lambda<1$).

*Proof*: omitted; for each case, use the equilibrium conditions from Propositions 1 and 2 together with equation (11), for each contract.

The results stated in Proposition 3 confirm the intuition that under incomplete information reputation can substitute for commitment in addressing the inflation bias of the one-shot game. Clearly this benefit only holds in pooling equilibrium. Separating equilibriua, and thus the full losses from the inflation bias, obtain where reputational incentives do not suffice as a discipline. This suggests that the Agent's utility would often be smaller if the Maastricht treaty pushed her from pooling into a separating equilibrium.

PROPOSITION 4: Comparing payoffs for the same equilibrium across contracts we find:

(i) In separating equilibrium the weak type will always prefer the unconditional EMU contract $f_3$ to the other two (for $T \geq 0$).

(ii) In pooling equilibrium the weak type will prefer EMU ($f_2$ or $f_3$) to no EMU ($f_1$) if $\gamma \leq (1-\lambda) + \sqrt{(1-\lambda)^2 + 2T/b_H^2}$ .

*Proof*: omitted; for each case use equation (12) and check the derivatives w.r.t $\gamma$ and $T$.

Note that (i) is intuitive, since in separating equilibrium the surprise inflation is placed in the first period anyway and thus is not affected by EMU. What remains are the benefits from reduced inflation bias and $T$. The condition in (ii) is identical to the condition that must hold such that the conditional contract makes pooling more likely. We refer the reader back to the earlier discussion of Proposition 2 in order to recall the two opposing effects from delegation. Thus, if the condition in (ii) is violated the treaty ($f_2$) will push the weak country into separating equilibrium and will make it worse of, as we will see in Proposition 5 (i) below. However, the condition is not very tight, unless reputation $\lambda$ is very high. Besides, empirically, at the time of the Maastricht negotiations there was a lot of optimism and at least a rhetoric of one-speed, rather than multi-speed Europe. At least in one of our interpretations this means that $\gamma$ was possibly seen as small enough to induce even the weak countries to sign. Alternatively, the fact that member states, with the exception of the opt-out cases (owing to low or negative $T$) did all sign up, may also mean that all countries are in fact strong and want to reap a positive $\delta T$. The effects of the continuing crisis in the EMS and the policy developments since Maastricht on the participation constraint are ambiguous[20]. The possibility of a small hard-core EMU (large $\gamma$) makes the constraint more binding, since weak countries having signed up for Maastricht may not want to be part of a small EMU. On the other hand, if the effect of the crisis has been to reduce weak countries' reputation (i.e. increased $(1-\lambda)$) they will become even more eager to join.

PROPOSITION 5: Making some comparisons across contracts and across equilibria we find:

(i) If conditional EMU ($f_2$) destroys pooling equilibrium the weak type will always be worse off in an alternative separating equilibrium.

(ii) If unconditional EMU ($f_3$) destroys pooling equilibrium the "marginal" weak type will be made better off if $\lambda \geq \frac{1}{2} + \frac{1}{2}\sqrt{(1-\gamma)^2 - 2T/b_H^2}$ .

*Proof*: omitted; use equation (13) and equilibrium conditions in Proposition 2.

The result under (i) confirms our earlier conjecture and means that a weak type would not sign the Maastricht treaty if the condition (ii) of Proposition 4 holds,

[20] Note that for the purpose of discussion here we relax one assumption of the model, which is perfect commitment to the contracts.

which we discussed above. The result in (ii) qualifies our earlier conjecture that moving away from pooling equilibrium will generally hurt the weak type. Here, for a big enough reputation this is not necessarily so, at least on the margin. Both, the benefits of delegation and increasing $T$ can compensate for the loss of reputation that the separating equilibrium induces relative to pooling. We summarize:

PROPOSITION 6: The equilibria described in Propositions 1 and 2 for the reputation game are also equilibria of the contracting game (i.e. satisfy participation on top of incentive compatibility constraints for both types of Agents) for

(i) conditional EMU ($f_2$)

$$\begin{cases} \text{for } \dfrac{T}{b_H^2} < \dfrac{\gamma^2}{2} - \gamma(1-\lambda) & \begin{cases} \text{for } \delta \le 1/2 & \text{always} \\ \text{for } \delta > 1/2 & \text{never} \end{cases} \\ \text{for } \dfrac{\gamma^2}{2} - \gamma(1-\lambda) \le \dfrac{T}{b_H^2} < \dfrac{\gamma^2}{2} & \begin{cases} \text{for } \delta \le 1/2 & \text{always} \\ \text{for } 1/2 < \delta \le 1/2(1 + T/b_H^2 - \gamma^2/2) & \text{never} \\ \text{for } \delta > 1/2(1 + T/b_H^2 - \gamma^2/2) & \text{always} \end{cases} \\ \text{for } \dfrac{T}{b_H^2} \ge \dfrac{\gamma^2}{2} & \text{always} \end{cases}$$

(ii) unconditional EMU ($f_3$)

$$\begin{cases} \delta \le 1/2 & \text{always} \\ 1/2 < \delta < 1/2\lambda(1-\gamma) & \text{if } \delta \le \dfrac{2\lambda - 1}{2\lambda - 1 + (1-\gamma)^2 - 2T/b_H^2} \\ \delta \ge 1/2\lambda(1-\gamma) & \text{if } T/b_H^2 \ge \gamma^2/2 - \gamma(1-\lambda) \end{cases}$$

*Proof*: omitted; note first that for each contract the regions of parameters satisfying the equilibrium conditions in Propositions 1 and 2 are disjoint (for $\lambda<1$).Thus for any set of parameters we can never have pooling and separating equilibrium coexist. Also recall that the strong type can never lose from EMU, thus participation constraints will only bind on the weak type. Given this we can make the comparisons suggested in equations (11) to (13) for the relevant cases and use the previous Propositions.

As discussed before, there are two possible reasons why the (weak) Agent's participation constraint may be violated. First, pooling equilibrium payoffs may be reduced by the delegation effect so much as to outweigh the reputation gain and the joint benefits of EMU. Second, the Agent may be pushed out of pooling into separating equilibrium by the treaty. Then he loses the benefits from reputation with no ($f_2$) or possibly insufficient ($f_3$) compensating benefits from EMU. Note that a large enough $T$ can relax all participation constraints. In conclusion,, at the Maastricht Treaty stage, while the Principal will always want to contract for a separating equilibrium, the Agent (if weak) will in general prefer pooling in order to reap the benefits of reputation. For that reason he may prefer that entry to EMU be made conditional to the unconditional contract ($f_3$). This can explain why there was very little opposition against the convergence criteria at the time they were drafted. The Treaty then enhances the weak countries' reputation in the transition to EMU, while serving as a partial exclusion device in the interest of the Principal as well.

## 5. SIGNALLING

The simple version of the model as presented in section four suffices to tell the basic reputation story. The extension to the general case ($b_L \geq 0$), where the strong type also has a strategic role to play is not trivial. For limitations of space, therefore, we will only give a brief discussion to convey the flavour of the results that were obtained. The main difference to the previous section is that the range of parameters for which separating equilibrium obtains will generally expand, because of the strong countries' incentives to signal their type in the first period. Thus the reputation effect in these circumstances will discipline the strong rather than the weak country and the Principal's task of screening out the weak countries is facilitated.

In deriving equilibrium here the incentive compatibility constraints in equation (9) must be checked for both types. Also, while the candidate pooling equilibrium remains unaltered, signalling may lead to a separating inflation rate $\pi^* \leq b_L$ , i.e. below the strong country's one-shot optimum. In looking for such a *separating equilibrium*, the first step is to define the lowest possible inflation rate that the strong would consider in order to separate herself as $\hat{\pi}_L$ and the lowest possible inflation rate that the weak would consider in order to mimick the strong as $\hat{\pi}_H$.

PROPOSITION 7: In the reputation game with $b_L \geq 0$ the weak type will never choose inflation below $\hat{\pi}_H$ and the strong type never below $\hat{\pi}_L$, where $r = b_H / b_L \geq 1$, with

$$\left.\begin{aligned} \hat{\pi}_H &= b_H\left(1 - \sqrt{2\delta(r-1)/r}\right) \\ \hat{\pi}_L &= b_L\left(1 - \sqrt{2\delta(r-1)}\right) \end{aligned}\right\} \qquad \textit{for } f_j(\pi_1) = f_1$$

$$\left.\begin{aligned} \hat{\pi}_H &= b_H\left(1 - \sqrt{2\delta\left[(1-\gamma^2/2) - (1-\gamma)/r + T/b_H^2\right]}\right) \\ \hat{\pi}_L &= b_L\left(1 - \sqrt{2\delta\left[r - (1-\gamma+\gamma^2/2) + T/b_H^2\right]}\right) \end{aligned}\right\} \qquad \textit{for } f_j(\pi_1) = f_2$$

$$\left.\begin{aligned} \hat{\pi}_H &= b_H\left(1 - \sqrt{2\delta(1-\gamma)(r-1)/r}\right) \\ \hat{\pi}_L &= b_L\left(1 - \sqrt{2\delta(1-\gamma)(r-1)}\right) \end{aligned}\right\} \qquad \textit{for } f_j(\pi_1) = f_3$$

*Proof*: omitted, solve equation (9) for $\hat{\pi}_i$ (as the candidate deviation inflation rate) as an equality for each contract.

From Proposition 7 we can already read off the effect the treaty has on the two players' incentives. For unconditional EMU, the delegation effect works in the same direction for both types. The strong is less willing to signal, the weak is less inclined to mimick. For the conditional contract (abstracting from $T$ for the moment) the incentive goes in the opposite direction for the strong type, since now the reward of lower expected inflation in EMU is contingent on successful signalling in period one. The effect is ambiguous for the weak type. Define $q$ as the inverse of $r$, then he will be less willing to mimick as $\gamma$ increases as long as $\gamma < q = b_L / b_H$. This condition is intuitive, since the greater the difference in preference (for given $\gamma$), i.e. the higher the gain from surprise inflation, the more likely will mimicking behaviour be. For given $q$, delegation $\gamma$ reduces the benefits from mimicking for if types are similar enough. Then the inflation bias effect is dominated by the suprise inflation effect.

PROPOSITION 8: The reputation game, with $b_L \geq 0$, has a *separating equilibrium* with

$$\pi_1^L = \pi^* = \hat{\pi}_H \quad \pi_2^L = b_L, \qquad \pi_1^H = \pi_2^H = b_H$$

$$\pi_1^e = \lambda\pi^* + (1-\lambda)b_H, \qquad \pi_2^e = \begin{cases} b_L & \textit{if } \pi_1 \leq \pi^* \\ b_H & \textit{if } \pi_1 > \pi^* \end{cases}$$

if

$$\begin{cases} \delta > \frac{1}{2}, \quad r < \left(\frac{2\delta+1}{2\delta-1}\right)^2 & \textit{for } f_j(\pi_1) = f_1 \\ \delta > \frac{1}{2}, \quad r < \left(\frac{2\delta+1}{2\delta-1}\right)^2, \quad \gamma \le \frac{b_L}{b_H} & \textit{for } f_j(\pi_1) = f_2 \\ \delta > \frac{1}{2}, \quad r < \left(\frac{2\delta(1-\gamma)+1}{2\delta(1-\gamma)-1}\right)^2 & \textit{for } f_j(\pi_1) = f_3 \end{cases}$$

If the signs of the inequalities on $r$ and $\delta$ are reversed, it can be show for contracts $f_1$ and $f_3$ that separating equilibrium obtains without signalling, i.e. $\pi^* = b_L$ . Note that for contract $f_2$ we only provide a sufficient condition and assume $T$=0, to ensure that the effect from $\gamma$ on the equilibrium condition is unambiguous. To obtain uniqueness we have deleted all dominated strategies $\pi^* < \hat{\pi}_H$

*Proof*: omitted, show $\hat{\pi}_H \ge \hat{\pi}_L$ for existence, using Proposition 7 and lots of algebra.

The results above at first sight appear counter-intuitive, since we require for separation that types are not too dissimilar. The paradox disappears if we consider two cases of dissimilarity separately. If the $b$ of the strong type is very low, she will not care about future expected inflation and thus has little incentive to signal. Conversely, if the weak's $b$ is very high, it pays very much to mimick and thus separating equilibrium is destroyed by violation of his incentive compatibility constraint.

We skip analysis of pooling equilibrium, which becomes extremely messy, and which has also been argued to be implausible when signalling is possible (Vickers 1986) and once the Cho-Kreps (1987) intuitive criterion is applied. Moreover the effects of the reputational forces at work are not radically altered with respect to the previous section. The key message to take from this section, therefore, is that signalling behaviour will promote separating equilibrium (if country preferences are no too different) and gives the strong countries a strategic role. Then it is more likely that the weak countries are separated out in the Maastricht process. The adoption of the convergence criteria and the subsequent behaviour of countries would then reflect the (attempted) signalling behaviour of the strong types. To convince the public (financial markets) and the Principal of their toughness they willingly choose to suffer what appears to be "excessive" deflation, "unnecessary" recession and high unemployment. The apparently "irrational" short term

behaviour by many European countries, notably France, "sticking to their guns" during the EMS crisis and resisting even "reasonable" realignments (or continuing to play the EMS game even after the latter's death) then become easily explained as part of a perfectly rational longer term strategy, which has escaped most economic commentators.

## 6. CONCLUSION AND POLICY IMPLICATIONS

We have shown how the Maastricht Treaty provisions, and the convergence criteria in particular, affect policymakers' incentives in a (monetary policy) reputation game. For the "conditional EMU" contract that chracterizes the Maastricht Treaty, greater joint benefits from EMU, a high discount factor and greater reputation make pooling behaviour more likely. The effect of delegation is ambiguous. We have shown that for large enough joint benefits and small enough delegation even weak countries are willing to sign up to Maastricht, while it is in the Principal's interest to try prevent weak countries from joining EMU and induce a separating equilibrium.

The empirical predictions of the two possible equilibria that we described are as follows. Under separating equilibrium strategic uncertainty is resolved ahead of EMU. Strong countries will have low inflation and suffer a recession in the convergence period, weak countries will enjoy a boom from surprise inflation. Under pooling equilibrium, all countries will have low inflation at first but strategic uncertainty will only be resolved once EMU is established, inducing a recession or a surprise inflation at that time. In this sense the two equilibria shift the costs of reputation building across time and across countries and the Maastricht criteria represent a (fragile) compromise.

The assumptions of the model that one wishes to relax for the discussion of policy are those of perfect contract commitment and fixed and certain parameters. This calls for the introduction of shocks and and an examination of the ex post credibility of the treaty, such as renegotiation proofness. In particular, many parameters of the treaty, in particular the size and composition of membership as well as the timing of EMU are determined in an on-going game. Most obviously, the criteria themselves are a moving target and are controversial in their interpretation. Still, our model has already identified some important elements of the Maastricht game that accord well with observation. It can explain the EMS crisis as a result of the Danish referendum in 1992, which made EMU look more remote (lower discount factor) and thus knocked countries out of pooling equlibrium. It gives a rationale for signalling behaviour like that displayed by

France over the past few years. It illustrates countries' attitudes towards the prospect of a multi-speed Europe and the turbulances in financial markets as the result of collapsing reputation in a separating equilibrium. Our model is unsatisfactory, however, in ruling out that lost reputation can be regained, but we can interpret changes in governments or political situations as re-establishing strategic uncertainty and re-starting the reputation game.

With regard to the current policy debate over the way forward for EMU our model can be used to assess the proposels that have been made to circumvent or amend the Maastricht treaty. The need to build reputation for EMU in particular rules out a quick EMU, particularly if large. Our analysis flatly rejects De Grauwe's (1994) proposal that entry to EMU should be made both unconditional and voluntary, which is a recipe for a low-reputation union that no-one would want to join. It also rules out De Grauwe's suggestion that EMU should go ahead without Germany, which in our model appears as the main source and producer of credibility within EMU. The model also argues against an early Europeanization of monetary policy, e.g. by upgrading the role of the European Monetary Institute and resurrecting the EMS as suggested by Artis (1994). The whole point of stage two of EMU, as modelled here, is to test *national* policymakers. In terms of preference revelation the collapse of the narrow ERM has been a blessing not a curse[21]. However, the Artis proposal does make a lot of sense if it is seen as a measure (we would say signal) to restore credibility and commitment to the Maastricht treaty.

This paper has given an economic defence of Maastricht as an attempt to coordinate and contract reputation building for EMU. Thus from our perspective the main obstacles to Monetary Union in Europe are not to be found in the provisions of the treaty but in the lack of commitment (perceived and real) to the treaty and a lack of consensus about its interpretation and ambitions. This itself may signal that convergence of preferences across Europe is as of yet insufficient to sustain as risky and ambitious a project as EMU.

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[21] German finance state secretary Haller (1994) has welcomed the new EMS (likening policymakers to automobilists): "while this places greater demands on the driver, it also permits a more effective assessment of his driving skills".

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**APPENDIX A:** Proof of PROPOSITION 1

Note first that the condition for $f_1$ is a special case that can be derived from the other two by setting $\gamma$ and $T$ equal to zero. Using equations (1), (4) and (5), with inflation rates and expectations as given in the Proposition, inserting into equation (9) for the H-type we have:

for $f_2$ : $(\lambda - 1/2)b_H^2 - \delta b_H^2/2 \geq -(1-\lambda)b_H^2 - \delta\left[(1-\gamma)^2 b_H^2/2 + (1-\gamma)b_H^2/2 + T\right]$

simplifying: $b_H^2\left[\delta(\gamma^2/2 - 1) + 1/2\right] \geq \delta T$ yields the proposition.

for $f_2$:

$(\lambda - 1/2)b_H^2 - \delta\left[(1-\gamma)b_H^2/2 - T\right] \geq -(1-\lambda)b_H^2 - \delta\left[(1-\gamma)^2 b_H^2/2 + (1-\gamma)b_H^2/2 + T\right]$

simplifying: $b_H^2/2 \geq \delta(1-\gamma)b_H^2$ yields the proposition. □

**APPENDIX B:** Proof of PROPOSITION 2

Note again that the condition for $f_1$ is a special case that can be derived from the other two by setting $\gamma$ and $T$ equal to zero. Using equations (1), (4) and (5), with inflation rates and expectations as given in the Proposition, inserting into equation (9) for the H-type we have:

for $f_2$ : $\delta\left[-(1-\gamma)^2 b_H^2/2 + \lambda(1-\gamma)b_H^2 + T\right] \geq b_H^2/2 - \delta b_H^2/2$

simplifying: $\delta\left[1 - (1-\gamma)^2 + 2\lambda(1-\gamma) + 2T/b_H^2\right] \geq 1$ yields the proposition.

for $f_3$ : $\delta\left[-(1-\gamma)^2 b_H^2/2 + \lambda(1-\gamma)b_H^2 + T\right] \geq b_H^2/2 - \delta\left[(1-\gamma)^2 b_H^2/2 + T\right]$

simplifying: $b_H^2\left[\delta\lambda(1-\gamma) - 1/2\right] \geq 0$ yields the proposition. □

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