

\\ 233 \\

**Delegation of Monetary Policy to a Central Banker  
with Private Information**

by

Marcello D'Amato\*

Barbara Pistoresi\*\*

May 1998

\* Università degli Studi di Salerno  
Dipartimento di Economia  
Via Ponte Don Melillo  
84084 Fisciano, Salerno (Italy)  
e-mail: [damato@bridge.diima.unisa.it](mailto:damato@bridge.diima.unisa.it)

\*\* Università degli Studi di Modena  
Dipartimento di Economia Politica  
Via Berengario, 51  
41100 Modena (Italy)  
e-mail: [pistoresi@unimo.it](mailto:pistoresi@unimo.it)

### **Abstract**

In this paper we solve a monetary policy game where a government appoints a completely independent central banker whose preferences from the point of view of private agents are private information as in Vickers (1986). We show that a bit of private information is sufficient to eliminate any incentive for the government to precommit monetary policy to a conservative agent: both in a separating equilibrium and in a pooling equilibrium the central banker's optimal degree of conservativeness is the same as the government's one.

J.E.L.: E58, D82

Keywords: Monetary Policy, Signalling Games

# 1 Introduction

The relationship between "society" and the agent in charge of monetary policy has been focused by recent literature as one of the main issues in the economic analysis of monetary policymaking, (see Persson and Tabellini, 1997, for a recent survey). The starting point for much of the recent literature has been a work by Kydland and Prescott (1977) who showed how, in a monetary policy game between a monetary authority and private agents the precommitment solution for the policymaker welfare dominates any discretionary solution. Rogoff (1985) interpreted their result as the possibility for a government prone to the temptation for inflation surprise to delegate monetary policy to an agent (central banker-CB henceforth) who does not take into account the benefits that unexpected inflation may have on government's target variables (unemployment, service on outstanding nominal public debt). Rogoff (1985) also showed that, in a model with nominal rigidity and scope for stabilization policy, the optimal CB's preferences are not such that the agent in charge for monetary policy sets an infinite weight on the inflation rate, though his preferences penalize inflation more than the median voter does<sup>1</sup>. This is the celebrated Rogoff's result about the convenience for a Government to commit monetary policy to an independent and "conservative" CB though not an infinitely conservative one, by trading off a certain amount of flexibility in the policy response for credibility.

The crucial hypothesis for this result is that the preferences of the appointed CB are common knowledge among the players of the game. Different

---

<sup>1</sup>See Alesina and Grilli (1992) for an explicit reinterpretation of the Rogoff's model in terms of a political game where a population of citizens, differing only with respect to the relative weight which they assign to inflation and stabilisation, votes upon the preferences of the "governor" to appoint. For an alternative approach on the analysis of the relationship between "society" and the agent in charge of monetary policy see Walsh (1995) and Persson and Tabellini (1993). Persson and Tabellini (1997), pp. 37 ss. offer a critical analysis of the main differences and analogies between the precommitment and the contracting approach to the normative analysis of monetary policy making.



authors<sup>2</sup> have emphasised that the environment in which the policymaker makes decisions is characterised by the presence of asymmetric information by the policymaker on its own preferences about alternative objectives to which policy is targeted. In the case of private information the action of the policymaker is constrained by private agents beliefs, but also has scope for policy actions that would be ineffective in the presence of complete information.

In this paper we ask whether the “conservative CB” result still holds in the presence of CB’s private information on its preferences. To answer this question we consider a simple version of the model as in Barro and Gordon (1983) and as in Vickers (1986)<sup>3</sup>. The model by Vickers is easily summarised: he considers a monetary authority in charge for two periods whose preferences are private information. In the first period, given agents expectations, he will set the inflation rate taking into account the fact that second period expectations by private agents will be set conditional on the observation of the first period behaviour. Vickers (1986) shows that both pooling and separating equilibrium may exist in this model and he provides the analysis of the time path followed by inflation and unemployment in either equilibrium and its welfare implications<sup>4</sup>. In order to address the question raised above, we modify Vickers’ game in two respects: a) we consider the case of a continuum of types that the CB may incarnate and b) we introduce a preliminary stage in which the government, given its own preferences, appoints a completely independent CB with suitable preferences that are private information. We consider both pooling and separating equilibrium and show how, in either case, the incentive to exploit the CB’s degree of conservativeness as a com-

---

<sup>2</sup>The issue of private information in monetary policy games has been analysed, for example, by Backus and Driffil (1985), Canzonery (1985), Rogoff (1987), Vickers (1986).

<sup>3</sup>The question we address in this paper naturally arises in Rogoff (1985) who states: “We have assumed that the preferences of the agent appointed to head the central bank is well known. Clearly many strategic problems arise when this assumption is relaxed”. However our analysis is cast in the original set up used by Barro and Gordon (1983) and extended by Vickers (1986) to the case of private information. This is mainly due to computational difficulties originating by the fact that the first order condition to the Government’s problem, defined by eq. 22a in Rogoff (1985) does not have closed form solution. Differently from Rogoff (1985), in the original set up used here there is no trade off between flexibility and credibility and, as it will be seen in a moment, the choice of the government trades off the possibility to exploit private information and credibility.

<sup>4</sup>Vickers (1986) also shows that only the separating equilibrium survives the application of some refinement criteria.

mitment device is modified by the presence of private information.

The remaining of the paper is organized as follows: in section 2 we outline the model and define the separating equilibrium and the pooling equilibrium in the monetary policy game; in section 3 we derive the optimal CB's degree of conservativeness set by the government in the political stage; in section 4 we conclude.

## 2 Equilibria in the monetary policy signalling game

The model is described as follows: at time zero a Government characterised by the preferences of his median voter is elected and appoints a CB in charge for two periods whose preferences about the trade off between the costs of inflation versus the benefits from unexpected inflation<sup>5</sup> are private information from the point of view of private agents. In each of the two periods when it is in charge, the CB plays a two stage subgame vis à vis private agents such that: in the first stage agents set their expectations about the inflation rate to be played by the CB and, given this expected level of inflation, they set nominal contracts. In the second stage, after observing contracts set by private agents, the CB sets out the optimal inflation rate. The incentive to reveal private information for the CB arises since private agents, setting contracts in the first stage of the second period will condition their expectations on what they observed in the second stage of the first period. The pay off to the CB is given by:

$$W_t = -\frac{1}{2}\pi_t^2 - \alpha(\pi_t^e - \pi_t) \quad (1)$$

where  $\alpha > 0$  represents the preference parameter that describes CB's relative weight set on unexpected inflation,  $\alpha \in [a, A]$  is private information to the CB i.e., from the point of view of private agents, it is distributed

---

<sup>5</sup> See Cukiermann (1993) for a detailed exposition of the main issues and interpretations involved in the use of this utility function as a characterisation of the government objectives.

according to  $F(\alpha)$ ,<sup>6</sup>  $t$  indicates the period of the game.  $\pi_t$  is the inflation rate which, for the sake of simplicity is assumed to be a perfectly controlled instrument,  $\pi_t^e$  represents expected inflation<sup>7</sup>.

Private agents seek to minimize forecast error on inflation rate according to the following per period payoff function<sup>8</sup>:

$$u_t = -(\pi_t - \pi_t^e)^2 \quad (2)$$

We solve the monetary policy game for the Bayes Nash equilibrium strategies and we obtain a couple of inflation rates played by CB:  $s = \{\pi_1(\alpha), \pi_2(\alpha)\}$ , and a couple of expected inflation rates played by private agents:  $e = \{\pi_1^e, \pi_2^e\}$ , where  $\pi_1^e = E(\pi_1)$  represents the first period expected inflation rate based on the prior beliefs and  $\pi_2^e = E(\pi_2 | \pi_1)$  represents the second period expected inflation rate contingent on the actual inflation rate observed in the first period and it is set according to the Bayes rule.

*Lemma 1*

For any arbitrary support  $[a, A]$  of  $F(\alpha)$ , a separating equilibrium exists in the range  $[\alpha^s, A]$ . Equilibrium strategies are the following ones:  $s^s = \{\pi_1(\alpha), \pi_2(\alpha)\}$ ,  $e^s = \{\pi_1^e, \pi_2^e\}$ ,

where  $\pi_1^s(\alpha) = \phi(\alpha)$ ,  $\pi_2^s(\alpha) = \alpha$ ,  $\pi_1^e(\alpha) = E[\phi(\alpha)]$ ,  $\pi_2^e(\alpha) = E(\pi_2 | \pi_1) = \alpha$ .

$\pi_1^s(\alpha) = \phi(\alpha)$  satisfies the following first order non linear differential equation:

$$\frac{d\phi}{d\alpha} = \frac{\alpha}{\alpha - \phi} \text{ and is such that } 0 < \phi(\alpha) < \pi_1^*(\alpha) = \alpha.$$

*Proof* see Appendix

The separating strategy is such that, in the first period any CB in the range  $[\alpha^s, A]$ , will select an inflation rate lower than under complete information (reducing the inflationary bias). Private agents will anticipate this

<sup>6</sup> Both the support and the distribution function are common knowledge and can be arbitrarily defined. However, it can be shown that, conditions for the existence of a separating equilibrium may restrict the support, cfr. Mailath (1987).

<sup>7</sup> See Cukierman (1993), pp. 34 e ss., for a critical analysis of the welfare function and the macroeconomic structure used in monetary policy games.

<sup>8</sup> For a thorough discussion of (2) see Rogoff (1987, p.146).

and will lower the expected level of inflation in the first period.<sup>9</sup>

In a signalling game such as this one there will also exist many pooling equilibria. A natural candidate for a pooling is the one in which the CB in the first period plays a pooling strategy that validates agents prior beliefs. This result is described in the following lemma.

*Lemma 2*

A candidate for a pooling equilibrium is described by the following strategies  $s^p\{\pi_1^p(\alpha), \pi_2^p(\alpha)\}$ ,  $e^p = \{\pi_1^e, \pi_2^e\}$  where,  $\pi_1^p(\alpha) = \bar{\alpha}$ ,  $\pi_2^p(\alpha) = \alpha$ ,  $\pi_1^e(\alpha) = \bar{\alpha}$ ,  $\pi_2^e(\alpha) = \bar{\alpha}$ . When out of equilibrium beliefs are such that after observing any deviation from  $\pi_1^p(\alpha) = \bar{\alpha}$ , agents will set  $\pi_2^e(\alpha) = A$ , this pooling equilibrium exists for  $\alpha \in [A - \sqrt{A^2 - \bar{\alpha}^2}, A]$ . When out of equilibrium beliefs are such that agents do not update beliefs after observing any deviation (passive conjectures), deviation is always worthwhile and the pooling equilibrium does not exist.

*Proof* See Appendix

### 3 The optimal CB's degree of conservatism when his preferences are private information

In this section we analyse the optimal strategy of a government that is willing to appoint a CB but is not able to release to private agents credible information about the CB's preferences about the trade off between the cost of inflation and the benefits of unexpected inflation<sup>10</sup>.

---

<sup>9</sup> A graphic characterisation of the separating equilibrium is in D' Amato and Pistoiesi (1996). The analytical solution for the separating schedule is provided in the appendix.

<sup>10</sup> As it is well known, a less extreme solution than "precommitment" (Kydland and Prescott, 1977) is provided in Rogoff (1985) where it is assumed that the CB's preferences are complete information, in his setting, rather than an infinite penalty on inflation, the median voter, ("society") will be willing to appoint a "conservative" CB, weighting inflation more than the median voter itself.



We finally come to the main point of the paper: in the economic framework outlined in the previous section, is it still the case that a government (i.e. a median voter) with given preferences has the incentive to appoint a conservative CB?<sup>11</sup> To answer this question consider that at the outset of the monetary policy game played by CB a government is elected and is willing to appoint a completely independent<sup>12</sup> CB whose preferences are not common knowledge.

As a benchmark, consider the case when the CB's type is complete information, then the monetary policy outcome will be the usual inflationary equilibrium played in the two periods. Under complete information on the preferences of the CB it is immediate to show that the optimal solution would be such that  $\alpha = 0$  (precommitment solution).

When the CB holds private information about its preferences we have two possible cases: either a separating or a pooling equilibrium strategies will be played by the CB<sup>13</sup>. Assuming that the monetary policy game equilibrium is a separating equilibrium, the government will take into account that the appointed CB must satisfy the incentive compatibility constraint for truthful revelation described in Lemma 1 and given by (A2) in the Appendix.<sup>14</sup> When the equilibrium outcome of the monetary policy game is assumed to be in pooling strategies, the government will take into account that the CB's behaviour will be described by strategies and constrained by beliefs as in Lemma 2. Let us solve the program for the government in either case.

The payoff function for the government is given by:

$$W^G = -\pi_1^2/2 - \alpha^G [\pi_1^e - \pi_1(\alpha)] - \pi_2^2/2 - \alpha^G [\pi_2^e - \pi_2(\alpha)] \quad (3)$$

---

<sup>11</sup> A problem similar to the one analysed in this section is analysed and solved by Ziv (1993) in the context of information sharing among oligopolists.

<sup>12</sup> Complete independence of the CB in the monetary policy game makes the information about the Government's type irrelevant for the private agents. In this case the contract between the CB and the government only has internal relevance and there is no point for the government to reveal its own preferences. On the same ground there is no point for the government in revealing the CB's preferences any announcement would not be credible.

<sup>13</sup> Differently from Vickers (1986), we do not apply refinement criteria in order to check if some of the equilibria can be eliminated. The main reason being that, under the hypothesis of continuity of types no refinement criterium can be safely applied. See Mailath (1987), (1992).

<sup>14</sup> Notice that, since the action of the CB is observable in the present model, the same solution can be obtained if the government, instead of appointing a CB with suitable preferences sets an inflation target in the two periods.

where  $\alpha^G$  represents the government's preference parameter for surprise inflation, and  $\alpha$  represents the CB's preferences in charge of monetary policy for the next two periods and represents the government's choice variable.

Given a separating equilibrium, the reduced form of equation (3), is given by:

$$W^{Gs} = -\frac{1}{2}[\phi(\alpha)]^2 - \alpha^G [E(\phi(\alpha)) - \phi(\alpha)] - \frac{1}{2}\alpha^2 \quad (4)$$

Given a pooling equilibrium, the reduced form of equation 3 is given by:

$$W^{Gp} = -\frac{1}{2}\bar{\alpha}^2 - \frac{1}{2}\alpha^2 - \alpha^G(\bar{\alpha} - \alpha) \quad (5)$$

The optimal CB's degree of conservativeness can be obtained by maximising (4) and (5) with respect to  $\alpha$ . We get the following proposition

*Proposition 1*

In the political stage of the game given either (i) a separating or (ii) a pooling equilibrium in the monetary policy game, the optimal CB's degree of conservativeness is the same as that of the government, i.e.  $\alpha^G = \alpha$ .

*Proof*

As for (i), the first order condition will be given by:  $W_{\alpha}^{Gs} = -\phi\phi' + \alpha^G\phi' - \alpha = 0$ . Using equation (A.2) for  $\phi'$ , derived in the Appendix and described in Lemma 1, we get  $(\alpha^G - \alpha)/(\alpha - \phi) = 0$ , which is satisfied for  $\alpha^G = \alpha$ . In the Appendix we will show that this is a sufficient for a global maximum.

As for (ii), the first order condition will be given by  $W_{\alpha}^{Gp} = -\alpha + \alpha^G = 0$ . The second order condition is satisfied since  $W_{\alpha\alpha}^{Gp} = -1$ .

Let us discuss now the reasons why, under private information of the CB on its preferences parameter, any incentive for the government to appoint a "conservative CB" disappears. Consider first the case of a separating equilibrium. In such an equilibrium, the appointment of a conservative CB will imply delegation costs in the first period and benefits in the second period. The first period cost is due to the fact that by appointing a CB with  $\alpha < \alpha^G$  implies that the CB will set a level of inflation lower than the one that would be selected by the government in the absence of delegation. This will prevent a weak government to exploit reduction in the expected inflation by private agents and will inflict "strong" types of governments separating costs that are higher than in the absence of delegation. In the second period, when

the equilibrium outcome is just the inflationary equilibrium, the appointment of a conservative CB would benefit any type of government. For the selected specification of the payoff functions, the cost of appointing a conservative CB will exactly counterbalance the benefits, this explains point (i) in proposition 1. In the pooling equilibrium considered here things are slightly different, since the first period inflation rate is constrained by prior beliefs, the choice of the banker is completely irrelevant for the first period outcome. Hence a rational government will trade-off only benefits and costs in the second period of the game. In this case a weak government will not waste the opportunity to artificially booming the economy by surprise inflation and hence will not select a conservative CB. A strong type of Government, on the other hand, will not like appointing a conservative CB since this latter will trigger a deflation in the second period which is larger than the deflation that the government itself is willing to pay in order to keep inflation low.

## 4 Conclusions

In this paper we have shown that when the government appoints a CB in charge for two periods, whose preferences are private information, the optimal degree of conservativeness is the same as the government's one. That is, private information, in the form considered in this paper, eliminates any incentive for society to appointing a CB whose preferences penalise inflation more than the median voter. The intuition for the result is that the introduction of private information on CB's preferences increases the cost for government's commitment up to the level that in the optimum, it will not be used to constrain future behaviour of the government. The general implication of our result, for the institutional design seems to indicate that a simple commitment argument can not be considered as a sound foundation for the set up of strategic setting of goals and legislative features shielding central banks from political pressures.

However this implication can not be taken too far since, as stated above, we analysed a monetary policy game within a model where the trade off between credibility and flexibility is not present. We think that this can be considered only a partial limitation since the model originally formulated by

Barro and Gordon (1983) and by Vickers (1996) can be safely considered relevant in circumstances where the surprise inflation is a strong temptation for the government regardless of the shocks that may hit the economy (stabilisation motive). However, an interesting task left for future work will be to set the same question addressed in the present paper within a model where the trade-off between flexibility and credibility is present. The point made in this paper, however, is very likely to carry over: signalling costs increase with the degree of conservativeness of the CB and tend to countervail the benefits of commitment.

## References

- Alesina A. and V. Grilli (1992), "The European Central Bank: Reshaping Monetary Politics in Europe", in Persson T. and G. Tabellini (1995), pp. 247-277.
- Backus D. and J. Driffil (1985), "Inflation and Reputation", *American Economic Review*, Vol. 75, pp. 530-538.
- Barro R. (1986), "Reputation in a Model of Monetary Policy with Incomplete Information", *Journal of Monetary Economics*, Vol. 17, pp. 3-20.
- Barro R. and D. Gordon (1983), "A Positive Theory of Monetary Policy in a Natural Rate Model", *Journal of Political Economy*, Vol. 91, pp. 589-610.
- Canzonery M. (1985), "*Monetary Policy Games and the Role of Incomplete Information*", Vol 75, N.5, pp. 1056-1070.
- Cukierman A. (1993), *Central Bank Strategy, Credibility, and Independence: Theory and Evidence*, Cambridge, Mass., The MIT Press.
- D' Amato M. and B. Pistoresi (1996), "La Riservatezza del Banchiere Centrale è un Bene o un Male?", *Materiali di Discussione*, Università di Modena, Dipartimento di Economia Politica.
- Driffil J. (1987a) "Macroeconomic Policy Games with Incomplete Information: Some Extensions" *CEPR Discussion Papers*, No.159.
- (1987b) "Macroeconomic Policy Games with Incomplete Information - A Survey", *Warwick Economic Research Papers* No. 288.
- Kydland F. and E. Prescott (1977), "Rules Rather than Discretion: the Inconsistency of Optimal Plans", *Journal of Political Economy*, Vol. 85, N.3, pp. 473-491.
- Mailath G. (1987), "Incentive Compatibility in Signaling Games with a Continuum of Types", *Econometrica*, Vol.55, N. 6, pp. 1349-1365.
- (1992), "*Signaling Games*", in Creedy et al. (ed.), *Recent Developments in Game Theory*, Edward Elgar Publishing Limited, pp. 65-93.
- Persson T. and G. Tabellini (1990), *Macroeconomic Policy, Credibility and Politics*, London, Harwood Academic Publishers.
- - - (1993), *Designing Institutions for Monetary Stability*, *Carnegie- Rochester Conference Series on Public Policy*, in Persson T. and G. Tabellini (1995).
- - - eds.(1995), *Monetary and Fiscal Policy*, Vol.1: Credibility, Cambridge, Mass., The MIT Press.

Rogoff K. (1985), "The Optimal Degree of Commitment to an Intermediate Monetary Target", *Quarterly Journal of Economics*, Vol.100, N.4, pp. 1169-1189.

- (1987), "Reputational Constraints on Monetary Policy" *Carnegie-Rochester Conference Series on Public Policy*, Vol. 26, pp. 141-182.

Vickers J. (1985), "Signalling in a Model of Monetary Policy with Incomplete Information", *Oxford Economic Papers*, Vol. 38, pp. 443-455.

Walsh C. (1995), "Optimal Contracts for Central Bankers", *American Economic Review*, Vol.85, n.1, pp. 150-167.

Ziv A. (1993), "Information Sharing in Oligopoly: the truth-telling problem", *Rand Journal of Economics*, pp.455-465, vol.24.

# A Appendix

## Proof of Lemma 1

By backward induction let us solve first the second period equilibrium outcome. This is obtained by maximising  $W_2 = -\pi_2^2/2 - \alpha(\pi_2^e - \pi_2)$  so that the the CB will select:  $\pi_2 = \alpha$ . Private agents, to minimize error forecasts will set expectations  $\pi_2^e = E(\alpha | \pi_1 = \phi) = \hat{\alpha}$ .

Given the equilibrium outcome of the second period, the reduced form pay-off function to the CB in the first period is given by:

$$\tilde{W} = -\frac{1}{2}\pi_1^2 - \alpha(E(\pi_1) - \pi_1) - \alpha^2/2 - \alpha(\hat{\alpha} - \alpha) \quad (\text{A1})$$

The separating strategy will be obtained by maximising (A1) with respect to  $\pi_1$  subject to  $\pi_1 = \phi(\alpha)$ , and  $\pi_2^e = \hat{\alpha} = \phi^{-1}(\alpha)$ . However, before solving this program, we need to check that (A1) satisfies regularity conditions for a separating equilibrium as stated in Mailath (1987). Belief monotonicity condition:  $\tilde{W}_{\hat{\alpha}} = -\alpha < 0$ , (the CB has incentive to be believed an inflation fighter, i.e. low); Type monotonicity condition:  $\tilde{W}_{\pi_1\alpha} = 1 > 0$ , (that is the larger the weight that CB sets on unexpected inflation the larger the welfare effect of increasing  $\pi_1$  for any given belief of private agents); Single crossing condition:  $\partial(\tilde{W}_{\pi_1}/\tilde{W}_{\hat{\alpha}})/\partial\alpha = -\pi_1/(-\alpha)^2$  which is satisfied since it does not change sign for a positive inflation rate.

The first order condition for maximising (A1) will yield

$$\frac{d\phi}{d\alpha} = \frac{\alpha}{\alpha - \phi} \quad (\text{A2})$$

A sufficient condition for (A2) to be a local maximiser for (A1) is the following one, (see Mailath, 1987,p.1355):  $\phi'\tilde{W}_{\pi_1\alpha} + \tilde{W}_{\hat{\alpha}\alpha} \geq 0$  and hence, since  $\pi_1 \in \phi$ , and  $\tilde{W}_{\hat{\alpha}\alpha} = -1$  and  $\tilde{W}_{\pi_1\alpha} = 1$ , we get the following restriction on  $\phi$ :  $\phi' > 1$  the is, from (A2),  $\phi > 0$ .

A sufficient condition for (A2) to be a global maximiser for (A1), is the following one  $\phi' \left\{ \tilde{W}_{\pi_1 \alpha} - (\tilde{W}_{\pi_1} / \tilde{W}_{\hat{\alpha}}) \tilde{W}_{\alpha \hat{\alpha}} \right\} \geq 0$ , which is satisfied for  $\phi' \{1 - (\alpha - \phi)/\alpha\} \geq 0$ , which is satisfied for  $0 \leq \phi \leq \alpha$ . This completes the proof of Lemma 1.

Equation (A2) can be solved by separating the variables and integrating to obtain the implicit function describing the separating strategy. A characterisation theorem in Mailath (1987), p.1353, plus an initial condition will allow us to select the relevant branch of the implicit function as the unique separating equilibrium strategy. In particular, set  $\phi = \alpha \cdot u$ , and after some algebra write equation (A2) in the following separable form:  $\frac{1-u}{1-(1-u)u} du = \frac{1}{\alpha} d\alpha$ . By integrating both members and by eliminating the auxiliary variable  $u$ , we get the following implicit solution:  $\frac{1}{\sqrt{3}} \text{Arc tan} \left( \frac{2u-1}{\sqrt{3}} \right) - \frac{1}{2} \log(1-u+u^2) = \log \alpha + k$ , where  $k$  represents the constant of integration which can be obtained by the initial value condition,  $\phi(A) = A$ . This solution is such that the relevant branch of the separating strategy is an increasing convex function such that,  $0 \leq \phi \leq \alpha$ ,  $\phi(A) = A$ , and  $1 \leq \phi' < \infty$ . Numerical simulations showing contourplots of the implicit function above by using Mathematica confirm the characterisation.

## Proof of lemma 2

Consider first out of equilibrium conjectures such that, observing any deviation from equilibrium strategy, private agents will set expectations for the second period to the inflation rate that would be selected by the worst possible type that the CB may incarnate in the support, i.e.  $\pi_2^e = A$ . In this case benefits from deviation will be given by  $W^d = \alpha^2 - \alpha(\bar{\alpha} + A)$ . Welfare from a pooling strategy will be given by  $W^p = (\alpha^2 - 2\alpha\bar{\alpha} - \bar{\alpha}^2)/2$ . Hence, deviation will be worthwhile for any type in the support if  $W^d > W^p$ , i.e.  $\alpha^2 - \alpha(\bar{\alpha} + A) > (\alpha^2 - 2\alpha\bar{\alpha} - \bar{\alpha}^2)/2$  which is satisfied if  $\alpha^2 - 2A\alpha + \bar{\alpha}^2 > 0$ , that is for values of  $\alpha$  outside the values of the two roots  $\alpha_i = A \mp \sqrt{A^2 - \bar{\alpha}^2}$ . This implies that deviation is worthwhile for  $\alpha \in [a, A - \sqrt{A^2 - \bar{\alpha}^2}]$ , on the other hand, pooling equilibrium will exist in the range  $\alpha \in [A - \sqrt{A^2 - \bar{\alpha}^2}, A]$ .

Consider now out of equilibrium beliefs defined by passive conjectures (no updating after deviation), to obtain welfare from deviation substitute  $\pi_1 = \alpha$  and  $\pi_2^e = \bar{\alpha}$  and obtain  $W^d = \alpha^2 - 2\alpha\bar{\alpha}$ , so that deviation is worthwhile if  $\alpha^2 - 2\alpha\bar{\alpha} > (\alpha^2 - 2\alpha\bar{\alpha} - \bar{\alpha}^2)/2$ , that is  $(\alpha - \bar{\alpha})^2 > 0$ , which is always satisfied.



## Proof of proposition 1

Given a pooling equilibrium, the optimality of  $\alpha^G = \alpha$  has been proved in the text.

Given a separating equilibrium a sufficient condition for  $\alpha^G = \alpha$  to be the optimal CB's type would be that (4) is a concave function in  $\alpha$ . However we will show that, though (4) is not globally concave in  $\alpha$ ,  $\alpha^G = \alpha$  is a global maximiser.

To show that (4) is not globally concave we compute  $W_{\alpha\alpha}^G = -(\phi')^2 + (\alpha^G - \phi)\phi'' - 1$  and use  $\phi' = \alpha/(\alpha - \phi)$ , and hence  $\phi'' = (\alpha\phi' - \phi)/(\alpha - \phi)^2$ . From the characterisation of  $\phi$  in Lemma 1, we know that it is a convex increasing function in  $\alpha$ , i.e.  $\phi''(\alpha) > 0$ .

Though (4) is not globally concave, we can show that for any  $\alpha^G < \alpha$  ( $\alpha^G > \alpha$ ),  $W^G$  is always increasing (decreasing). To this aim consider the inequality

$$W_{\alpha}^G = \phi\phi' + \alpha^G\phi' - \alpha > 0 \tag{A3}$$

substitute the definition of  $\phi'$  from (A2) and get:  $[-\alpha\phi + \alpha^G\alpha - \alpha(\alpha - \phi)]/(\alpha - \phi) > 0$ . In a separating equilibrium  $(\alpha - \phi) < 0$ , so condition (A3) will be equivalent to  $-\alpha\phi + \alpha^G\alpha - \alpha(\alpha - \phi) < 0$ , i.e. (A3) holds for  $\alpha < \alpha^G$ . By reverting inequality (A3) we immediately obtain that  $W^G$  is always decreasing for  $\alpha > \alpha^G$ . This proves the result.



1. Maria Cristina Marcuzzo [1985] "Yoan Violet Robinson (1903-1983)", pp. 134
2. Sergio Lugaresi [1986] "Le imposte nelle teorie del sovrappiù", pp. 26
3. Massimo D'Angelillo e Leonardo Paggi [1986] "PCI e socialdemocrazie europee. Quale riformismo?", pp. 158
4. Gian Paolo Caselli e Gabriele Pastrello [1986] "Un suggerimento hobsoniano su terziario ed occupazione: il caso degli Stati Uniti 1960/1983", pp. 52
5. Paolo Bosi e Paolo Silvestri [1986] "La distribuzione per aree disciplinari dei fondi destinati ai Dipartimenti, Istituti e Centri dell'Università di Modena: una proposta di riforma", pp. 25
6. Marco Lippi [1986] "Aggregations and Dynamic in One-Equation Econometric Models", pp. 64
7. Paolo Silvestri [1986] "Le tasse scolastiche e universitarie nella Legge Finanziaria 1986", pp. 41
8. Mario Forni [1986] "Storie familiari e storie di proprietà. Itinerari sociali nell'agricoltura italiana del dopoguerra", pp. 165
9. Sergio Paba [1986] "Gruppi strategici e concentrazione nell'industria europea degli elettrodomestici bianchi", pp. 56
10. Nerio Naldi [1986] "L'efficienza marginale del capitale nel breve periodo", pp. 54
11. Fernando Vianello [1986] "Labour Theory of Value", pp. 31
12. Piero Ganugi [1986] "Risparmio forzato e politica monetaria negli economisti italiani tra le due guerre", pp. 40
13. Maria Cristina Marcuzzo e Annalisa Rosselli [1986] "The Theory of the Gold Standard and Ricardo's Standard Comodity", pp. 30
14. Giovanni Solinas [1986] "Mercati del lavoro locali e carriere di lavoro giovanili", pp. 66
15. Giovanni Bonifati [1986] "Saggio dell'interesse e domanda effettiva. Osservazioni sul cap. 17 della General Theory", pp. 42
16. Marina Murat [1986] "Betwin old and new classical macroeconomics: notes on Lejonhufvud's notion of full information equilibrium", pp. 20
17. Sebastiano Brusco e Giovanni Solinas [1986] "Mobilità occupazionale e disoccupazione in Emilia Romagna", pp. 48
18. Mario Forni [1986] "Aggregazione ed esogeneità", pp. 13
19. Sergio Lugaresi [1987] "Redistribuzione del reddito, consumi e occupazione", pp. 17
20. Fiorenzo Sperotto [1987] "L'immagine neopopulista di mercato debole nel primo dibattito sovietico sulla pianificazione", pp. 34
21. M. Cecilia Guerra [1987] "Benefici tributari nel regime misto per i dividendi proposto dalla commissione Sarcinelli: una nota critica", pp. 9
22. Leonardo Paggi [1987] "Contemporary Europe and Modern America: Theories of Modernity in Comparative Perspective", pp. 38
23. Fernando Vianello [1987] "A Critique of Professor Goodwin's 'Critique of Sraffa'", pp. 12
24. Fernando Vianello [1987] "Effective Demand and the Rate of Profits. Some Thoughts on Marx, Kalecki and Sraffa", pp. 41
25. Anna Maria Sala [1987] "Banche e territorio. Approccio ad un tema geografico-economico", pp. 40
26. Enzo Mingione e Giovanni Mottura [1987] "Fattori di trasformazione e nuovi profili sociali nell'agricoltura italiana: qualche elemento di discussione", pp. 36
27. Giovanna Procacci [1988] "The State and Social Control in Italy During the First World War", pp. 18
28. Massimo Matteuzzi e Annamaria Simonazzi [1988] "Il debito pubblico", pp. 62
29. Maria Cristina Marcuzzo (a cura di) [1988] "Richard F. Kahn. A discipline of Keynes", pp. 118
30. Paolo Bosi [1988] "MICROMOD. Un modello dell'economia italiana per la didattica della politica fiscale", pp. 34
31. Paolo Bosi [1988] "Indicatori della politica fiscale. Una rassegna e un confronto con l'aiuto di MICROMOD", pp. 25
32. Giovanna Procacci [1988] "Protesta popolare e agitazioni operaie in Italia 1915-1918", pp. 45
33. Margherita Russo [1988] "Distretto Industriale e servizi. Uno studio dei trasporti nella produzione e nella vendita delle piastrelle", pp. 157
34. Margherita Russo [1988] "The effect of technical change on skill requirements: an empirical analysis", pp. 28
35. Carlo Grillenzoni [1988] "Identification, estimations of multivariate transfer functions", pp. 33
36. Nerio Naldi [1988] "Keynes' concept of capital", pp. 40
37. Andrea Ginzburg [1988] "locomotiva Italia?", pp. 30
38. Giovanni Mottura [1988] "La 'persistenza' secolare. Appunti su agricoltura contadina ed agricoltura familiare nelle società industriali", pp. 40
39. Giovanni Mottura [1988] "L'anticamera dell'esodo. I contadini italiani della 'restaurazione contrattuale' fascista alla riforma fondiaria", pp. 40
40. Leonardo Paggi [1988] "Americanismo e riformismo. La socialdemocrazia europea nell'economia mondiale aperta", pp. 120
41. Annamaria Simonazzi [1988] "Fenomeni di isteresi nella spiegazione degli alti tassi di interesse reale", pp. 44
42. Antonietta Bassetti [1989] "Analisi dell'andamento e della casualità della borsa valori", pp. 12
43. Giovanna Procacci [1989] "State coercion and worker solidarity in Italy (1915-1918): the moral and political content of social unrest", pp. 41
44. Carlo Alberto Magni [1989] "Reputazione e credibilità di una minaccia in un gioco bargaining", pp. 56
45. Giovanni Mottura [1989] "Agricoltura familiare e sistema agroalimentare in Italia", pp. 84
46. Mario Forni [1989] "Trend, Cycle and 'Fortuitous cancellation': a Note on a Paper by Nelson and Plosser", pp. 4
47. Paolo Bosi, Roberto Golinelli, Anna Stagni [1989] "Le origini del debito pubblico e il costo della stabilizzazione", pp. 26
48. Roberto Golinelli [1989] "Note sulla struttura e sull'impiego dei modelli macroeconomici", pp. 21
49. Marco Lippi [1989] "A Short Note on Cointegration and Aggregation", pp. 11
50. Gian Paolo Caselli e Gabriele Pastrello [1989] "The Linkage between Tertiary and Industrial Sector in the Italian Economy: 1951-1988. From an External Dependence to an International One", pp. 40
51. Gabriele Pastrello [1989] "Francois quesnay: dal Tableau Zig-zag al Tableau Formule: una ricostruzione", pp. 48
52. Paolo Silvestri [1989] "Il bilancio dello stato", pp. 34
53. Tim Mason [1990] "Tre seminari di storia sociale contemporanea", pp. 26
54. Michele Lalla [1990] "The Aggregate Escape Rate Analysed through the Queueing Model", pp. 23
55. Paolo Silvestri [1990] "Sull'autonomia finanziaria dell'università", pp. 11

56. Paola Bertolini, Enrico Giovannetti [1990] "Uno studio di 'filiera' nell'agroindustria. Il caso del Parmigiano Reggiano", pp. 164
57. Paolo Bosi, Roberto Golinelli, Anna Stagni [1990] "Effetti macroeconomici, settoriali e distributivi dell'armonizzazione dell'IVA", pp. 24
58. Michele Lalla [1990] "Modelling Employment Spells from Emilia Labour Force Data", pp. 18
59. Andrea Ginzburg [1990] "Politica Nazionale e commercio internazionale", pp. 22
60. Andrea Giommi [1990] "La probabilità individuale di risposta nel trattamento dei dati mancanti", pp. 13
61. Gian Paolo Caselli e Gabriele Pastrello [1990] "The service sector in planned economies. Past experiences and future perspectives", pp. 32
62. Giovanni Solinas [1990] "Competenze, grandi industrie e distretti industriali. Il caso Magneti Marelli", pp. 23
63. Andrea Ginzburg [1990] "Debito pubblico, teorie monetarie e tradizione civica nell'Inghilterra del Settecento", pp. 30
64. Mario Forni [1990] "Incertezza, informazione e mercati assicurativi: una rassegna", pp. 37
65. Mario Forni [1990] "Misspecification in Dynamic Models", pp. 19
66. Gian Paolo Caselli e Gabriele Pastrello [1990] "Service Sector Growth in CPE's: An Unsolved Dilemma", pp. 28
67. Paola Bertolini [1990] "La situazione agro-alimentare nei paesi ad economia avanzata", pp. 20
68. Paola Bertolini [1990] "Sistema agro-alimentare in Emilia Romagna ed occupazione", pp. 65
69. Enrico Giovannetti [1990] "Efficienza ed innovazione: il modello "fondi e flussi" applicato ad una filiera agro-industriale", pp. 38
70. Margherita Russo [1990] "Cambiamento tecnico e distretto industriale: una verifica empirica", pp. 115
71. Margherita Russo [1990] "Distretti industriali in teoria e in pratica: una raccolta di saggi", pp. 119
72. Paolo Silvestri [1990] "La Legge Finanziaria. Voce dell'enciclopedia Europea Garzanti", pp. 8
73. Rita Paltrinieri [1990] "La popolazione italiana: problemi di oggi e di domani", pp. 57
74. Enrico Giovannetti [1990] "Illusioni ottiche negli andamenti delle Grandezze distributive: la scala mobile e l'appiattimento delle retribuzioni in una ricerca", pp. 120
75. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez I", pp. 150
76. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez. II", pp. 145
78. Antonietta Bassetti e Costanza Torricelli [1990] "Una riqualificazione dell'approccio bargaining alla selezione di portafoglio", pp. 4
77. Antonietta Bassetti e Costanza Torricelli [1990] "Il portafoglio ottimo come soluzione di un gioco bargaining", pp. 15
79. Mario Forni [1990] "Una nota sull'errore di aggregazione", pp. 6
80. Francesca Bergamini [1991] "Alcune considerazioni sulle soluzioni di un gioco bargaining", pp. 21
81. Michele Grillo e Michele Polo [1991] "Political Exchange and the allocation of surplus: a Model of Two-party competition", pp. 34
82. Gian Paolo Caselli e Gabriele Pastrello [1991] "The 1990 Polish Recession: a Case of Truncated Multiplier Process", pp. 26
83. Gian Paolo Caselli e Gabriele Pastrello [1991] "Polish firms: Pricate Vices Pubblis Virtues", pp. 20
84. Sebastiano Brusco e Sergio Paba [1991] "Connessioni, competenze e capacità concorrenziale nell'industria della Sardegna", pp. 25
85. Claudio Grimaldi, Rony Hamoui, Nicola Rossi [1991] "Non Marketable assets and households' Portfolio Choice: a Case of Study of Italy", pp. 38
86. Giulio Righi, Massimo Baldini, Alessandra Brambilla [1991] "Le misure degli effetti redistributivi delle imposte indirette: confronto tra modelli alternativi", pp. 47
87. Roberto Fanfani, Luca Lanini [1991] "Innovazione e servizi nello sviluppo della meccanizzazione agricola in Italia", pp. 35
88. Antonella Caiumi e Roberto Golinelli [1992] "Stima e applicazioni di un sistema di domanda Almost Ideal per l'economia italiana", pp. 34
89. Maria Cristina Marcuzzo [1992] "La relazione salari-occupazione tra rigidità reali e rigidità nominali", pp. 30
90. Mario Biagioli [1992] "Employee financial participation in enterprise results in Italy", pp. 50
91. Mario Biagioli [1992] "Wage structure, relative prices and international competitiveness", pp. 50
92. Paolo Silvestri e Giovanni Solinas [1993] "Abbandoni, esiti e carriera scolastica. Uno studio sugli studenti iscritti alla Facoltà di Economia e Commercio dell'Università di Modena nell'anno accademico 1990/1991", pp. 30
93. Gian Paolo Caselli e Luca Martinelli [1993] "Italian GPN growth 1890-1992: a unit root or segmented trend representatin?", pp. 30
94. Angela Politi [1993] "La rivoluzione fraintesa. I partigiani emiliani tra liberazione e guerra fredda, 1945-1955", pp. 55
95. Alberto Rinaldi [1993] "Lo sviluppo dell'industria metalmeccanica in provincia di Modena: 1945-1990", pp. 70
96. Paolo Emilio Mistrulli [1993] "Debito pubblico, intermediari finanziari e tassi d'interesse: il caso italiano", pp. 30
97. Barbara Pistoresi [1993] "Modelling disaggregate and aggregate labour demand equations. Cointegration analysis of a labour demand function for the Main Sectors of the Italian Economy: 1950-1990", pp. 45
98. Giovanni Bonifati [1993] "Progresso tecnico e accumulazione di conoscenza nella teoria neoclassica della crescita endogena. Una analisi critica del modello di Romer", pp. 50
99. Marcello D'Amato e Barbara Pistoresi [1994] "The relationship(s) among Wages, Prices, Unemployment and Productivity in Italy", pp. 30
100. Mario Forni [1994] "Consumption Volatility and Income Persistence in the Permanent Income Model", pp. 30
101. Barbara Pistoresi [1994] "Using a VECM to characterise the relative importance of permanent and transitory components", pp. 28
102. Gian Paolo Caselli and Gabriele Pastrello [1994] "Polish recovery form the slump to an old dilemma", pp. 20
103. Sergio Paba [1994] "Imprese visibili, accesso al mercato e organizzazione della produzione", pp. 20
104. Giovanni Bonifati [1994] "Progresso tecnico, investimenti e capacità produttiva", pp. 30
105. Giuseppe Marotta [1994] "Credit view and trade credit: evidence from Italy", pp. 20
106. Margherita Russo [1994] "Unit of investigation for local economic development policies", pp. 25
107. Luigi Brighi [1995] "Monotonicity and the demand theory of the weak axioms", pp. 20
108. Mario Forni e Lucrezia Reichlin [1995] "Modelling the impact of technological change across sectors and over time in manufacturing", pp. 25
109. Marcello D'Amato and Barbara Pistoresi [1995] "Modelling wage growth dynamics in Italy: 1960-1990", pp. 38
110. Massimo Baldini [1995] "INDIMOD. Un modello di microsimulazione per lo studio delle imposte indirette", pp. 37

111. Paolo Bosi [1995] "Regionalismo fiscale e autonomia tributaria: l'emersione di un modello di consenso", pp. 38
112. Massimo Baldini [1995] "Aggregation Factors and Aggregation Bias in Consumer Demand", pp. 33
113. Costanza Torricelli [1995] "The information in the term structure of interest rates. Can stochastic models help in resolving the puzzle?" pp. 25
114. Margherita Russo [1995] "Industrial complex, pôle de développement, distretto industriale. Alcune questioni sulle unità di indagine nell'analisi dello sviluppo." pp. 45
115. Angelika Moryson [1995] "50 Jahre Deutschland. 1945 - 1995" pp. 21
116. Paolo Bosi [1995] "Un punto di vista macroeconomico sulle caratteristiche di lungo periodo del nuovo sistema pensionistico italiano." pp. 32
117. Gian Paolo Caselli e Salvatore Curatolo [1995] "Esistono relazioni stimabili fra dimensione ed efficienza delle istituzioni e crescita produttiva? Un esercizio nello spirito di D.C. North." pp. 11
118. Mario Forni e Marco Lippi [1995] "Permanent income, heterogeneity and the error correction mechanism." pp. 21
119. Barbara Pistoresi [1995] "Co-movements and convergence in international output. A Dynamic Principal Components Analysis" pp. 14
120. Mario Forni e Lucrezia Reichlin [1995] "Dynamic common factors in large cross-section" pp. 17
121. Giuseppe Marotta [1995] "Il credito commerciale in Italia: una nota su alcuni aspetti strutturali e sulle implicazioni di politica monetaria" pp. 20
122. Giovanni Bonifati [1995] "Progresso tecnico, concorrenza e decisioni di investimento: una analisi delle determinanti di lungo periodo degli investimenti" pp. 25
123. Giovanni Bonifati [1995] "Cambiamento tecnico e crescita endogena: una valutazione critica delle ipotesi del modello di Romer" pp. 21
124. Barbara Pistoresi e Marcello D'Amato [1995] "La riservatezza del banchiere centrale è un bene o un male? Effetti dell'informazione incompleta sul benessere in un modello di politica monetaria." pp. 32
125. Barbara Pistoresi [1995] "Radici unitarie e persistenza: l'analisi univariata delle fluttuazioni economiche." pp. 33
126. Barbara Pistoresi e Marcello D'Amato [1995] "Co-movements in European real outputs" pp. 20
127. Antonio Ribba [1996] "Ciclo economico, modello lineare-stocastico, forma dello spettro delle variabili macroeconomiche" pp. 31
128. Carlo Alberto Magni [1996] "Repeatable and una tantum real options a dynamic programming approach" pp. 23
129. Carlo Alberto Magni [1996] "Opzioni reali d'investimento e interazione competitiva: programmazione dinamica stocastica in optimal stopping" pp. 26
130. Carlo Alberto Magni [1996] "Vaghezza e logica fuzzy nella valutazione di un'opzione reale" pp. 20
131. Giuseppe Marotta [1996] "Does trade credit redistribution thwart monetary policy? Evidence from Italy" pp. 20
132. Mauro Dell'Amico e Marco Trubian [1996] "Almost-optimal solution of large weighted equicut problems" pp. 30
133. Carlo Alberto Magni [1996] "Un esempio di investimento industriale con interazione competitiva e avversione al rischio" pp. 20
134. Margherita Russo, Peter Börkey, Emilio Cubel, François Lévêque, Francisco Mas [1996] "Local sustainability and competitiveness: the case of the ceramic tile industry" pp. 66
135. Margherita Russo [1996] "Camionetto tecnico e relazioni tra imprese" pp. 190
136. David Avra Lane, Irene Poli, Michele Lalla, Alberto Roverato [1996] "Lezioni di probabilità e inferenza statistica" pp. 288
137. David Avra Lane, Irene Poli, Michele Lalla, Alberto Roverato [1996] "Lezioni di probabilità e inferenza statistica - Esercizi svolti -" pp. 302
138. Barbara Pistoresi [1996] "Is an Aggregate Error Correction Model Representative of Disaggregate Behaviours? An example" pp. 24
139. Luisa Malaguti e Costanza Torricelli [1996] "Monetary policy and the term structure of interest rates", pp. 30
140. Mauro Dell'Amico, Martine Labbé, Francesco Maffioli [1996] "Exact solution of the SONET Ring Loading Problem", pp. 20
141. Mauro Dell'Amico, R.J.M. Vaessens [1996] "Flow and open shop scheduling on two machines with transportation times and machine-independent processing times in NP-hard", pp. 10
142. M. Dell'Amico, F. Maffioli, A. Sciomechen [1996] "A Lagrangean Heuristic for the Pirze Collecting Travelling Salesman Problem", pp. 14
143. Massimo Baldini [1996] "Inequality Decomposition by Income Source in Italy - 1987 - 1993", pp. 20
144. Graziella Bertocchi [1996] "Trade, Wages, and the Persistence of Underdevelopment" pp. 20
145. Graziella Bertocchi and Fabio Canova [1996] "Did Colonization matter for Growth? An Empirical Exploration into the Historical Causes of Africa's Underdevelopment" pp. 32
146. Paola Bertolini [1996] "La modernization de l'agriculture italienne et le cas de l'Emilie Romagne" pp. 20
147. Enrico Giovannetti [1996] "Organisation industrielle et développement local: le cas de l'agroindutrie in Emilie Romagne" pp. 18
148. Maria Elena Bontempi e Roberto Golinelli [1996] "Le determinanti del leverage delle imprese: una applicazione empirica ai settori industriali dell'economia italiana" pp. 31
149. Paola Bertolini [1996] "L'agriculture et la politique agricole italienne face aux recents scenarios", pp. 20
150. Enrico Giovannetti [1996] "Il grado di utilizzo della capacità produttiva come misura dei costi di transazione: una rilettura di 'Nature of the Firm' di R. Coase", pp. 75
151. Enrico Giovannetti [1996] "Il I° ciclo del Diploma Universitario Economia e Amministrazione delle Imprese", pp. 25
152. Paola Bertolini, Enrico Giovannetti, Giulia Santacaterina [1996] "Il Settore del Verde Pubblico. Analisi della domanda e valutazione economica dei benefici", pp. 35
153. Giovanni Solinas [1996] "Sistemi produttivi del Centro-Nord e del Mezzogiorno. L'industria delle calzature", pp. 55
154. Tindara Addabbo [1996] "Married Women's Labour Supply in Italy in a Regional Perspective", pp. 85
155. Paolo Silvestri, Giuseppe Catalano, Cristina Bevilacqua [1996] "Le tasse universitarie e gli interventi per il diritto allo studio: la prima fase di applicazione di una nuova normativa" pp. 159
156. Sebastiano Brusco, Paolo Bertossi, Margherita Russo [1996] "L'industria dei rifiuti urbani in Italia", pp. 25
157. Paolo Silvestri, Giuseppe Catalano [1996] "Le risorse del sistema universitario italiano: finanziamento e governo" pp. 400
158. Carlo Alberto Magni [1996] "Un semplice modello di opzione di differimento e di vendita in ambito discreto", pp. 10
159. Tito Pietra, Paolo Siconolfi [1996] "Fully Revealing Equilibria in Sequential Economies with Asset Markets" pp. 17
160. Tito Pietra, Paolo Siconolfi [1996] "Extrinsic Uncertainty and the Informational Role of Prices" pp. 42
161. Paolo Bertella Farnetti [1996] "Il negro e il rosso. Un precedente non esplorato dell'integrazione afroamericana negli Stati Uniti" pp. 26
162. David Lane [1996] "Is what is good for each best for all? Learning from others in the information contagion model" pp. 18

163. Antonio Ribba [1996] "A note on the equivalence of long-run and short-run identifying restrictions in cointegrated systems" pp. 10
164. Antonio Ribba [1996] "Scomposizioni permanenti-transitorie in sistemi cointegrati con una applicazione a dati italiani" pp. 23
165. Mario Forni, Sergio Paba [1996] "Economic Growth, Social Cohesion and Crime" pp. 20
166. Mario Forni, Lucrezia Reichlin [1996] "Let's get real: a factor analytical approach to disaggregated business cycle dynamics" pp. 25
167. Marcello D'Amato e Barbara Pistoiesi [1996] "So many Italies: Statistical Evidence on Regional Cohesion" pp. 31
168. Elena Bonfiglioli, Paolo Bosi, Stefano Toso [1996] "L'equità del contributo straordinario per l'Europa" pp. 20
169. Graziella Bertocchi, Michael Spagat [1996] "Il ruolo dei licei e delle scuole tecnico-professionali tra progresso tecnologico, conflitto sociale e sviluppo economico" pp. 37
170. Gianna Boero, Costanza Torricelli [1997] "The Expectations Hypothesis of the Term Structure of Interest Rates: Evidence for Germany" pp. 15
171. Mario Forni, Lucrezia Reichlin [1997] "National Policies and Local Economies: Europe and the US" pp. 22
172. Carlo Alberto Magni [1997] "La trappola del Roe e la tridimensionalità del Van in un approccio sistemico", pp. 16
173. Mauro Dell'Amico [1997] "A Linear Time Algorithm for Scheduling Outforests with Communication Delays on Two or Three Processor" pp. 18
174. Paolo Bosi [1997] "Aumentare l'età pensionabile fa diminuire la spesa pensionistica? Ancora sulle caratteristiche di lungo periodo della riforma Dini" pp. 13
175. Paolo Bosi e Massimo Matteuzzi [1997] "Nuovi strumenti per l'assistenza sociale" pp. 31
176. Mauro Dell'Amico, Francesco Maffioli e Marco Trubian [1997] "New bounds for optimum traffic assignment in satellite communication" pp. 21
177. Carlo Alberto Magni [1997] "Paradossi, inverosimiglianze e contraddizioni del Van: operazioni certe" pp. 9
178. Barbara Pistoiesi e Marcello D'Amato [1997] "Persistence of relative unemployment rates across Italian regions" pp. 25
179. Margherita Russo, Franco Cavedoni e Riccardo Pianesani [1997] "Le spese ambientali dei Comuni in provincia di Modena, 1993-1995" pp. 23
180. Gabriele Pastrello [1997] "Time and Equilibrium. Two Elusive Guests in the Keynes-Hawtrey-Robertson Debate in the Thirties" pp. 25
181. Luisa Malaguti e Costanza Torricelli [1997] "The Interaction Between Monetary Policy and the Expectation Hypothesis of the Term Structure of Interest rates in a N-Period Rational Expectation Model" pp. 27
182. Mauro Dell'Amico [1997] "On the Continuous Relaxation of Packing Problems - Technical Note" pp. 8
183. Stefano Bordini [1997] "Prova di Idoneità di Informatica Dispensa Esercizi Excel 5" pp. 49
184. Francesca Bergamini e Stefano Bordini [1997] "Una verifica empirica di un nuovo metodo di selezione ottima di portafoglio" pp. 22
185. Gian Paolo Caselli e Maurizio Battini [1997] "Following the tracks of atkinson and micklewright the changing distribution of income and earnings in Poland from 1989 to 1995" pp. 21
186. Mauro Dell'Amico e Francesco Maffioli [1997] "Combining Linear and Non-Linear Objectives in Spanning Tree Problems" pp. 21
187. Gianni Ricci e Vanessa Debba [1997] "Una soluzione evolutiva in un gioco differenziale di lotta di classe" pp. 14
188. Fabio Canova e Eva Ortega [1997] "Testing Calibrated General Equilibrium Model" pp. 34
189. Fabio Canova [1997] "Does Detrending Matter for the Determination of the Reference Cycle and the Selection of Turning Points?" pp. 35
190. Fabio Canova e Gianni De Nicolò [1997] "The Equity Premium and the Risk Free Rate: A Cross Country, Cross Maturity Examination" pp. 41
191. Fabio Canova e Angel J. Ubide [1997] "International Business Cycles, Financial Market and Household Production" pp. 32
192. Fabio Canova e Gianni De Nicolò [1997] "Stock Returns, Term Structure, Inflation and Real Activity: An International Perspective" pp. 33
193. Fabio Canova e Morten Ravn [1997] "The Macroeconomic Effects of German Unification: Real Adjustments and the Welfare State" pp. 34
194. Fabio Canova [1997] "Detrending and Business Cycle Facts" pp. 40
195. Fabio Canova e Morten O. Ravn [1997] "Crossing the Rio Grande: Migrations, Business Cycle and the Welfare State" pp. 37
196. Fabio Canova e Jane Murrain [1997] "Sources and Propagation of International Output Cycles: Common Shocks or Transmission?" pp. 41
197. Fabio Canova e Albert Marcet [1997] "The Poor Stay Poor: Non-Convergence Across Countries and Regions" pp. 44
198. Carlo Alberto Magni [1997] "Un Criterio Strutturalista per la Valutazione di Investimenti" pp. 17
199. Stefano Bordini [1997] "Elaborazione Automatica dei Dati" pp. 60
200. Paolo Bertella Farnetti [1997] "The United States and the Origins of European Integration" pp. 19
201. Paolo Bosi [1997] "Sul Controllo Dinamico di un Sistema Pensionistico a Ripartizione di Tipo Contributivo" pp. 17
202. Paola Bertolini [1997] "European Union Agricultural Policy: Problems and Perspectives" pp. 18
203. Stefano Bordini [1997] "Supporti Informatici per la Ricerca delle soluzioni di Problemi Decisionali" pp. 30
204. Carlo Alberto Magni [1997] "Paradossi, Inverosimiglianze e Contraddizioni del Van: Operazioni Aleatorie" pp. 10
205. Carlo Alberto Magni [1997] "Tir, Roe e Van: Distorsioni linguistiche e Cognitive nella Valutazione degli Investimenti" pp. 17
206. Gisella Facchinetti, Roberto Ghiselli Ricci e Silvia Muzzioli [1997] "New Methods For Ranking Triangular Fuzzy Numbers: An Investment Choice" pp. 9
207. Mauro Dell'Amico e Silvano Martello [1997] "Reduction of the Three-Partition Problem" pp. 16
208. Carlo Alberto Magni [1997] "IRR, ROE and NPV: a Systemic Approach" pp. 20
209. Mauro Dell'Amico, Andrea Lodi e Francesco Maffioli [1997] "Solution of the cumulative assignment problem with a well-structured tabu search method" pp. 25
210. Carlo Alberto Magni [1997] "La definizione di investimento e criterio del Tir ovvero: la realtà inventata" pp. 16
211. Carlo Alberto Magni [1997] "Critica alla definizione classica di investimento: un approccio sistemico" pp. 17
212. Alberto Roverato [1997] "Asymptotic prior to posterior analysis for graphical gaussian models" pp. 8
213. Tindara Addabbo [1997] "Povertà nel 1995 analisi statica e dinamica sui redditi familiari" pp. 64
214. Gian Paolo Caselli e Franca Manghi [1997] "La transizione da piano a mercato e il modello di Ising" pp. 15
215. Tindara Addabbo [1998] "Lavoro non pagato e reddito esteso: un'applicazione alle famiglie italiane in cui entrambi i coniugi sono lavoratori dipendenti" pp. 54

216. Tindara Addabbo [1998] "Probabilità di occupazione e aspettative individuali" pp 36
217. Lara Magnani [1998] "Transazioni, contratti e organizzazioni: una chiave di lettura della teoria economica dell'organizzazione pp 39
218. Michele Lalla, Rosella Molinari e Maria Grazia Modena [1998] "La progressione delle carriere: i percorsi in cardiologia" pp 46
219. Lara Magnani [1998] "L'organizzazione delle transazioni di subfornitura nel distretto industriale" pp 40
220. Antonio Ribba [1998] "Recursive VAR orderings and identification of permanent and transitory shocks" pp12
221. Antonio Ribba [1998] "Granger-causality and exogeneity in cointegrated Var models" pp 5
222. Luigi Brighi e Marcello D'Amato [1998] "Optimal Procurement in Multiproduct Monopoly" pp 25
223. Paolo Bosi, Maria Cecilia Guerra e Paolo Silvestri [1998] "La spesa sociale nel comune Modena" Rapporto intermedio pp 37
224. Mario Forni e Marco Lippi [1998] "On the Microfoundations of Dynamic Macroeconomics" pp22
225. Roberto Ghiselli Ricci [1998] "Nuove Proposte di Ordinamento di Numeri Fuzzy. Una Applicazione ad un Problema di Finanziamento pp 7
226. Tommaso Minerva [1998] "Internet Domande e Risposte" pp 183
227. Tommaso Minerva [1998] "Elementi di Statistica Computazione. Parte Prima: Il Sistema Operativo Unix ed il Linguaggio C" pp. 57
228. Tommaso Minerva and Irene Poli [1998] "A Genetic Algorithms Selection Method for Predictive Neural Nets and Linear Models" pp. 60
229. Tommaso Minerva and Irene Poli [1998] "Building an ARMA Model by using a Genetic Algorithm" pp. 60
230. Mauro Dell'Amico e Paolo Toth [1998] "Algorithms and Codes for Dense Assignment Problems: the State of the Art "pp 35
231. Ennio Cavazzuti e Nicoletta Pacchiarotti [1998] How to play an hotelling game in a square town pp 12
232. Alberto Roverato e Irene Poli [1998] Un algoritmo genetico per la selezione di modelli grafici pp 11

