Bankers' versus Workers' Europe (I): Asymmetric Information in EMU

Laura Bottazzi[1]
Università Bocconi, IGIER and CEPR

Paolo Manasse[2]
Università degli Studi di Milano and IGIER

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[1]authors' address: IGIER, via Salasco3/5,20136 Milano

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Abstract

The delegation of monetary policy to a supranational central bank creates a *conflict of interest* between residents of different countries. For example, the country in recession may favor more inflation to boost output, while the country in boom prefers exactly the opposite.This conflict gives rise to an *adverse selection* problem. Provided each government has private information about the current state of the economy, it may try to exploit it in order to shift the common monetary policy to his own preferred way. The paper shows that problems of this kind can generate both *an inflation and primary deficit bias* (in line with the worries of Workers' Europe addressed by the "stability pact") as well as *an excess monetary discipline and recession bias* (in line with the worries addressed by the Bankers' Europe concern).When information problems are particularly severe, monetary and fiscal policy becomes relatively insensitive to business cycle conditions, and *too little "smoothing"* is done over the business cycle.

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1 Introduction

As European countries are getting ready for the introduction of the Single Currency in January 1999, doubts and concerns about the new institutional framework are rapidly growing. On the one hand, there is an increasing apprehension that inflation and monetary turmoil may be back in Europe under the pressure of deficit-prone countries (Workers' Europe). On the other hand, worsening unemployment rate strengthens the concern about further tightening of fiscal and monetary policy (Bankers' Europe). The recent French-German disputes over the so-called "stability (and growth) pact", and over the presidency of the European Central Bank (ECB), are an obvious illustration of these tensions.

Is there a rationale for such concerns? Is price stability or employment at risk in the new monetary regime? The paper addresses these questions.

In this paper we think of a monetary union in terms of an allocation of powers, whereby monetary policy is delegated to a single Central Bank while fiscal policy is managed at national level. We study one consequence[1] of this institutional set-up, namely the fact that the delegation of monetary policy to a supra-national body, giving rise to a conflict of interest among partecipating countries, may raise the *incentive to manipulate information* by national policy-makers[2].

Even when the central bank and the government within a country share the same information about the state of the economy, we often observe that the government over-emphasizes the need for laxer monetary policy and lower interest rates. This is often justified by rosy assessments of current inflation prospects and optimistic projections of public imbalances. There are many examples of this "figure massaging".

In the early 80's, British labor economists have been bewildered by the ever-changing definition of unemployment. According to P. Greg (1994),

"..Charges made against the count method of estimating unemployment have concerned allegations about politically inspired manipulation of the figures through numerous changes in coverage during the 1980s.The supporting evidence for these changes is that all but one of these changes have been

[1] In a companion paper (Bottazzi and Manasse (1997)), we analyze the implications of the EMU for the strategic interaction among policy-makers.

[2] We do not consider the other important dimension of institutional change, namely the political equilibrium aspect of integration, as we feel that this is already well understood (cf Persson and Tabellini (1994))

unidirectional-downwards. Critics have expressed a view that calculating unemployment on the old (pre-1982) coverage would result in a considerably higher total figure.."[3]

Another example occurred in Britain in early 1993, when mortgage rates were eliminated from the CPI. The conventional wisdom was that the purpose of the change was to prevent inflation from shooting up whenever interest rates were raised. In a recent paper, Giavazzi (1993) presents a number of examples where the Italian government used its discretion in the formation of the state budget, in order to influence the distribution of the deficit over time[4]. More recently, many "creative" accounting procedures were introduced in 1997 by European governments in order to comply with the 3% Maastricht criterion for the deficit/GDP ratio. These exercises in "window-dressing" include the (successful) case of France Telecom pension funds, the German (attempted) sale of the Bundesbank's gold reserves to the treasury, and a similar case in Belgium and Italy, where the government has tried to deduct from its deficit the proceeds from a capital gain tax on a gold transaction between two other public bodies, the Italian Exchange Bureau (UIC) and the Bank of Italy.

Clearly, some of these episodes were motivated by political (electoral) reasons. In the paper we argue that *economic* incentives to manipulate information may be seriously enhanced by a monetary union. In particular, asymmetric information may seriously undermine the working of the European Monetary Union (EMU), when the following conditions occur:

a) domestic *shocks* to output in the member countries are *idiosyncratic*,

[3] According to Moore (1997)

"*...in the 1970s, the figure for unemployment broadly relate to those receiving unemployment benefits, plus those who did not receive benefits but registered themselves regularly for possible work. Increasingly during the early 1980's the latter group was excluded from the count and the former group was tightened up. For examples, in 1981, some 195000 individuals were struck off the count by the removal of those in training or in temporary work; in 1982, a further 216000 individuals were struck off when benefit claimants only were included in the figures; in 1983, some 107000 men who were over 60 years of age, not working and not entitled to benefits or credits, were similarly struck off the count. An important consequence of these and other changes was the unease expressed by the general public about what the published figures actually meant and how the changes, which occurred both up or down, could be effectively assessed*"

[4] By imputing interest payments due by local governments to capital, rather than current, expenditures, the government was able to shift the burden of the public sector deficit to the following fiscal years.

and *serially uncorrelated;*

b) there are *lags* in the availability of information, so that monetary policy must be run on a day-by-day basis, relying (at least temporarily) on whatever information is available, and

c) the relevant statistical information are collected by national public agencies .

As to point a), a large body of empirical literature confirms that, both at aggregate (Bini Smaghi and Vori (1993)) and disaggregate (Helg, Manasse, Monacelli and Rovelli , (1995)), levels, at least 60% of GDP (or industrial output) volatility in Europe is explained by asymmetric shocks (i.e. country-specific as opposed industry-specific shocks). For informational asymmetry to play a role, it must also be the case that shocks to output are independently distributed, and cannot be inferred by past history[5].

As to point b) it is well known that many macroeconomic statistics, such as GDP or employment, only become available on a quarterly basis, so that "leading indicators" are often employed to judge the current state of the economy. Preliminary estimates for these variables often exhibit remarkable differences from final figures[6], thus allowing a scope for "favorable" forecasts.

Although Eurostat is responsible for implementing the European standard for national accounts (Sec) across the EC, the *primary* source of this information is (and will continue to be) national statistical agencies. Even in EMU, national official agencies will crucially continue to be responsible for gathering and compiling data on output, industrial production, prices etc. This means that, for example, in the case of a "sudden fall" in activity (required by the Stability and Growth pact for exempting a country from complying with the 3% deficit/output ceiling), the information for judging "how deep and sudden" the recession is, will be provided by the country invoking the exemption.

The idea of the paper is as follows. With a national central bank in each country, monetary and fiscal policy are optimally used for tax smoothing purposes. Here, the government *has no incentive* to hide any information to the central bank, since the national policy-makers share the same goals. The optimal policy is to raise inflation and lower income taxes in a recession and,

[5] >From the long standing debate on unit-roots in GDP, see Stock and Watson(1988), we take it that the consensus view is that most GDP series exhibit a high degree of persistence , with roots that are either one or very close to one.

[6] International forecasters, like the OECD, routinely carry out exercises (so called "post-mortem"s) in order to account for deviations between forecast and realisations.

conversely, lower inflation and raise income taxes in a boom. In a monetary union, however, the ECB must consider "aggregate", domestic and foreign, welfare when choosing the common inflation rate. This creates a *conflict of interest* between residents of participating countries, whenever shocks are *asymmetric*. The country in recession might favor more inflation to boost output, while the country in boom might prefer exactly the opposite. In turn, such conflict gives rise to an *adverse selection* problem. Provided each government has private information about the state of the domestic economy, it may try to exploit it in order to shift the common monetary policy to his own preferred way. For example, in a recession, the domestic government would like to reduce income tax rates and run a larger primary deficit, and thus may try to convince the ECB that his economic situation is indeed worse than actually is. This would get him more inflation, more seignorage, and would allow him to lower the income tax rate, with beneficial effects for output and consumption. The paper shows that problems of this kind can generate both *an inflation and primary deficit bias* (in line with the worries of Workers' Europe addressed by the "stability" part of the "stability and growth pact") as well as *an excess monetary discipline and recession bias* (in line with the worries of a Bankers' Europe, addressed by the "growth" part of the pact). Moreover, when information problems are particularly severe, monetary policy in EMU becomes relatively insensitive to business cycle conditions, so that *too little "smoothing"* is done by the ECB in equilibrium.

The paper builds upon Bordignon, Manasse and Tabellini (BMT) (1996), who study inter-regional redistribution under asymmetric information. In this paper we look at EMU from a public economics perspective. A multi-currency regime corresponds to a "federalist" allocation of taxing rights, where *all* tax bases are devoluted to local authorities. A monetary union, conversely, corresponds to a situation in which the federal government (the ECB) advocates the right to tax one base (money) in all the federation, by imposing a common tax rate (inflation). Revenue (seignorage) is then redistributed to local governments, which keep their entitlement to the other base (labor income) and finance the provision of local public goods.

The paper can be read from a normative point of view. National governments design a state-contingent contract, laying out the rate of inflation that must be attained by the ECB governor in each state of nature. The point of the paper is understanding how asymmetric information on each country's state affects the optimal contract.

Above the "standard" inefficiency of a single currency in the presence of

asymmetric shocks, we show that there are other welfare cost associated with EMU which are typically ignored by the standard literature. These are due to the attempts of member governments to misreport information to the ECB, in order to affect her policy.

This is a general conclusion. In the model this occurs because seignorage is an alternative source of revenue for member countries. The same logic would apply to different models, for example , if we let the ECB choose the interest rate (instead of the rate of inflation), and governments were motivated by the desire to affect their interest payments on the national debt (rather then the revenue from seignorage). Adapting the previous example, a country may wish to depict his economic situation worse that actually is in order to induce the ECB to choose a lower interest rate (rather than a higher rate of money growth) so as to allow him to cut interest payments on the debt (rather than for obtaining extra revenue from seignorage) and reduce the burden of income taxes. The same qualitative results would apply.

The plan of the paper is the following. Section 1 presents the model. Section 2 considers the benchmark case of full-information in order to compare two regimes. In the first, each country maintains monetary independence (so that two central banks set the domestic rate of inflation independently). The second is a Monetary Union, as defined in the previous paragraph. With full information, the ECB directly observes the state of the two economies. In Section 3 we extend the set-up to asymmetric information, where only national authorities observe the state of the domestic economy, and the ECB must rely on the information supplied by each country.

2 The Model

The world consists of two countries. Each country (domestic and foreign) is populated by a representative infinitely lived agent. Both economies produce only one homogeneous good with only one production factor, labor l, which is immobile.[7]. For the sake of simplicity, technology is assumed to be linear. Households supply labor, spend part of their disposable income on consumption (c), and save the rest by accumulating real money balances (m). There is neither capital nor bonds in the economy, but there exist two distinct national currencies, each held exclusively by residents. Governments

[7]Since only one good is produced, trade plays no role in the model. We discuss trade and real exchange rate spillover effects in EMU in Bottazzi, Manasse (1997).

finance public goods g, by levying distortionary taxes on labor income and by seignorage. For simplicity, we focus on the domestic country.

2.1 Households

Preferences are described by an additively separable utility function, where separability is assumed both with respect to time and with respect to the arguments. Consumers choose the sequence $\{c_t, m_{t+1},\ x_t\}_v^\infty$ so as to maximize the expected present discounted value of their utility stream[8]

$$E_v \sum_{t=v}^{\infty} \rho^{t-v} \mathcal{U}(c_t, m_{t+1,} x_t, g_t) = E_v \sum_{t=v}^{\infty} \rho^{t-v} (U(c_t) + W(m_{t+1}) + V(x_t) + H(g_t)\ ) \tag{1}$$

where $0 < \rho < 1$ denotes the rate of time preference, m_{t+1} is the stock of domestic balances carried over from time t to time $t+1$, expressed in units of time $t+1$ goods[9], x_t represents leisure time, and U, V, W and H are quasi-concave functions. The effective time endowment is subject to (productivity) shocks, e_t.The real wage is equal to one, given the assumption of linear technology. Consumers spend their labor income in consumption goods, pay an income tax and an inflation tax on the stock of money balances, and save by adding to their money holdings:

$$m_{t+1}(1+\pi_t) = m_t + (1-\tau_t)l_t - c_t \tag{2}$$

$$l_t + x_t = 1 + e_t \tag{3}$$

where π_t is the domestic rate of inflation between t and $t+1$, τ_t is the labor income tax rate, and e_t is a zero mean *i.i.d.* disturbance, and can take only three different realizations , $\varepsilon^+ > 0, \varepsilon^- = -\varepsilon^+ \text{and}\, 0$, with equal probability:

$$e_t = \begin{cases} \varepsilon^+ > 0\ w.p\ \frac{1}{3} \\ 0\ \ w.p\ \ \frac{1}{3} \\ \varepsilon^- = -\varepsilon^+\ w.p\ \frac{1}{3} \end{cases} \tag{4}$$

[8] Since we need to justify why individuals hold real money balances, we need a model of intertemporal choice.

[9] An alternative approach would be to assume that money economizes on transaction costs. In this case real balances enter the budget constraint rather than the utility function. Under certain regularity conditions the two approaches are equivalent. See Feenstra (1986)

Solving the utility maximization program subject to the constraints (2) and (3), the first order conditions are given by:

$$\begin{aligned} U_{c_t} &= \lambda_t && (5)\\ V_{x_t} &= (1-\tau_t)\lambda_t && (6)\\ E_t W_{m_{t+1}} &= \lambda_t(1+\pi_t) - \rho E_t \lambda_{t+1} && (7)\\ \lim_{T\to\infty} E_t \prod_{s=0}^{T} m_{t+T+1}(1+\pi_{t+s}\ ) &= 0 && (8) \end{aligned}$$

where λ_t is the multiplier on the constraint (2). A subscript below a function denotes a derivative.

The first and the second conditions imply that at each point in time the marginal rate of substitution between consumption and leisure must equal the real disposable wage rate from (5) and (6). Equation (7) is a standard arbitrage condition that ensures that no gains can be made by re-allocating consumption in time. Finally, (8) rules out Ponzi games.

>From these expressions we can solve for c_t and l_t in terms of λ_t,

$$\begin{aligned} c_t &= C(\bar{\lambda}_t) && (9)\\ l_t &= L(\bar{\tau}_t, \overline{\lambda}_t, \overset{+}{e}_t) && (10) \end{aligned}$$

where the sign above a variable denotes the sign of the derivative with respect to that variable. The multiplier λ_t denotes the marginal value of money. When λ_t falls the demand for goods and leisure rises, so that the supply of labor declines. In the same way, an increase in the tax rate reduces net earnings and lowers labor supply.

2.2 Government

The government provides public goods and levies taxes on labor income and real balances:

$$g_t = \tau_t l_t + \mu_t m_t \qquad (11)$$

where μ_t is the rate of growth of nominal domestic money between $t+1$ and t.

2.3 Equilibrium

The equilibrium in the goods market requires in each period the equality between supply and demand of home goods (by the government and by domestic households) :

$$C(\lambda_t) + g_t = L(\tau_t, \lambda_t, e_t) \tag{12}$$

2.4 Solution

We now assume that utility is linear in consumption so that two simplifications are gained. First, the marginal utility of money is constant over time, $\lambda_t = 1$ *all* t, so that equation (7) yields the demand for real balances $m_{t+1} = M(\pi_t)$[10]. More importantly, the condition for leisure simplifies to the labor supply function

$$l_t = L(\tau_t) + e_t \quad , \quad L_\tau = 1/V_{xx} < 0 \tag{13}$$

Hence, we can interpret a high (low) realization of e_t as a positive (negative) innovation to hours worked and to output. In the paper we will refer to a "boom" when $e_t = \varepsilon_t^+$ and to a "recession" when $e_t = \varepsilon_t^-$.

In the following sections we will make two assumptions: 1) that policymakers are benevolent and 2) that they only care about long run welfare of domestic households. Both assumptions are made for analytical tractability. The first allows us to concentrate on the issue of asymmetric information in a simple setting . The second enables us to solve a static, rather than dynamic, game so that policy makers select constant (in expected terms) path for μ and τ. By definition, $m_{t+1} = m_t(1+\pi_t)/(1+\mu_t)$ so that in steady state real balances are constant and $\mu = \pi$. We can summarize the steady-state welfare implications of constant money growth and labor tax rates with the indirect utility function

$$\begin{aligned} \mathcal{W}(\tau, \pi, e) &= (1-\tau)(L(\tau)+e) - \pi M(\pi) + V(1-L(\tau)) \\ &\quad + W(M(\pi)) + H(\tau(L(\tau)+e) + \pi M(\pi)) \end{aligned} \tag{14}$$

[10] The fact that the marginal utility of money is constant rules out the time-inconsistency problem via monetary surprises à la Calvo(1978). To save on notation we let $\rho - > 1$.

The welfare function shows the nature of the optimal tax problem of this economy. Both the income and the inflation tax finance the provision of public goods that are valued by consumers, at the cost of distorting labor supply and money demand.

3 Full Information (Second Best)

3.1 Two National Currencies

The timing of events is described in Figure 1. At stage 0, the shocks, e and e^* (for the foreign county), are realized. At stage 1, each central bank independently chooses the rate of growth of money, given the choice of the other central bank. Then, each fiscal authority, having observed π and π^*, chooses the tax rate $\tau(\tau^*)$, given the choice of the other country $\tau^*(\tau)$. Finally, domestic and foreign households choose $c, l,\ m$ .Together with the government budget constraint and households decisions, π and τ determine the quantity of the public good g.

t=0	t = 1	t=2	t=3
e(e)*	CB(CB*)	Fiscal authorities	*c,l,m*
is realized	sets $\pi(\pi*)$	sets $\tau(\ \tau*)$	(c^*, l^*, m^*)

Figure. 1

Under full information, the realizations of $e(e^*)$ are common knowledge. With this timing we are assuming that monetary authorities can commit with respect to the fiscal authorities.[11] As usual, the game is solved backward. Note that the domestic welfare does not depend on foreign variables. At stage 2, the domestic government solves

$$\underset{\tau}{Max}\ \mathcal{W}(\pi, \tau, e)\ s.t.\ \ \pi = given \tag{15}$$

The first order conditions for this problem is $\mathcal{W}_\tau(\pi, \tau, e) = 0$. At stage 1 the Central Bank solves

$$\underset{\pi}{Max}\ \mathcal{W}(\pi, \tau, e)\ s.t.\ \mathcal{W}_\tau(\pi, \tau, e) = 0 \tag{16}$$

[11] We study lack of credibility of the ECB in Bottazzi, Manasse (1997a).

>From the envelope theorem the solution of this problem is $\mathcal{W}_\tau(\pi,\tau,e) = \mathcal{W}_\pi(\pi,\tau,e) = 0$ which can be rewritten as :

$$\begin{aligned} H_g(.) &= \frac{1}{1-\eta(\tau,e)} \\ H_g(.) &= \frac{1}{1-\varepsilon(\pi)} \end{aligned} \tag{17}$$

where $\eta(\tau,e) = \frac{-\tau\, L_\tau}{L+e}$ is the elasticity of labor supply with respect to the tax rate, and $\varepsilon\ (\pi) = -\frac{\pi\, M_\pi}{M}$ is the elasticity of money demand with respect to the inflation rate. By definition, the elasticity of labor supply is decreasing in the productivity shock $\eta_e(\tau,e) < 0$. When hours worked increase, the labor supply becomes more rigid. Intuitively since the marginal utility of leisure is decreasing, the longer people work the higher the wage increase required to further raise the supply of labor. Also, from the second order conditions, both elasticities are increasing function of theirs respective tax rates $\eta_\tau(\tau,e)$, $\varepsilon_{_\pi}\ (\pi) > 0$.

The two equations in (17) imply that the more elastic is the tax base, i.e. the more distortionary is the tax, the lower is the corresponding optimal tax rate. Hence π and τ are chosen so as to equate the distortions (elasticities) across the two tax bases. This requires $\eta(\tau,e) = \varepsilon\ (\pi)$.

These two equations can be solved jointly to yield $\tau = T(e)$ and $\pi = \Pi(e)$.

It immediately follows that

Lemma 1 *The optimal state-contingent tax and inflation policies, $\tau = T(e)$ and $\pi = \Pi(e)$, are increasing and, respectively, decreasing in the productivity shock, $T_e(e) > 0$ and $\Pi_e(e) < 0$.*

Proof. Differentiate totally the condition $\eta(\tau,e) = \varepsilon(\pi)$. One obtains $\Pi_e(e) = \eta_e(\tau,e)/\varepsilon_\pi(\pi) < 0$, and $T_e(e) = -\ \eta_e(\tau,e)/\eta_\tau(\tau,e) > 0$ ■

Intuitively, a positive shock to productivity makes the labor supply relatively more rigid and calls for higher optimal labor tax rate. As the marginal utility of the public good falls, a lower inflation tax is required. As a result, money demand also becomes more inelastic, so that distortions across the two tax bases are equalized.

In other words, as a result of distortion smoothing, fiscal and monetary policies are used "counter-cyclically" over the business cycle. During "recessions" (negative output shocks) labor tax rates are lowered and money

growth is raised, and the opposite during "booms" :

$$\begin{array}{c} \tau^+ = T(\varepsilon^+) \ > \tau_0 = T(0) > \tau^- = T(\varepsilon^-) \\ \pi^- = \Pi(\varepsilon^-) > \pi_0 = \Pi(0) > \pi = \Pi(\varepsilon^+) \end{array} \tag{18}$$

Note that, if the realization of the shocks were private information for either the government or the Central Bank, neither of them could gain by misrepresenting the state of the economy to the other, as they are both benevolent.

3.2 Monetary Union (Third Best)

In a Monetary Union, the two countries give up the control of monetary policy to the ECB, so that the tax *base* and the tax *rate* of seignorage are common between the two countries. Therefore, m and m^* must be now interpreted as the demand for the common currency (Euro) by domestic and foreign households.

If domestic and foreign shocks were perfectly correlated (symmetric), the loss of one instrument for tax smoothing purposes would be costless. For example, if both economies experienced a negative productivity shock, they would agree to an expansionary monetary policy. With asymmetric disturbances ($e \neq e^*$), however a *conflict of interest* arises: a country experiencing a "boom" would favor a tighter monetary and fiscal policy than that preferred by the country in "recession". Asymmetric shocks give rise to the standard inefficiency discussed in the Optimal Currency Area literature. However, in this context, there is an additional distortion due to imperfect information. As we shall see, each country may have an incentive to misreport information about the state of the economy in order to influence the (common) monetary policy of the ECB.

Let σ $(1-\sigma)$ represent the share of seignorage distributed to the domestic (foreign) government. The budget constraints now read:

$$g = \tau l + \sigma\pi(m + m^*) \tag{19}$$

$$g^* = \tau^* l^* + (1 - \sigma)\,\pi(m + m^*) \tag{20}$$

Since the demand for money only depends on the common rate of inflation, π, it follows that $m = m^*$ in equilibrium.

We discuss the issue of optimal seignorage redistribution and credibility in EMU at length in another paper (see Bottazzi and Manasse (1997a))[12]. In this paper we simply assume that σ is constitutionally fixed to 1/2, the ex-ante optimal value for symmetric countries[13].

The timing of events is still described by Figure 1. At stage 2, each government chooses $\tau = \arg\max W(\tau, \pi, e)$ taking π as given. >From the first equation in (17) we can solve for τ as a function of the common inflation and of the state of the economy, $\tau = T^E(\pi, e)$. In that case,

Lemma 2 *a) the optimal labor tax rate in EMU is decreasing in inflation,* $T^E_\pi(\pi, e) < 0$.

b) the optimal labor tax rate in EMU is increasing in the productivity parameter, $T^E_e(\pi, e) > 0$,

provided the following condition holds:

$$-\eta_e/(1-\eta)^2 > -H_{gg}\tau \tag{21}$$

Proof. see appendix.

Intuitively, part a) says that inflation and the labor tax rate are strategic substitutes. As the revenue from the inflation tax rises, public spending increases and its marginal utility falls, calling for lower income taxes (income effect). Part b) has the following interpretation. When e rises for a given inflation rate, we have two contrasting effects on the optimal tax rate. On the one hand, higher revenues from labor income tax reduce the marginal utility of the public good and call for a *lower* tax rate (income effect, on the r.h.s). On the other hand, labor supply becomes more inelastic, calling for a *higher* tax rate (substitution effect, on the l.h.s.). Under the condition (21), the substitution effect dominates.

Back to stage 1, the ECB, taking into account the behavior of fiscal authorities, chooses the optimal (state-contingent) monetary policy so as to maximize the Union's welfare:

$$\pi^E = \Pi^E(e, e^*) = \arg\max \left[W(T^E(\pi, e), e, \pi) + W^*(T^E(\pi, e^*), e^*, \pi)\right] \tag{22}$$

It is easy to show that

[12] BMT (1996) discuss redistribution under asymmetric information.

[13] According to the ECB Statute, seignorage will be redistributed on the basis of fixed weights (computed considering population and GDP of each member).

Lemma 3 *The optimal policy* $\Pi^E(.)$ *has the following properties:*

i) $\Pi^E_e < 0$ and $\Pi^E_{e^*} < 0$
ii) $\Pi^E(e, e^*) = \Pi^E(e^*, e)$
iii) $\Pi^E(e, e) = \Pi(e)$

Proof. : see Appendix

The first property means that the tax-smoothing/counter-cyclical nature of the optimal inflation policy is preserved in the Union. Monetary policy becomes tighter (looser) when either economy is hit by a positive (negative) shock. The second property is symmetry: all what matters is the overall state of the union's economy, and not who experiences which shock. From iii), if the shocks are symmetric, so that both countries are contemporaneously in boom or recession, the ECB adopts exactly the policy that each independent national central bank would have chosen in that state (their second best). Accordingly, a country does not suffer from welfare loss by relinquishing monetary independence when shocks are symmetric.

Corollary 4 *>From the previous Lemma , it also follows that*

iv) $\Pi(e^*) < \Pi^E(e, e^*) < \Pi(e),\ if\ \ e < e^*$
v) $\left|\Pi(e) - \Pi^E(e, e^*)\right| < \left|\Pi(e^*) - \Pi^E(e, e^*)\right|,\ if\ \ e < e^*$

Part iv) states that when shocks are asymmetric, the ECB chooses a rate of inflation that is a "compromise" between those desired by the two countries. If the foreign country is in a boom (e^*) and the domestic country in recession (e), the ECB implements a policy that is "too tight" from the point of view the domestic country, and "too loose" from the point of view of the foreign country.

Finally, from v) the ECB always chooses an inflation rate that is closer to that preferred the country who is "worse off". This follows from the concavity of the welfare function in π and τ.

4 Asymmetric Information

The two countries are equal in expected value but there are exogenous innovations to productivity, so that in some state of nature output is above, below or equal to the trend. The ECB cannot verify the state of the two economies. Due to this assumption, the ECB cannot enforce truth telling by threatening

a future punishment for the government who lies. The ECB can verify (and write a contract contingent on) the income tax *rates* applied by each national government, but she cannot observe the tax *bases*, which depend upon the realizations of the shock e[14]. National governments, conversely, observe the state of their domestic economy. We have a typical adverse selection problem, in that the European Central Bank chooses the common rate of inflation (according to "aggregate" the state of the federation), but has to rely only on the information supplied by national governments. National governments may try to exploit their informational advantage in order to induce the ECB to choose a policy that better fits the state of their *own* economy.

Since we have only two countries, this adverse selection problem is complicated by the strategic interaction between governments: the incentive to misreport information depends on what the other government reports.

A rule of the game is that countries agree to split seignorage according to the fixed fraction $\sigma = \frac{1}{2}$.The timing is as follows:

1. The ECB writes a contract $\Pi^A(\tau_i, \tau_j)$ that maps all possible realizations of the tax rates (τ_i, τ_j) to an inflation rate (the superscript A refers to adverse selection).

2. Nature determines whether a country is hit by a positive, negative or zero shock. Each government observes its own e, but not that of the other country. The ECB observes neither.

3. The domestic (foreign) government observes the state of its own economy, and chooses a tax rate, $\tau = T(e)$ as a function of $e(e^*)$, given the policy function to which the ECB has committed, $\Pi^A(\tau, \tau_c^*)$, and the conjecture on the tax rate chosen by the other government, τ_c^*.

4. National governments receive their fraction of seignorage, and finance public goods .

We invoke the direct revelation principle, so that if there exists an equilibrium to the complex game stated above, it will be equivalent (from the point of view of the principal, the ECB), to the equilibrium of the following simpler game.

1. Each national government separately communicates his "type" (i.e. the state of the economy) to the ECB.

2. On the basis of these announcements the Central Bank chooses π and

[14]This assumption requires that also g be unobservable, since if it were, the ECB could recover the state e from the government budget constraint (see the discussion in BMT (1996)).

confidentially suggests to each government which tax rate to choose.

3. On the basis of his own shock and of the ECB's suggestion, each government chooses his tax rate.

In an equilibrium with truthful and obedient strategies, each country announces the true value of its own shock and adopts the tax rate suggested by the ECB.

We consider dominant strategy mechanism. [15]

There are nine possible and equally likely states of nature. Three are symmetric states, where countries experience the same shock : $(\varepsilon^+, \varepsilon^+)$,$(\varepsilon^-$, $\varepsilon^-), (0, 0)$. The other six are asymmetric cases, where one country has a positive shock, and the other has a negative shock $(\varepsilon^+, \varepsilon^-)$, $(\varepsilon^-, \varepsilon^+)$; where one has positive and the other zero disturbance, $(\varepsilon^+, 0)$, $(0,\varepsilon^+)$; and finally , one negative, one zero shock $(\varepsilon^-, 0), (0, \varepsilon^-)$. Let the index $i = +, -, 0$ denote the type announced by a country, so that for example $i = +$ means the country declares a positive shock ε^+. Similarly, let π^{ij} and τ^{ij} denote respectively the rate of inflation chosen and the income tax rate assigned to country i , when types i and j are announced. Since the model is symmetric, we focus on symmetric contracts, where the identity of the country is irrelevant and all that matters is which types are declared.

Figure 2 illustrates the governments' reaction functions and indifference curves drawn in the inflation-tax rate space, i.e. in the variables that are observed by the ECB. R^+, R^0 and R^- denote the reaction functions $T^E(\pi, e)$ associated to positive, null or negative shocks, respectively. As stated in Lemma 3.2, these curves slope downward, since governments react to a lower rate of inflation by rasing the income tax rate. Also, under Assumption 1 in (21), R^+ is located to the right of R^0, because when a country experiences a positive shock it wants to raise its labor tax rate, for any given inflation rate. Points L, M and H show the second best combination of inflation and tax rate corresponding to negative, zero, and positive shocks, respectively. A country in recession would favor the most expansionary monetary policy and the lowest income tax rate (point L), and conversely for the country in a boom (point H).

The indifference curves (of type zero) are given by the elliptic curves in Figure2.

[15] This solution concept has the advantage of not being sensitive to beliefs that governments have about each other, and would therefore be preferred by the ECB. However, focusing on Dominant strategy mechanism restricts the set of possible solutions (see Fudemberg and Tirole (1991), p. 270).

Their lope is $\frac{d\pi}{d\tau} \mid_{W=const} = \frac{-W_\tau}{W_\pi}$. Hence, an indifference curve is flat at the intersection with the reaction function (where $W_\tau = 0$).The shape of the indifference curves has a simple explanation. Between D and A, both income taxes and the inflation rate are lower than in the second best. In a sense they are "scarce" and the indifference curve is downward sloping , as is usually the case. Above and to the left of the second best, however, between A and B, the curve is positively sloped, because here inflation is excessive (π is a "bad", $W_\pi < 0$), while the income tax rate is too low (τ is a "good", $W_\tau > 0$). Along this segment inflation is a " bad" because the welfare loss due to lower money demand more than offset the gains due to more public goods. Between points B and C, the indifference curve slopes downward, because both tax rates are excessive. Between C and D, inflation is a good and the tax rate a bad, and the curve slopes upwards.

Welfare increases as we move to "inner" indifference curves, closer to the second best .The SS lines in Figure 3a correspond to the loci where $W_\pi(.) = 0$, (for types 0 and $-$), so that the indifference curves are vertical when crossing the SS. This curve goes through the bliss point, and is always flatter than the reaction curve. It is easy to show[16] that the SS curve associated with a "richer" country (like SS_0 in the figure) always lies *below* that of a "poorer" one (SS_-). Intuitively, for the same tax rate, the richer country has more revenue and prefers a lower inflation rate. This property has an important implication: when the indifference curves of two types cross *to the left* of their reaction functions, (see point C), the poorer's curve cuts the richer's from *below* . Similarly, when they cross *to the right* of both types' reaction functions, the poorer's indifference curve cuts the other's from *above*.[17]

The indifference curves of different types may intersect an even number of times. In order to rule out multiple contracts[18], we need to impose the following assumption:

Monotonicity: the marginal rate of substitution between π and τ is monotone in types.

Figure 3b shows one example where the indifference curves violate this monotonicity condition. Here the indifference curves cross twice, at A and B, with slopes of the same sign (negative) at both intersection points. At

[16] This follow from the fact that $W_{\pi e} = M(H_{gg}\tau(1-\varepsilon(\pi)) < 0$

[17] This property turns out to be important in determminig the the nature of the equilibrium contract

[18] The monotonicity condition that follows is not sufficient to rule out multiple equilibria in the case where all incentive constraints bind.

point A, π and τ are "bads", and the rich, on the lower curve, dislikes inflation π relatively more than the poor, since he is willing to accept the same marginal increase in inflation in exchange for a larger fall in income taxes. Conversely, at point B, π and τ are "goods" and indifference curve slope downward as usual. Now, the richer type values inflation less, since he is ready to accept larger cut in inflation in exchange for a given increase in taxes. Hence, going from A to B the rich cares more about inflation when inflation is "too high" (point A), but cares less when inflation is "too low "(point B). The marginal rate of substitution between π and τ is not monotone in types

Our assumption of monotonicity implies that whenever indifference curves cross twice, their slopes at intersection points cannot be concordant. In other words, if the indifference curves are both negatively (or positively) sloped in one intersection, one curve must be positively sloped and the other negatively sloped at the other intersection point, as in Figure 3a.

4.1 The optimal contract

A contract is a policy that maps couples of announcements (i, j) into a choice of π and into suggested values for tax rates. The optimal contract maximizes total welfare among all incentive compatible policies.

It is very simple to characterize the optimal policy in symmetric states:

Lemma 5 *For all symmetric announcements $i = j$, the optimal incentive compatible policy under asymmetric information coincides with the policy chosen under full information . In turn, this policy is equal to the one chosen under monetary independence(second best):*

$\pi_A^{ii} = \Pi^E(i,i) = \Pi(i)$
$\tau_A^{ii} = T^A(i,i) = T^E(i,i) = T(i); \quad for \ \ all \ \ i$

Intuitive proof. Suppose that both countries are in state i, and confidentially report the true state to the ECB. If the ECB chooses the inflation rate that is most preferred by each country, $\Pi(i)$, and suggests the rate $T(i)$, she clearly maximizes total, as well individual welfare, and thus makes truth-telling a dominant strategy. Hence, when symmetric states occur, the incentive compatibility constraints do not bind and the asymmetric information contract coincide with that of full information, that gives the best allocation.

Another simplification can be obtained by considering the "extreme" cases where a country has a bad ε^- or good shock ε^+. Here truth telling is always a dominant strategy. The reason is quite simple. It turns out that the equilibrium monetary policy with adverse selection $\Pi^A(.)$ satisfies property $i)$ of Lemma 3, that is, inflation rises whenever a country reports a worse state of nature. Therefore, if one country experiences a recession, he will never report a more favorable state of nature than the true one. By lying, he would only harm himself, by making monetary policy even more restrictive (and therefore having to raise income taxes even further). Truth telling is always the dominant strategy for such a country. A similar reasoning applies to a country in boom: by lying the fiscal authority would only induce higher inflation, and lower taxes, which he dislikes. To summarize, we can conclude that, eventually, only type 0 may have an incentive to lie, so that the ECB needs to worry only about the incentive compatibility constraints of type 0 in asymmetric states of natures $(0, \varepsilon^+), (0, \varepsilon^-)$. Conversely, when shocks are asymmetric, the full information solution can be implemented.

It must be stressed that when we refer to a certain "type", we are *not* referring to the *identity* of a particular country, say Italy or Germany, but to the *state* which may occur with positive probability in every country. This is important as it implies that "reputational" considerations which may induce truthtelling in a repeated game, play no role. All countries are identical, and *any* country who happens to be in state 0 may be tempted to lie. Even if it were verifiable, a country's past trust-worthiness is useless for predicting future trustworthiness: next time the liar may be some else.

Let $\underline{\pi} = \{\pi^{+-}, \pi^{+0}, \pi^{-0}\}$ denote the (common) inflation rate in states $(+-), (0+), (0-)$ respectively, and $\underline{\tau} = \{\tau^{ij}\} = \{\tau^{+-}, \tau^{-+}, \tau^{0-}, \tau^{+0}, \tau^{-0}, \tau^{+0}\}$ denote the vector of tax rates suggested to the country who declares state i when the other declares j, in the same states. The optimal contract is therefore the solution to the following problem:

$$\max_{\underline{\pi},\ \underline{\tau}} \ \Big[W(\pi^{+-}, \tau^{+-}, \varepsilon^+) + W(\pi^{+-}, \tau^{-+}, \varepsilon^-)\Big] + \Big[W(\pi^{+0}, \tau^{+0}, \varepsilon^+) + W(\pi^{+0}, \tau^{0+}, 0)\Big]$$

$$+ \ \Big[W(\pi^{-0}, \tau^{0-}, 0) + W(\pi^{-0}, \tau^{-0}, \varepsilon^-)\Big] \qquad (23)$$

st..

$$W(\pi^{+0}, \tau^{0+}, 0) \ \geq \ W(\pi^{+-}, \tau^{-+}, 0) \ \ (IC.1)$$

$$W(\pi^{-0}, \tau^{0-}, 0) \;\geq\; W(\pi^{+-}, \tau^{+-}, 0) \;\; (IC.2) \tag{24}$$

Together, the two IC constraints ensure that truthful revelation is a dominant strategy [19]. Whether the other country reports a boom (IC.1) or a recession (IC.2), type zero must always prefer to tell the truth. For example, in the first case, by revealing his type it receives $\tau^{0+}$and seignorage $\pi^{0+}M(\pi^{0+})$. Had he pretended to be in recession, he would have obtained $\tau^{-+}$and $\pi^{+-}M(\pi^{+-})$. IC.2 has a similar interpretation[20].

Depending on the consumers' preferences there are four possible cases.

i) Neither constraint binds, ii) only the first , or iii) the second binds, or vi) both constraints bind. We give an intuitive and graphical illustration, while leaving formal proofs for the Appendix.

Let's start with the case where none of the constraints binds (we denote with λ_i the multiplier associated with the i-th constraint).

4.1.1 Case 1: Full Information ($\lambda_1 = \lambda_2 = 0$)

It is trivial to show that when there are no incentives to lie, the optimal contract under adverse selection coincides with the full information contract.

By definition, all the full information allocations lie on a reaction function, since at the common inflation rate(s), tax rates are undistorted ($W_\tau = 0$). For example, in Figure 4 the optimal allocation for state $(+,-)$ is given by points A (for the country declaring a boom) and J (for the country in recession).

Lemma 6 *When* $\lambda_1 = \lambda_2 = 0$, $\tau_A^{ij} = \tau^{ij}$, $\pi_A^{ij} = \pi^{ij}$ *for all* i, j.

Proof. It follows directly from the f.o.c's of Problem (see Appendix)

4.1.2 Case 2: Workers' Europe ($\lambda_1 > 0$, $\lambda_2 = 0$)

Consider now the case in which IC1 is binding and IC2 is not . Here type 0, confronted with the full information contract, *may pretend to be in recession whenever (he conjectures that) the other country has reported a boom.* He

[19] Alternatively we could have chosen the less restrictive concept of incentive compatibility for bayesian implementation (see Laffont and Tirole(1996)). If an equilibrium with dominant strategies exists, however, it clearly also satisfy the latter concept, while the converse is not true.

[20] When lying , under the conjecture that the other reports a boom, type 0 will never want to also report a boom, since we know that $W(\pi^{+0}, \tau^{0+}, 0) < W(\pi^{++}, \tau^{++}, 0)$.

does so because he *prefers more inflation and a higher primary deficit* (i.e. a lower income tax rate) to his full information allocation. In order to have more seignorage and less income taxes, he must convince the ECB that the overall economic situation is indeed *worse* than actually is. Conversely, under the assumption that the other country has reported a recession, type 0 has no incentive to lie, and therefore he reports the true state 0. By reporting the truth, he obtains a relatively less restrictive monetary policy, while reporting a boom would only result in lower inflation and higher taxes, which he dislikes (IC2 does not bind).

In Figure 4 , point I represents the full information allocation (τ^{0+}, π^{0+}) that type 0 obtains by reporting his true state, given that the other country reports a boom . Corresponding to the common inflation rate π^{0+}, point K , on the R^+ reaction curve, gives the tax rate for the country reporting the boom , τ^{+0}. Analogously, point J represents the full information allocation (τ^{-+}, π^{+-}) that a country declaring a recession obtains (given that the other reports a boom). In this case, type zero prefers J to I, since the former point lies on an inner indifference curve. Hence the full-information contract is not incentive compatible. The Central Bank must offer type 0 a new contract, such as I', that makes him indifferent between lying $(\tau^{-+}, \pi^{+-})_A$, point J', and telling the truth , $(\tau^{0+}, \pi^{0+})_A$, point I'.

These allocation must lie on the same indifference curve of type 0. Since the ECB needs not distort the fiscal choices of type 0 when he reports his true state, the allocation for truthful revelation I' must lie on the R_0 reaction curve. Note that also point B satisfies the property of being at the intersection of the two indifference curves and lying on R_0. However, while type zero is clearly indifferent between I' and B, type $(+)$ is obviously much worse off in B than in I', since in the former allocation monetary policy is unduly expansionary for a country experiencing a boom. Hence we can rule out point B on efficiency grounds. As a consequence, when types $(0, +)$ are reported, the ECB assigns I' to the country who reports 0,and K' to the country that reports a boom . Type zero is better off with respect to the full information allocation: inflation is indeed higher and the income tax lower. For the same reason, type $(+)$ is worse off than in full information, since K$'$ is more distant than K from type $(+)$ second best, H. Note that there is no need to distort the fiscal choice of the country in a boom, as he has no incentive to lie. Therefore also K' lies on his reaction curve R^+.

In order to induce self-revelation of type 0, the allocation of the country that (truthfully) reports a recession , $(\tau^{-+}, \pi^{+-})_A$, has been distorted. In

fact, J', the new allocation for type $(-)$, when types $(+,-)$ are declared, lies to the left of R^-. This means that when at the inflation rate $\pi_A^{+-}$is selected , the country in recession would have chosen a tax rate (on $R-$) that is larger than the value "suggested" by the ECB. The reason why this tax rate must be distorted *downwards* is simple. Recall (cf. condition (b) in Lemma 2), that a country in recession prefers a lower tax rate than a country in state 0. Therefore a lower tax rate is a credible signal for being in recession. By sufficiently lowering the tax rate suggested for type (-), the ECB can be sure that type 0 is better off by reporting the true state.

In the figure, the rate of inflation in state $(+,-)$ is higher under adverse selection than under full information. This, however, is not always the case. In the appendix we show that the effect of asymmetric information is to induce the ECB choose a rate π^{+-} that is closer to 0's preferences. [21]

In short, in this "Workers' Europe" case, type 0 prefers more inflation and less income taxes, and may try to convince the ECB that the overall economic situation is indeed *worse* than actually is, by reporting a recession. In order to induce self-revelation, the best that the ECB can do make inflation closer to type 0 preferences and suggest *lower tax rates* in states $(0,+)$ and $(+,-)$. Finally, recall that type 0 has no incentive to lie under the presumption that the other government reports a recession (IC2 does not bind). As a result, the contract specifies the full-information allocations in the state $(0,-)$. Not surprisingly, asymmetric information reduces total welfare.

We can summarize these results in the following

Proposition 7 *The solution for optimal contract under adverse selection in the case when only IC1 is binding,* $\lambda_1 > 0, \lambda_2 = 0$ *is such that*

i) $\pi_A^{0+} > \pi^{0+}$; $\pi_A^{+-} > \pi^{+-}$ iff $W_\pi(\pi^{+-}, \tau^{-+}, 0) > 0$;

ii) the tax rates for type zero are undistorted and lower than in full information: $\tau_A^{0j} < \tau^{0j}$ for $j = +, -$.

iii) the tax rate τ^{-+} is distorted downwards, $\tau_A^{-+} < \arg\max W(\pi^{+-}, \tau^{-+}, \varepsilon^-)$, and tax rates for the other types fall, $\tau_A^{ij} < \tau^{ij}$ for $i \neq j$, $i, j = +, -$

vi) for the state $(0,-)$, where IC1 does not bind, the contract specifies the full information allocation, $\pi_A^{0-} = \pi^{0-}, \tau_A^{-0} = \tau^{-0}$; $\tau_A^{0-} = \tau^{0-}$.

[21] In particular, $\pi_A^{+-} > \pi^{+-}$ occurs when type zero has such strong preferences for inflation and against income taxation, that even when he is assigned the full information tax rate for type $-$, τ^{-+} , he would like to raise inflation π^{+-} and lower taxation even further. That is, $\pi_A^{+-} > \pi^{+-}$ if $W_\pi(\pi^{+-}, \tau^{-+}, 0) > 0$ and viceversa.

Denoting total welfare by $W \equiv \sum_i \sum_j W^{ij}$ for $i, j = -, 0, +$

Corollary 8 *i) on average, type* 0 *gains*

$W_A^{0+} > W^{0+}$, $W_A^{0-} = W^{0-}$
ii) overall, asymmetric information reduces the union's expected utility:
$W_A < W$

4.1.3 Case 3: Bankers' Europe ($\lambda_1 = 0,\ \lambda_2 > 0$).

This case is similar to the one analyzed above. Here IC2 is binding while IC1 is not. In words, type 0 prefers a *lower* rate of inflation and a *higher* income tax rate relatively to its full information allocation. Hence, whenever he conjectures that the other country has reported a recession, he pretends to be in a boom.This case is perfectly symmetrical to our previous case.

4.1.4 Case 4a: "Inaction" in Monetary Policy ($\lambda_2 > 0,\ \lambda_1 > 0$)

When both constraints bind, type 0 is always tempted to lie (unless he thinks that also the other country is in state 0). Hence, when he conjectures that the other country has reported a recession, he is better off reporting a boom. When the opponent is thought to have reported a boom, he reports a recession.

As a consequence, the ECB is confronted with the following dilemma: whenever $(+, -)$ is reported, it could be that a) the two countries are both sincere; b) the country who announces $(+)$ is lying, the true state being $(0, -)$; c) the country who announces $(-)$ is lying, the true state being $(+, 0)$.The problem here is that it may be very costly to make self-revelation *strictly* preferred by type 0, since this may require distorting the allocations of the country in recession *and* in boom. For this reason we discuss two possible contracts[22]. In the first one, the ECB aims at truthful revelation of information. In the second, the ECB acknowledges that *strict* separation is too costly , and therefore aims at making type 0 *indifferent* between truth telling and lying (thus achieving separation in a weaker sense). In both cases, we get the result of "inaction": monetary policy becomes insensitive to the state of the economy, and too little smoothing is done via inflation. The two contracts, however, differ in one important respect: namely that in the first

[22]We thank Pier Paolo Battigalli for raising this point in discussions.

one inflation is distorted *away* from the extreme (very high/low) inflation rates, while in the second *towards* them . Let's start from the first solution.

As in the previous cases, the ECB makes type zero unwilling to lie by distorting type + and − allocations, see Figure 5. In particular, in state $(0,+)$, type zero, who aims at raising inflation, must be prevented from declaring a recession. The ECB must increase π^{0+} from the full information allocation, point F, up to point D, along type zero reaction curve. This leaves type zero indifferent between truth telling (D) and pretending to be poor (point B). In fact points D and B lie on the same indifference curve of type zero. As before, the ECB achieves self-revelation of the country in recession *distorting* τ^{-+} *downwards* (point B falls to the left of R^-). Again, the willingness to lower the tax rate is a credible signal of recession. Similarly, in state $(0,-)$ the ECB must prevent type zero, who aims at lowering inflation, from reporting a boom. Therefore she indeed lowers π^{0-} from point G to point C, along type zero reaction curve, while self-revelation of the country in boom is achieved by *distorting* τ^{+-} *upwards,* to point A. Again, by construction, type 0 is indifferent between correctly reporting his true state and being assigned the (undistorted) allocation C, and lying by reporting a boom, which indeed yield lower inflation, in A, but requires him to set an inefficiently high tax rate.

As a result, compared with full information, inflation rates in states $(0,+)$ and $(0,-)$ are "squeezed" towards the middle, while tax rates for the country in boom and in recession, are , respectively lowered (from E to E') and raised (from S to S'). *Too little distortion smoothing* is done by monetary *and* fiscal policy in these states. In order to achieve self-selection, however, when the two countries experience the most asymmetric shocks in $(+,-)$ the tax rate of the country in boom is distorted upward (to point A), and that of the country in recession downward (to point B).

Clearly, type zero is better off with respect to the full information allocation. Conversely, countries in recession or in boom are worse off. In the Appendix we prove the following

Proposition 9 *The solution for optimal contract under adverse selection in the case when both IC1 and IC2 are binding,* $\lambda_1 > 0, \lambda_2 > 0$ *is such that in states (0,+) and (0,-)*

i) inflation is closer to that preferred by type zero, $\pi_A^{0+} > \pi^{0+}$; $\pi_A^{0-} < \pi^{0-}$
ii) the tax rates for type zero are undistorted $\tau_A^{0j} = \arg\max W(\pi^{0j}, \tau^{0j}, 0)$,

$j = +, -$ and are closer to his the second best, $\tau_A^{0+} < \tau^{0+}$, $\tau_A^{0-} > \tau^{0-}$

iii) in state (+,-), the tax rate of the country in recession is distorted downwards, $\tau_A^{-+} < \arg\max W(\pi^{+-}, \tau^{-+}, \varepsilon^-)$, and that of the country in boom is distorted upwards $\tau_A^{+-} > \arg\max W(\pi^{+-}, \tau^{+-}, \varepsilon^+)$

Corollary 10 *i) type* 0 *gains,* $W_A^{0+} > W^{0+}$, $W_A^{0-} > W^{0-}$, *and types* $+, -$ *loose,*$W_A^{+0} < W^{0+}$, $W_A^{-0} < W^{-0}$

ii) overall, asymmetric information reduces the union's expected utility: $W_A < W$

4.1.5 Case 4b: An alternative Contract

The ECB may find that the previous policy that aims at *strict* separation is too costly. She may therefore be willing to content herself with making type 0 *indifferent* between truth telling and lying, thus achieving separation in a weaker sense. As before this contract makes inflation less responsive to the cycle. Interestingly, however, inflation now becomes more biased towards the extremes, in the sense of being tailored for the needs of the countries in the very bad or in the very good states. Intuitively, when the ECB gives up the objective of strict self-revelation of type 0, there is no need to give him rents. At the contrary, type zero is the one who is penalized for (potentially) introducing "noise" into the system.

Formally, the ECB maximizes (23) subject to (24) holding with *equality.* By substituting the constraints into the objective function, it is easy to see that, when the state $(+, -)$ is reported, the ECB simply assigns equal probabilities to the events in *a)-c)* above. The optimal inflation rate π_A^{+-} maximizes expected utility in this sense (cf. equation (36) in the Appendix). This last case is illustrated in Figure 6.

Point F represent the full information allocation designed for type 0 in state (0,+). The asymmetric information contract is found in this way. When type 0 conjectures that the other reports a boom, he must be indifferent between reporting the true state $(0, +)$,and getting point A (or A') and reporting a recession $(-, +)$, and being assigned point Z. Hence the ECB lowers π^{0+} from F to point A (or A').

>From the first order condition it is easy to show that the allocation for the poor in state (+,-), point Z, lies between R^0 and R^-, so that the tax rate for the country in recession is now distorted *upwards.*

Similarly, point G represent the full information allocation for type 0 in state (0,-). With the new contract, type 0 must be indifferent between reporting the truth in state $(0,-)$, point X (or X'), and reporting a boom, (+,-), yielding an allocation such as Y. Thus in state (0,-) the ECB raises the inflation rate from G to X .

It is easy to show that Y, the allocation designed for the country in boom in state $(+,-)$, must lie to the left of R^+(see the Appendix).Hence the tax rate for the country in boom is distorted *downwards.*

We now need to pin down the rates of inflation in the states where type zero is tempted to lie, π_A^{-0}, π_A^{0+}. It can be shown that when (-, 0) is reported , the ECB chooses the inflation rate preferred by type $(-)$: $\pi_A^{-0} = \pi_A^{--} (= \pi^{--})$, and allows him to implement his second best tax rate $\tau_A^{-0} = \tau_A^{--} (= \tau^{--})$ (point L on R^-). Similarly, when state $(+, 0)$ is reported , the ECB chooses the inflation rate preferred by $(+)$: $\pi_A^{+0} = \pi_A^{++} (= \pi^{++})$ and allows him to implement his second best tax rate $\tau_A^{+0} = \tau_A^{++} (= \tau^{++})$ (point H on R^+).

This policy penalizes type 0 in two ways: the inflation rates π^{0+} and π^{0-} are biased *away* from π^{00}, and his fiscal choices are distorted (τ^{0i}, $i = +, -$ are off the reaction curve R^0). Rents are redistributed to the country in boom and recession whose second best is implemented whenever the other country reports state zero.

Similarly to the previous contract, *too little smoothing is done by inflation and taxation,* as π and τ become less sensitive to the union economic conditions ($\pi_A^{-0} = \pi_A^{--}$, $\pi_A^{+0} = \pi_A^{++}, \tau^{0-} = \tau^{--}, \tau^{0+} = \tau^{++}$). However, monetary and fiscal policy are now biased towards the extremes: they become "very loose" in state $(0,-)$, "very restrictive" in state $(0,+)$.

Clearly this contract, if implemented [23] will amplify the business cycle peaks and troughs.

We summarize the results for this case in the following proposition:

Proposition 11 *The solution for optimal contract under adverse selection when both constraints are binding* ($\lambda_1,\ \lambda_2 > 0$) *and the ECB aims at making type 0 indifferent between lying and truthtelling is such that i) the country who reports either a boom or a recession, while the other reports 0, gets its most preferred allocation,*

$$\pi_A^{-0} = \pi^{--} > \pi^{-0}; \tau_A^{-0} = \tau^{--} < \tau^{-0}$$

[23] This countract will be implemented whenever it attains a level of welfare larger than that obtained by the contract described in section 4a.

$$\pi_A^{+0} = \pi^{++} < \pi^{0+}; \quad \tau_A^{+0} = \tau^{++} > \tau^{+0}$$

ii) in state $(+-)$ the tax rate for the country in boom (recession) is distorted downwards (upwards)
$\tau_A^{+-} < \arg\max W(\pi^{+-}, \tau^{+-}, \varepsilon^{+}), \ \tau_A^{-+} > \arg\max W(\pi^{-+}, \tau^{-+}, \varepsilon^{-})$
Proof. see appendix

Corollary 12 *i) types*$(+)$ *and* $(-)$ *gain at the expenses of type 0*

$W_A^{+0} > W^{+0}, \ W_A^{-0} > W^{0-},$
$W_A^{0-} < W^{0-}, \ W_A^{0+} < W^{0+}$

ii) overall welfare is reduced with respect to full information
$W_A < W$

5 Conclusions

Our analysis shows that delegation of monetary, *but not fiscal*, policy to a supra-national body may raise the *incentives to manipulate information* by national policy-makers. Asymmetric shocks create a *conflict of interest* between residents of participating countries. A country in recession may favor more inflation so as to be able to lower the income tax rate and to boost output, while a country in boom may prefer exactly the opposite. In turn, such conflict gives rise to an *adverse selection* problem.

Given the current unemployment rate in Europe, one may think that the more relevant risks lie on the side of excessive inflation and primary deficits (Workers' Europe). For this case, our analysis shows that the trade-off between inflation and stabilization worsen in EMU. Not only monetary policy cannot be tailored to each country individual needs, but it cannot be tailored to the average needs of member countries, either. As long as asymmetric information is present, optimal monetary policy is likely to become distorted towards excessive inflation and towards tolerating fiscal imbalances for countries in recession.

The "stability and growth" pact can be viewed as an attempt to put constraints on fiscal policy, so as to prevent monetization of public deficits. This agreement implicitly assumes that causality runs from excessive deficits

to inflation. If our interpretation is correct, however, the argument is upside down. National governments may be able to run excessive deficits, *as a consequence* of their ability to push for excessive inflation, and not the other way round.

The analysis highlights another major risk for EMU. When there are preferences for a stable rate of inflation, informational problems become particularly severe. As a consequence, monetary and fiscal policy becomes relatively insensitive to business cycle conditions, so that *too little "smoothing"* is done by inflation. This may result in two different scenarios. In one , monetary policy becomes inactive and the rate of inflation is kept approximately constant over the business cycle.

Surprisingly, asymmetric information may also lead the ECB and national government to choose sub-optimal stabilization by oscillating between periods of severe deflation (*stop),* extreme expansions (*go*), possibly aggravating business cycle peaks and throughs.

6 References

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7 Appendix

7.1 Proofs for Section 3

Proof of Lemma 3.2: Totally differentiating τ with respect to π and e we obtain $T_{\pi}^{E}(\pi,e) = -H_{gg}M(1-\varepsilon)\left(H_{gg}(L+e)(1-\eta) - \frac{\eta_{\tau}}{(1-\eta)^2}\right)^{-1}$ and $T_{e}^{E}(\pi,e) = (\frac{\eta_{e}}{(1-\eta)^2} - H_{gg}\tau)\left(H_{gg}(L+e)(1-\eta) - \frac{\eta_{\tau}}{(1-\eta)^2}\right)^{-1}$

The second term in parenthesis in both expressions is negative. Since H_{gg} <0 , $T_{\pi}^{E}(\pi,e) < 0$.Provided $\eta_{e}/(1-\eta)^2 < H_{gg}\tau$ then $T_{e}^{E}(\pi,e) > 0$.

Proof of Lemma 3.3: The F.O.C. from the maximization program implies $[H_g + H_{g^*}]/2 = (1-\varepsilon(\pi))^{-1}$ .Totally differentiating this expression the effect of the shock on the optimal π can be derived: $\frac{d\pi}{de} = M_e = (1/2)H_{gg}[\tau + (1-\eta)(L+e)T_e](\frac{\varepsilon_{\pi}}{(1-\varepsilon)})^{-1}$.The higher the value of the shock the lower the optimal rate of growth of money. In particular, when $e < e^*,\ g < g^*$. Hence $H_g > H_{g^*}$ and $H_g > \frac{H_{g^*}+H_g}{2} > H_{g^*}$. Since $\frac{1}{(1-\varepsilon(\pi))}$is convex in π the optimal $\Pi^{E}(e,e^*)$ is closer to the rate of money growth which is optimal for the country experiencing the lowest shock.

7.2 Proof for Section 4.

The optimal contract is found by maximizing the function :

$$\begin{gathered}[W(\pi^{+-},\tau^{+-},\varepsilon^{+}) + W(\pi^{+-},\tau^{-+},\varepsilon^{-})] + \\ W(\pi^{+0},\tau^{+0},\varepsilon^{+}) + W(\pi^{+0},\tau^{+0},0) + W(\pi^{-0},\tau^{0-},0) + W(\pi^{-0},\tau^{-0},\varepsilon^{-}) + \\ \lambda_1[W(\pi^{+0},\tau^{0+},0) - W(\pi^{+-},\tau^{-+},0)] + \lambda_2[W(\pi^{-0},\tau^{0-},0) - W(\pi^{+-},\tau^{+-},0)]\end{gathered} \tag{25}$$

with respect to $\{\pi^{+-},\pi^{+0},\pi^{-0},\tau^{+-},\tau^{-+},\tau^{0-},\tau^{+0},\tau^{-0},\tau^{+0}\}$,where λ_i is the multiplier associated with the ICi-th constraint (i=1,2).

The F.O.C. becomes:

$$\begin{aligned}\frac{\partial L}{\partial \pi^{+-}} &= \left[W_{\pi}(\pi^{+-},\tau^{+-},\varepsilon^{+}) + W_{\pi}(\pi^{+-},\tau^{-+},\varepsilon^{-})\right] - \lambda_1 W_{\pi}(\pi^{+-},\tau^{-+},0)) \\ &\quad -\lambda_2 W_{\pi}(\pi^{+-},\tau^{+-},0) = 0 \qquad (26)\\ \frac{\partial L}{\partial \pi^{+0}} &= [W_{\pi}(\pi^{+0},\tau^{+0},\varepsilon^{+}) + W_{\pi}(\pi^{+0},\tau^{0+},0)] + \lambda_1 W_{\pi}(\pi^{+0},\tau^{0+},0) = 0 \qquad (27)\\ \frac{\partial L}{\partial \pi^{-0}} &= \left[W_{\pi}(\pi^{-0},\tau^{0-},0) + W_{\pi}(\pi^{-0},\tau^{-0},\varepsilon^{-})\right] + \lambda_2 W_{\pi}(\pi^{-0},\tau^{0-},0) = 0 \qquad (28)\end{aligned}$$

$$\frac{\partial L}{\partial \tau^{+-}} = W_\tau(\pi^{+-}, \tau^{+-}, \varepsilon^+) - \lambda_2 W_\tau(\pi^{+-}, \tau^{+-}, 0) = 0 \quad (29)$$

$$\frac{\partial L}{\partial \tau^{-+}} = W_\tau(\pi^{+-}, \tau^{-+}, \varepsilon^-) - \lambda_1 W_\tau(\pi^{+-}, \tau^{-+}, 0) = 0 \quad (30)$$

$$\frac{\partial L}{\partial \tau^{0-}} = W_\tau(\pi^{-0}, \tau^{0-}, 0) + \lambda_2 W_\tau(\pi^{-0}, \tau^{0-}, 0) = 0 \quad (31)$$

$$\frac{\partial L}{\partial \tau^{-0}} = W_\tau(\pi^{-0}, \tau^{-0}, \varepsilon^-) = 0 \quad (32)$$

$$\frac{\partial L}{\partial \tau^{0+}} = W_\tau(\pi^{+0}, \tau^{0+}, 0) + \lambda_1 W_\tau(\pi^{+0}, \tau^{0+}, 0) = 0 \quad (33)$$

$$\frac{\partial L}{\partial \tau^{+0}} = W_\tau(\pi^{+0}, \tau^{+0}, \varepsilon^+) = 0 \quad (34)$$

7.2.1 Case 2: Workers' Europe $(\lambda_1 > 0,\ \lambda_2 = 0)$

Here only IC1 binds, that is to say, when the other country declare +, type zero is better off pretending to be $(-)$. From equation (29) and (31)-(34) it is easy to see that τ^{+-} as well as the tax rates that are assigned when one country announces a zero shock, $\tau^{0-}, \tau^{-0}, \tau^{0+}, \tau^{+0}$, lie on the appropriate reaction functions. Hence, given π, they are "optimal" or "undistorted".

Moreover, from (27) and the fact that τ^{0-}, τ^{-0} are undistorted, it follows that in the state $(0, -)$ where type 0 has no incentive to lie, the solutions with adverse selection (subscript A) and full information coincide:

$$\pi_A^{-0} = \pi^{-0} \quad (35)$$

$$\tau_A^{0-} = \tau^{0-}, \tau^{-0} = \tau^{-0}$$

Consider now equation (27) . This can be rewritten as

$$W_\pi(\pi^{+0}, \tau^{0+}, 0) + W_\pi(\pi^{+0}, \tau^{+0}, \varepsilon^+) = -\lambda_1 W_\pi(\pi^{+0}, \tau^{0+}, 0) \quad (36)$$

>From $\pi^{+0} < \pi^{00}$ and the fact that $\tau^{0+}$is chosen optimally, it follows that $W_\pi(\pi^{+0}, \tau^{0+}, 0) > 0$, so that the r.h.s of the last equation is negative. Since the l.h.s evaluated in the full information equals zero (and from $W_{\pi\pi} < 0$), we conclude that

$$\pi_A^{+0} > \pi^{+0}$$

In turn, this implies that the corresponding tax rates, which are found on the appropriate reaction curves, satisfy

$$\begin{aligned} \tau_A^{+0} &< \tau^{+0} \\ \tau_A^{0+} &< \tau^{0+} \end{aligned}$$

The intuition of these results is straightforward: in order to prevent type 0 to lie, in state (0,+), we make him indifferent by giving him an allocation where π is more expansionary, i.e. closer to the value desired by the country. In so doing we penalize type + who now experiences a more expansionary monetary policy and a lower fiscal burden.

Finally , consider the allocation designed for the poor in state $(-,+)$, $(\pi_A^{+-},\ \tau_A^{-+})$. From the IC1 constraint, type 0 must be indifferent between telling the truth (that yields $(\pi_A^{+0},\ \tau_A^{0+})$) and pretending to be poor (resulting in $(\pi_A^{+-},\ \tau_A^{-+})$). This says that at $(\pi_A^{+-},\ \tau_A^{-+})$, both for the "true" type $(-)$ and for the zero type, a small increase in the tax rate must change welfare in the same direction: i.e.

$sgn\ W_\tau(\pi^{+-}, \tau^{-+}, \varepsilon^-) = sgn W_\tau(\pi^{+-}, \tau^{-+}, 0)$.

Graphically, this means that the equilibrium tax rate τ_A^{-+} must be found either to the left or to the right of *both* $0's$ and $-'s$ Reaction functions. However, our previous discussion on indifference curves implies that a) if two intersections occur, only in one of them the slope of the indifference curves is concordant, b) the intersection where the indifference curves have concordant slope occurs only to the left right of the reaction functions, a point such as J'. From (26), we know that the first two terms, evaluated at the full information allocation, must sum to zero. If $\lambda_1 > 0, \lambda_2 = 0$, then $W_\pi(\pi^{+-}, \tau^{-+}, 0) > 0$ implies that $\pi_A^{+-} > \pi^{+-}$. This completes the proof of Proposition 7 $W_A < W$

7.2.2 Case 4: Inaction and Extremism ($\lambda_2 > 0,\ \lambda_1 > 0$)

As explained in the text, we look at the case where both constraints bind with strict equality. After substituting these constraints into (25), the FOC's for this case becomes :

$$\begin{aligned} \frac{\partial L}{\partial \pi^{+-}} &= W_\pi(\pi^{+-}, \tau^{+-}, \varepsilon^+) + W_\pi(\pi^{+-}, \tau^{-+}, \varepsilon^-) + W_\pi(\pi^{+-}, \tau^{-+}, 0) \\ &\quad + W_\pi(\pi^{+-}, \tau^{+-}, 0) = 0 \qquad (37) \\ \frac{\partial L}{\partial \pi^{+0}} &= W_\pi(\pi^{+0}, \tau^{+0}, \varepsilon^+) = 0 \qquad (38) \end{aligned}$$

$$\frac{\partial L}{\partial \pi^{-0}} = W_\pi(\pi^{-0}, \tau^{-0}, \varepsilon^-) = 0 \quad (39)$$

$$\frac{\partial L}{\partial \tau^{+-}} = W_\tau(\pi^{+-}, \tau^{+-}, \varepsilon^+) + W_\tau(\pi^{+-}, \tau^{+-}, 0) = 0 \quad (40)$$

$$\frac{\partial L}{\partial \tau^{-+}} = W_\tau(\pi^{+-}, \tau^{-+}, \varepsilon^-) + W_\tau(\pi^{+-}, \tau^{-+}, 0) = 0 \quad (41)$$

$$\frac{\partial L}{\partial \tau^{-0}} = W_\tau(\pi^{-0}, \tau^{-0}, \varepsilon^-) = 0 \quad (42)$$

$$\frac{\partial L}{\partial \tau^{+0}} = W_\tau(\pi^{+0}, \tau^{+0}, \varepsilon^+) = 0 \cdot \quad (43)$$

$$[W(\pi^{+0}, \tau^{0+}, 0) = W(\pi^{+-}, \tau^{-+}, 0)] \quad (44)$$

$$[W(\pi^{-0}, \tau^{0-}, 0) = W(\pi^{+-}, \tau^{+-}, 0)] \quad (45)$$

Conditions (38)and (43) say that in state $(+, 0)$, type $+$ is given his second best allocation, so that

$$\pi_A^{+0} = \pi^{++} < \pi^{+0}$$
$$\tau_A^{+0} = \tau^{++} > \tau^{+0}$$

>From (39)and(42) the same holds for type $-$ in state $(-, 0)$:

$$\pi_A^{-0} = \pi^{--} > \pi^{+0}$$
$$\tau_A^{-0} = \tau^{--} < \tau^{-0}$$

Finally, the first IC constraint, (44) imply that the allocation designed for type $+$ in state $(+, -)$ is such that type zero is indifferent between revealing his type (that yields π_A^{-0}, τ_A^{0-}) and pretending to be rich (that gives π_A^{+0}, τ_A^{+-}).Moreover, (40) require that the point π_A^{+-}, τ_A^{-+} lies between type 0 and type $+$ reaction functions, such as point Y. Similarly , equations (41) and (45) require that the tax rate τ_A^{-+} lies between type 0 and type $-$ reaction functions, such as point Z.

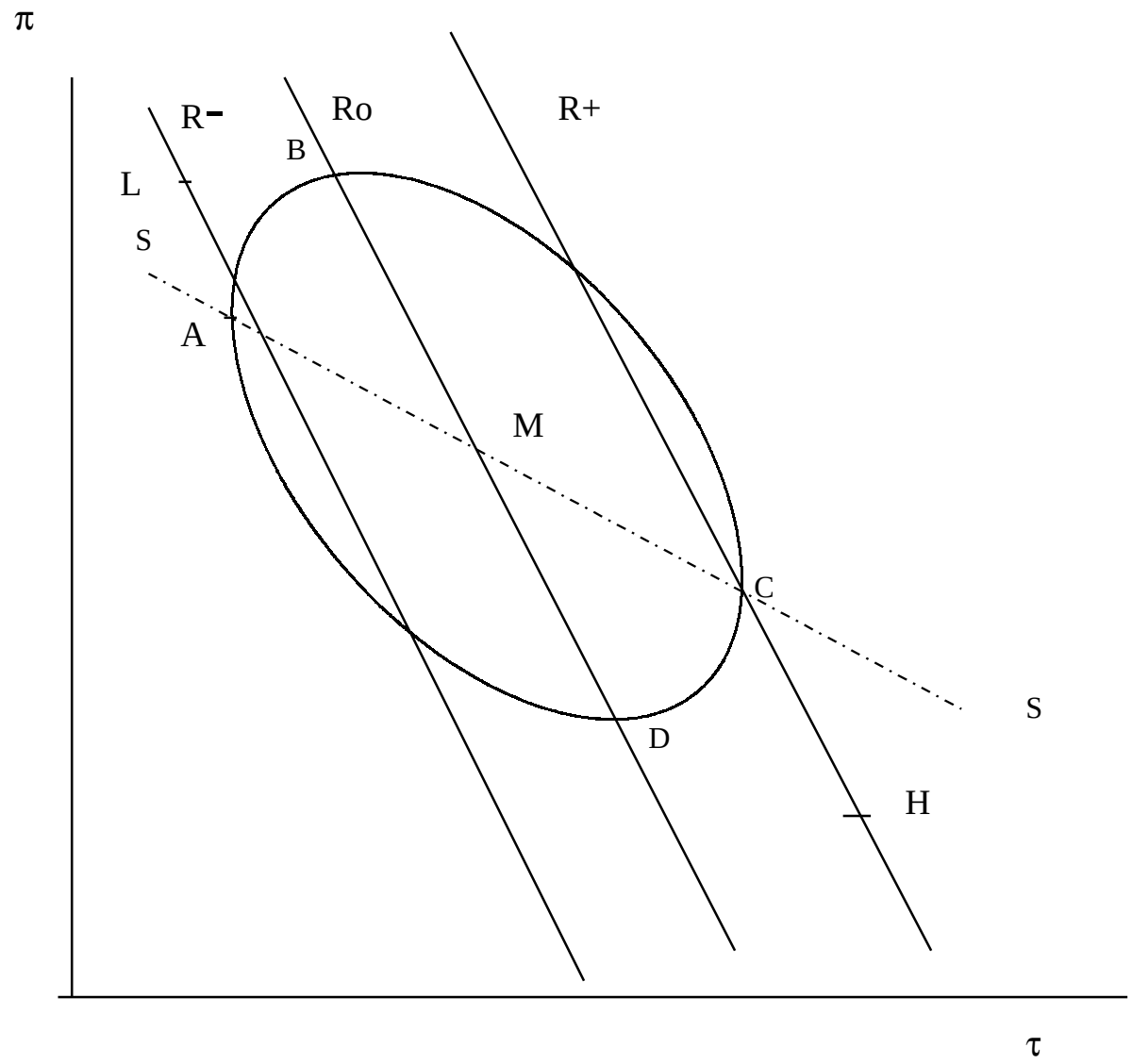

Figure 2. The indifference curve

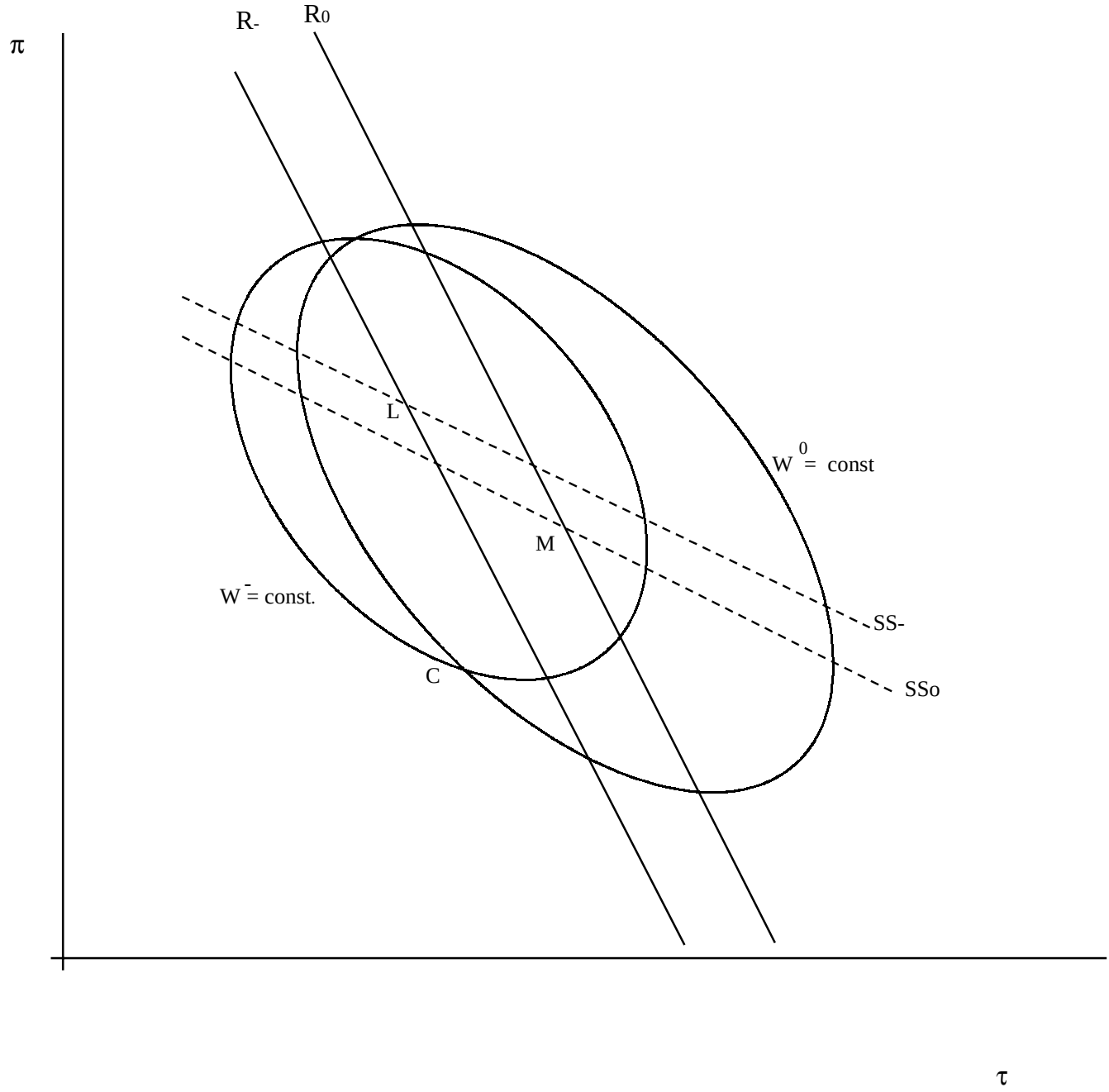

Figure 3a. The case of double crossing under the monotonicity assumption

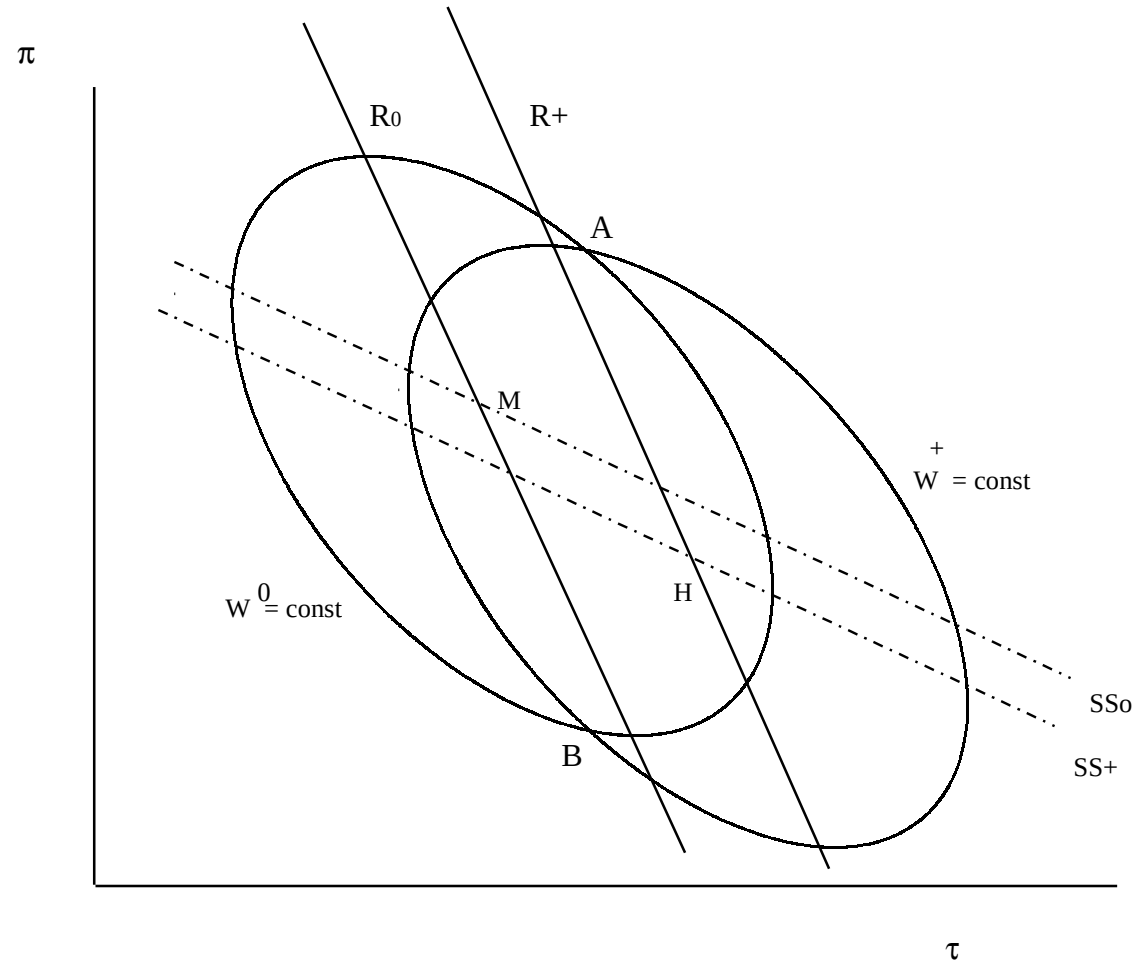

Figure 3b . The case of equal sign double crossing

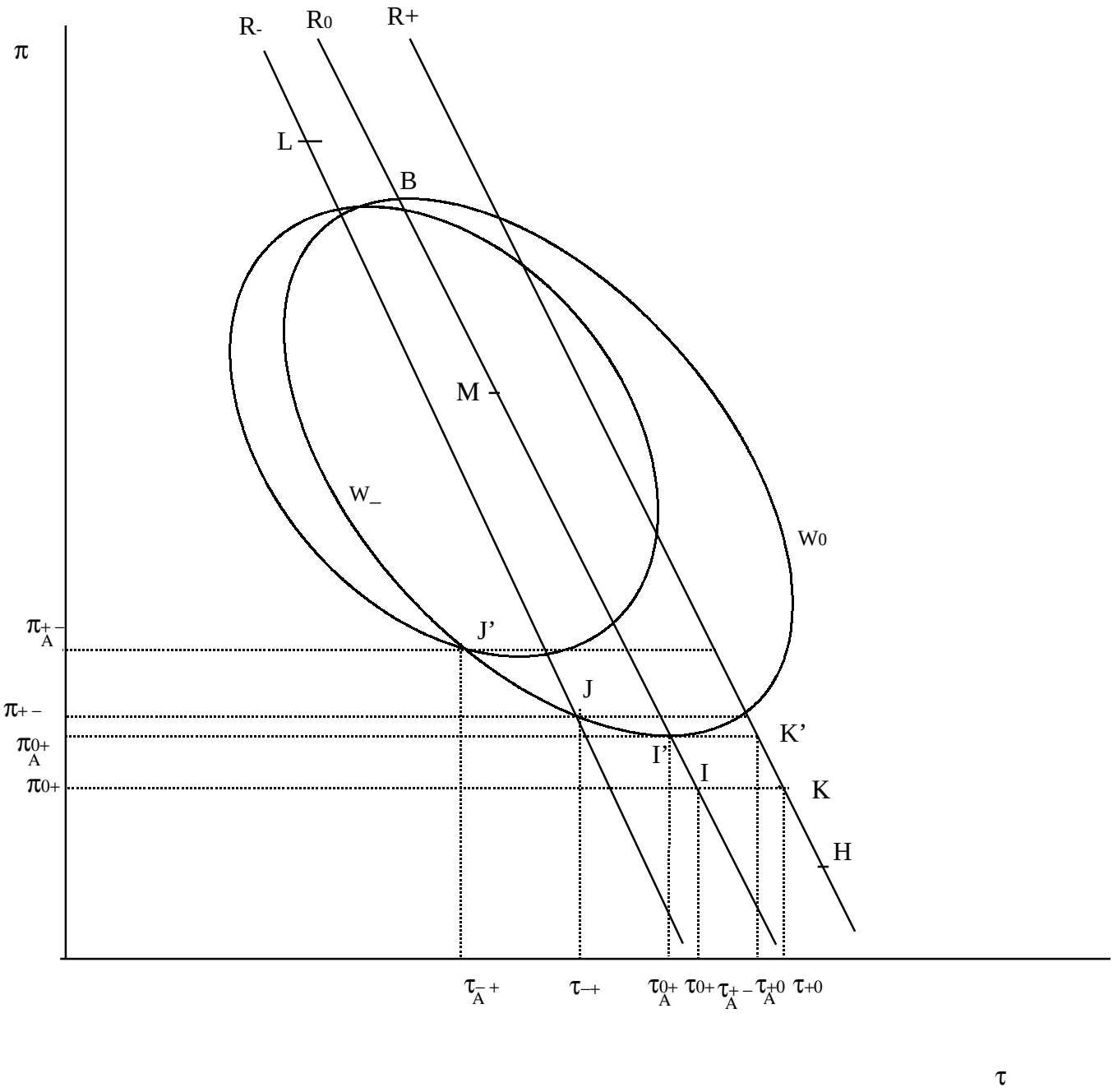

Figure 4. The case of Workers'Europe

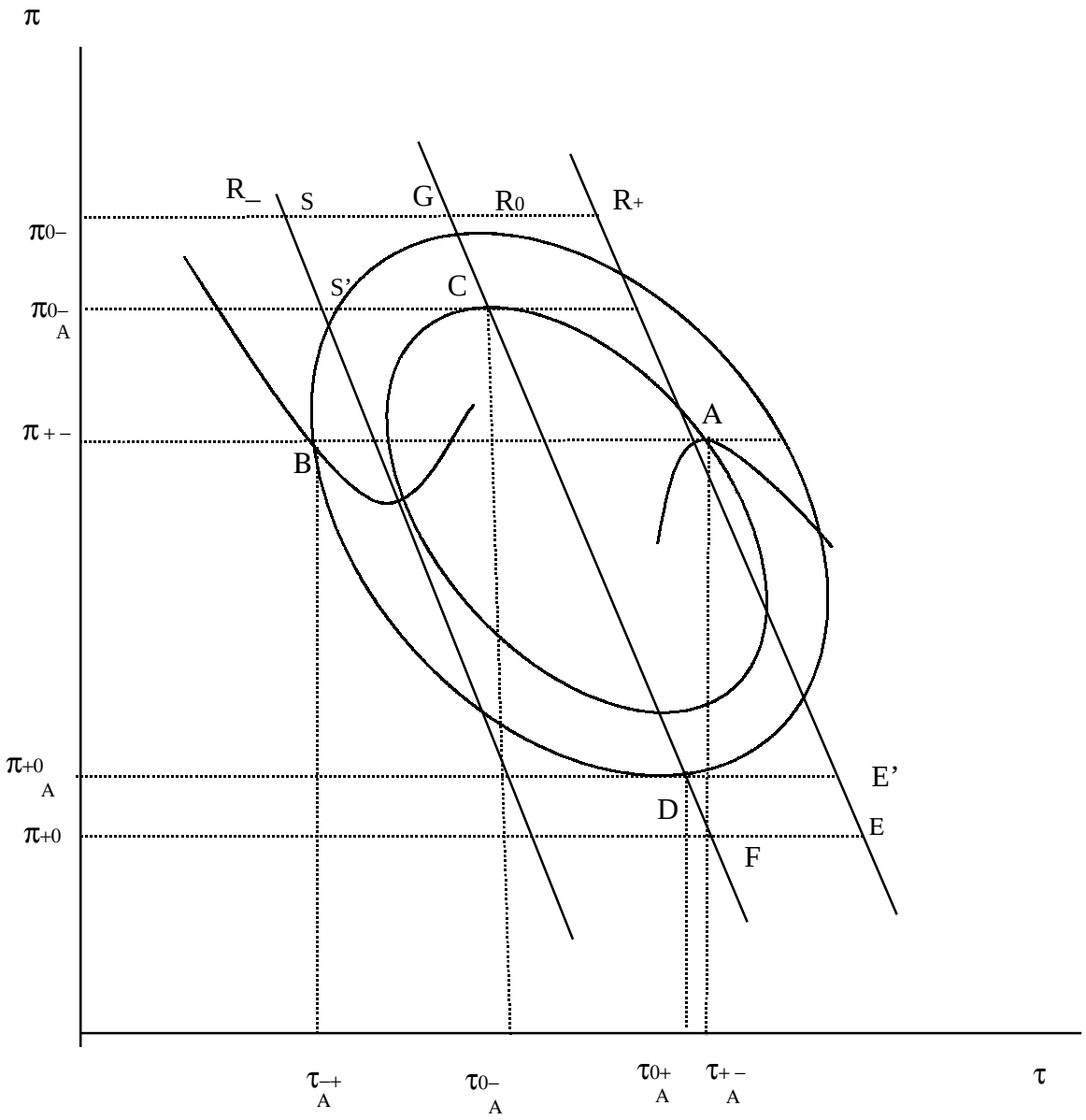

Figure 5. Inaction in Monetary Policy

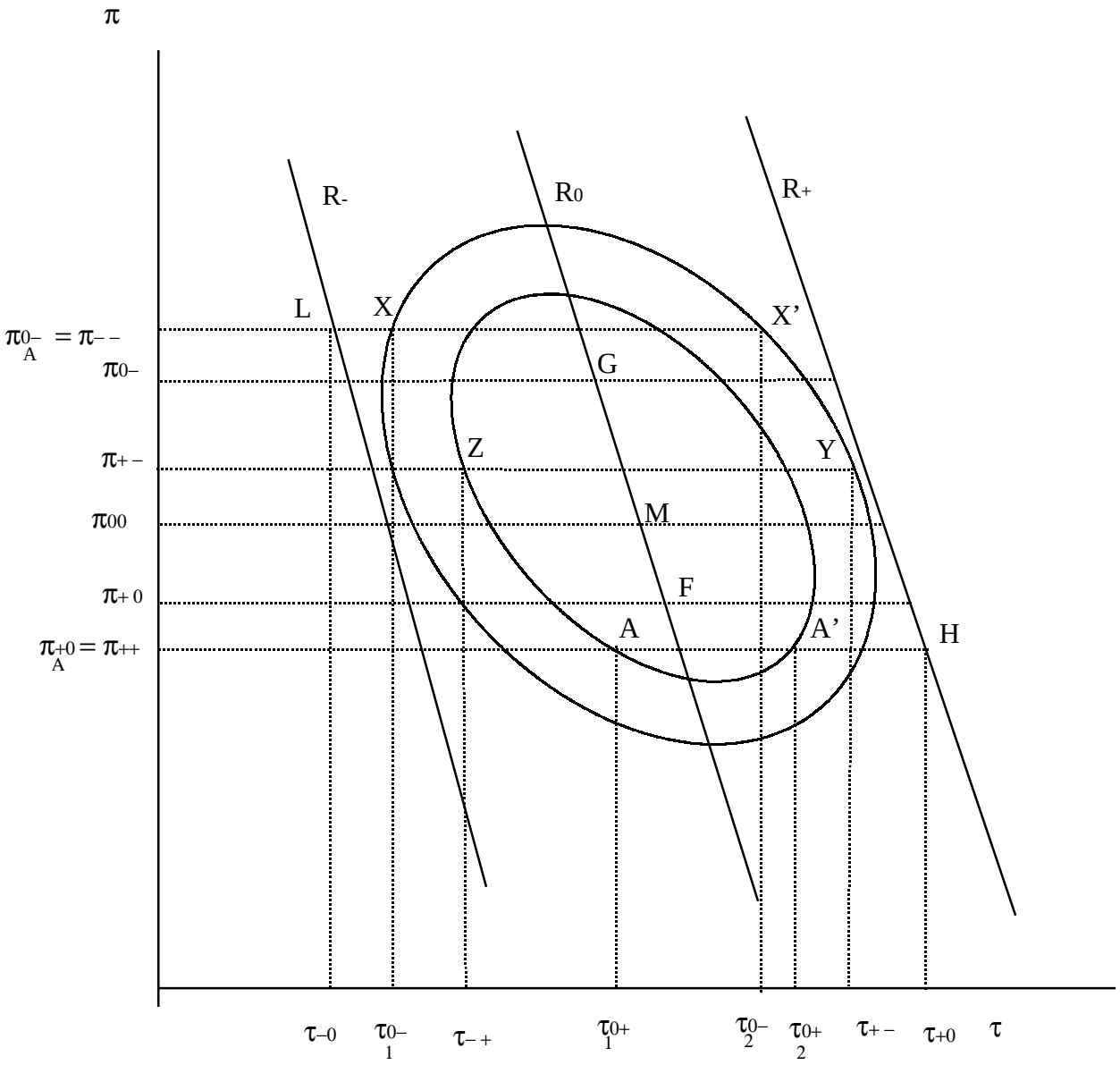

Figure 6. The alternative contract