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ON THE THEORETICAL DETERMINATION OF OPTIMAL CURRENCY AREAS IN THE FRAMEWORK OF CLUB THEORY*

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The paper provides an analytical approach to determine ex ante the optimal size (number of participants) and the optimal monetary conditions (inflation rate) of a monetary union. In the first part, the case of homogenous members is presented from the »total economy point of view» put forward by club theory. In the second part, the case of heterogenous members is explained on the background of the prospective European Monetary Union. Here also the »individual member point of view» and stability problems are discussed. (JEL: F31, F36, F41, F42)

1. Introduction

The European Community now envisages a two-stage time schedule culminating possibly in a European monetary union and a supranational European central bank. Before the first phase A – which is planned to start at the earliest in 1999 – begins, the leaders of European governments have to decide upon prospective candidates for the monetary union in 1997: if a considerable number of countries meets the so-called Maastricht criteria, phase A may, then, begin. During this stage, the European System of central banks will be set up, accompanied by a fixing of the bilateral exchange rates between the prospective members of the monetary union. It is in phase A when the »EURO» (be)comes truly an independent currency though national monies can still circulate. Phase B serves to issue coins and notes denominated in »EURO». One expects that phase B can begin in 2002. During this last phase national currencies have to be surrendered to the monetary authorities and be exchanged into »EURO». Initially, EMU will only be open to those countries which satisfy the convergence conditions with respect to exchange rates, interest rates and budget deficits. These are regarded as prerequisites for the success and indeed the very existence of EMU.

The first convergence condition laid down for EMU is the exchange-rate situation in the EMS. The less the exchange rate has been used in the past (at least in the last two years) as an instrument of adjustment (by taking advantage of wide bands of fluctuation and/or realignments or bilateral devaluations), the more have

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the countries concerned been in a position to deal successfully with imbalances (inflation, unemployment and current account deficits) by means of factor mobility (the Mundell criterion) and/or flexible factor prices (including their lowering). Or convergence of key economic variables had already taken place.[1]

The long-term nominal interest rate (the benchmark is the average of the three countries with the lowest loans rates) may only exceed this benchmark by a maximum of 2 percentage points. This reflects the demand for a substantial integration of the financial markets (Ingram and Whitman) of those countries wishing to participate in EMU.[2] The liberalisation of capital transfers on July 1, 1990 (Stage 1 of the Delors-Plan) was a prerequisite for the fulfilment of this second convergence condition. This made it possible to correct current account imbalances by means of private capital transfers, thus removing the need for an adjustment of exchange rates.

The third condition is the convergence of inflation rates (with the average of the three strongest currencies as the benchmark): a country's inflation rate may not deviate by more than 1½% from the reference rate. This reflects the criterion according to which there must be substantial harmonisation of inflation rates (Magnifico) or of preferences with regard to economic policy (Kindleberger): »A union of economies with substantially different national price trends would not only jeopardise external equilibrium, but would also be an obstacle to the achievement of domestic economic goals. Fixed exchange rates may well lead to an export of inflation from countries with high rates of inflation to more stable countries» (Menkhoff and Sell, 1992, 386).

The fourth convergence condition lays down ceilings for the budget deficits of individual countries: new debt should not exceed 3% of GNP p.a. and total national debt should not exceed 60% of GNP. The purpose here is to avoid both diminishing the autonomy of the future European central bank (revision of monetary goals or lack of resolution with regard to interest rates) and the forcing up of the common interest rate without prior agreement. In the wider sense fiscal harmonisation is also included among the convergence of policy preferences (Menkhoff, Sell and Stiefl, 1993).

The four EC convergence conditions, however, do not take into consideration the following optimality criteria for currency areas: degree of openness (McKinnon), diversification in production and export (Kenen), political and economic dominance of one member country (Graboyes), optimisation of currency reserve requirements (Schiemann), as well as internal origin and low correlation of exogenous shocks among individual countries (Tower and Willett, and Grubel) and fiscal integration (Johnson).

Nevertheless, we should bear in mind that if it were to take into consideration all optimality criteria, the EC would have difficulty in deciding how many and which countries (sooner or later) would be eligible for EMU. So far no comprehensive and operational procedure has been developed to determine the size of an *optimal European currency area*; the proposals existing in the literature like those of Canzoneri and Rogers (1990), von Hagen and Neumann (1991), De Grauwe and Vanhaverbeke (1991), Menkhoff and Sell (1992, 1993) and others are either confined to very few criteria and/or suffer from a partial equilibrium bias. There seems to be still much room for theoretical work in the field of optimal currency areas before a reassessment of the European monetary union issue is useful.

Some very interesting theoretical papers have been published in the recent past: the contributions of Melitz (1993) and Bayoumi (1994) highlight problems as asymmetric disturbances within the currency union or the drop in the speed of adjustment of the terms of trade to the long-run equilibrium level; however, they do not address a major monetary issue of curren-

[1] *»... the EMS has been effective in reducing the tendency towards exchange rate misalignment ... This achievement has been attained via the long-run convergence of monetary policy within the EMS.» (MacDonald and Taylor 1991, 557).*

[2] *»The adoption of a common currency is justified when the benefit in the form of an enlargement of the financial market is large enough to offset the disadvantages arising from the fact that it is no longer possible to change domestic interest rates» (Martin Feldstein in: Deutsche Bundesbank, Auszüge aus Presseartikeln No 6, Jan 23, 1992, 13).*

cy areas: the »choice» of the *union wide inflation rate*. This decision is not independent from the number of members that participate in the union. Hence, a general equilibrium approach is needed which happens to design the inherent simultaneity in the decision making process. The following model is an attempt to overcome this deficiency by drawing heavily on the insights of club theory. After briefly illustrating the suitability of club theory for the analysis of monetary unions we will then proceed to an assessment of an optimal currency area from the »total economy point of view»; the first approach is devoted to the case of homogenous members while the second approach deals with the case of heterogenous members. The latter also serves to focus on the prospective European Monetary Union and its stability problems.

2. A Method for the Determination of Optimal Currency Areas

2.1 Optimal Currency Areas and Club Theory

Currency areas share many of the characteristics attributed to private clubs: voluntary membership, freedom to withdraw, net benefits derived from membership, the principle of exclusion and sharing (Petersen, 1990, 141, and Cornes and Sandler, 1986, 159ff). Another common feature is that both must take so-called »dual decisions» (ibid. 161): not only must a decision be taken with regard to the *quantity of the club good* to be provided, but the *number of members* must also be established. These decisions are not independent of each other and must be taken simultaneously: a decision must be taken with respect to the optimal rate of inflation, in a sense the club good of a monetary union. At the same time the optimal number of members must be determined, just as any club must decide upon the number of members who may join (see Munduch and Nitschke, 1988, 318ff.), Frey (1985, 120ff.) has been one of the very first to detect the club properties of monetary unions; one should add that monetary unions will most likely be *exclusive* clubs (see also Rossi, 1992, 65) – though membership is *voluntary* – which »share impure public goods and require size restriction owing to crowding and congestion»(Sandler and Tschirhart, 1980, 1482).

In the actual reality of *Europe* two basic options seem to exist: either the number of monetary union candidates will be determined politically, leaving it to the so found member countries to optimise their common club good, i.e. the inflation rate, or the countries will decide upon the inflation rate to »pursue» in the union and will optimise with regard to the most suitable number of club members. Either procedure cannot produce more than a *partial* equilibrium. Theoretically, it is much more appealing to search for an ex ante *general* equilibrium. In the following, we will first attempt to develop the economic logic of the general equilibrium setting and then proceed to a more special solution in the second part of the paper which tends to reproduce the European situation. In terms of club theory, the approach chosen will be in both parts the »*total economy model*» which is different from the »*within club model*» which goes back to Buchanan (see ibid., 1483). Also, the questions will be addressed as to how benefits and revenues of the monetary union are to be distributed among the (heterogenous) members in order to stabilize the size and the supply of the club good and the number of participants.

2.2 General Equilibrium in the Case of Homogenous Members: A Formal Approach

It is most important to state the problem in terms of both members and non-members of the monetary union (see Sandler and Tschirthart, 1981, 1088); otherwise, an economy-wide welfare maximum will not be attained. Let the total number of identical countries in the economy be denoted by $\bar{n}$. We assume, for simplicity, that economies are not only identical but, also, that the weight in the global welfare of each of the countries is the same.[3]

Utility from being a member in the monetary union stems (i) from participating in the net

[3] *Both assumptions do not affect the generality of the results achieved.*

revenue of the union wide inflation rate ($R - C$) and (ii) from the net benefits of integration within the common currency area ($IB - IC$). On the other hand, utility from non-being a member in the monetary union stems (i) from the net revenue of one own's inflation rate ($\tilde{R} - \tilde{C}$) and (ii) from the net benefits of *not* being integrated into a common currency area ($N\tilde{I}B - N\tilde{I}C$). Such net benefits are calculated as the difference between gross »Non-Integration Benefits», measured by the ability to make active use of its own exchange rate as a policy instrument and »Non-Integration Costs», measured by the (higher) information and transaction costs vis-à-vis to the member states when staying outside the monetary union. All the countries under consideration are small vis a vis the rest of the world and purchasing power parity holds.

Unlike the classical »total economy view» club formation analysis, there is no »transformation-function» for the production of the two inflation rates. However, the maximisation of total welfare is bounded by the »budget constraint» that total inflation tax revenue ($\breve{R}$) can only be generated within (R) and outside ($\tilde{R}$) the monetary union and is an exogenous variable for the optimization problem: the amount of overall budget deficits to be financed by inflation tax revenues is given to the optimizing agent.[4] He, the benevolent social planner, is able to allocate the individual inflation tax revenues (i.e. of members and non-members) collected by national authorities/the union authority such as to maximise total welfare in the world economy. Hence, we maximise in the following an additively separable Benthamite social welfare function of members (n) and non-members ($\bar{n} - n$) of the monetary union subject to the inflation tax revenue constraint ($\breve{R}$). The resulting Lagrangian expression is (see Sandler and Tschirhart, 1980, 1488 and 1981, 1088)[5]:

$$(1)\quad \max_{n,\pi,\tilde{\pi},\lambda} L = n\left[(R-C)+(IB-IC)\right] + (\bar{n}-n)\left[(\tilde{R}-\tilde{C})+(N\tilde{I}B-N\tilde{I}C)\right] + \lambda\left[\breve{R} - nm(\pi)\pi - (\bar{n}-n)\tilde{m}(\tilde{\pi})\tilde{\pi}\right]$$

where:

$$(2)\quad R = R(\pi,n); \qquad R_\pi, R_n > 0$$

$$(3)\quad C = C(\pi,n); \qquad C_\pi, C_n > 0$$

$$(4)\quad IB = IB(\pi,n); \qquad IB_\pi, IB_n > 0$$

$$(5)\quad IC = IC(\pi,n); \qquad IC_\pi, IC_n > 0$$

Hence, we assume benefits and costs to depend on the size of membership (n)[6] and on the provision of the club good (π) and that members are not affected by the decisions ($\tilde{\pi}$) of the non-members.[7]

$$(6)\quad \tilde{R} = \tilde{R}(\tilde{\pi}); \qquad \tilde{R}_{\tilde{\pi}} > 0$$

$$(7)\quad \tilde{C} = \tilde{C}(\tilde{\pi}); \qquad \tilde{C}_{\tilde{\pi}} > 0$$

$$(8)\quad N\tilde{I}B = N\tilde{I}B(\tilde{\pi},n); \qquad N\tilde{I}B_{\tilde{\pi}}, N\tilde{I}B_n > 0$$

$$(9)\quad N\tilde{I}C = N\tilde{I}C(\tilde{\pi},n); \qquad N\tilde{I}C_{\tilde{\pi}} N\tilde{I}C_n > 0$$

[4] *This assumption has the following implication (example): let the inflation tax revenue allocated by the social planner to the monetary union be more than what is needed to cover the union-wide budget deficits; the emerging surplus in form of ordinary tax revenues will, then, have to be exported to those non-member countries that have been allocated less inflation tax revenues than needed to cover their national budget deficits. These transactions will be accomodated by the respective exchange rates.*

[5] *The Lagrangian function (1) does not imply that the union monetary authority is able to collect the inflation tax from both members and non-members. It just reflects the optimization problem of a social planner who wants to maximize the benefits of the entire (world) economy subject to the overall inflation tax revenue constraint. The utilites (and by that the inflation tax revenues) of members and non-members are calculated separately (first and second term of the right hand side). This reasoning corresponds to the model of Sandler/Tschirhart (1981) who derive an economy-wide welfare maximum subject to (inter alia) the membership size of a consumer cooperative. The constraint of the entire inflation tax in equation (1) is equivalent to their formulation of the transformation function.*

[6] *This assumption is consistent with the former supposition of identical countries as in club theory »congestion» and »camaraderie» effects do not hang upon differences at the individual (country) level.*

[7] *As long as the individual non-members are small in comparison to the monetary union as a whole their impact on the inflation rate of the union is negligible. By assumption the behavior of the non-members is non-cooperative not only towards the union but also among each other. So a noticeable rise of prices can occure only, if the dominant strategy of each non-member is a strategic devaluation vis-à-vis to the rest of the world. This would result in a ruinous competition of mutual devaluations which is improbable to be a stable outcome.*

(10) $\breve{R} = nR + (\bar{n} - n)\tilde{R} = constant$

Taking derivatives of (1) with respect to π, n, $\tilde{\pi}$ and λ yields the following necessary conditions for a maximum[8]:

$$(11) \quad \frac{\partial L}{\partial \pi} = n\Bigg[\overbrace{(R_\pi - C_\pi)}^{NR_\pi} + \overbrace{(IB_\pi - IC_\pi)}^{NIB_\pi}\Bigg] - n\lambda\big[m(\pi)_\pi \pi + m(\pi)\big] \overset{!}{=} 0$$

$$(12) \quad \frac{\partial L}{\partial n} = \Bigg[\overbrace{(R - C)}^{NR} + \overbrace{(IB - IC)}^{NIB}\Bigg] + n\Bigg[\overbrace{(R_n - C_n)}^{NR_n} + \overbrace{(IB_n - IC_n)}^{NIB_n}\Bigg] - \Bigg[\overbrace{(\tilde{R} - \tilde{C})}^{N\tilde{R}} + \overbrace{(N\tilde{I}B - N\tilde{I}C)}^{NN\tilde{I}B}\Bigg] + (\bar{n} - n)\Bigg[\overbrace{(N\tilde{I}B_n - N\tilde{I}C_n)}^{NN\tilde{I}B_n}\Bigg] - \lambda\big[m(\pi)\pi - \tilde{m}(\tilde{\pi})\tilde{\pi}\big] \overset{!}{=} 0$$

$$(13) \quad \frac{\partial L}{\partial \tilde{\pi}} = (\bar{n} - n)\Bigg[\overbrace{(\tilde{R}_{\tilde{\pi}} - \tilde{C}_{\tilde{\pi}})}^{N\tilde{R}_{\tilde{\pi}}} + \overbrace{(N\tilde{I}B_{\tilde{\pi}} - N\tilde{I}C_{\tilde{\pi}})}^{NN\tilde{I}B_{\tilde{\pi}}}\Bigg] - \lambda(\bar{n} - n)\big[\tilde{m}(\tilde{\pi})_{\tilde{\pi}}\tilde{\pi} + \tilde{m}(\tilde{\pi})\big] \overset{!}{=} 0$$

$$(14) \quad \frac{\partial L}{\partial \lambda} = \breve{R} - nm(\pi)\pi - (\bar{n} - n)\tilde{m}(\tilde{\pi})\tilde{\pi} \overset{!}{=} 0$$

An abbreviated version of the four conditions [(11)–(14)] is given by:

$$(11a) \quad \frac{\partial L}{\partial \pi} = n(NR_\pi + NIB_\pi) - n\lambda m(\pi)(1 + \eta_{m,\pi}) \overset{!}{=} 0$$

$$(12a) \quad \frac{\partial L}{\partial n} = NR + NIB + n(NR_n + NIB_n) - \big(N\tilde{R} + NN\tilde{I}B\big)$$

$$(13a) \quad \frac{\partial L}{\partial \tilde{\pi}} = (\bar{n} - n)\big(N\tilde{R}_{\tilde{\pi}} + NN\tilde{I}B_{\tilde{\pi}}\big) - \lambda(\bar{n} - n)\tilde{m}(\tilde{\pi})(1 + \eta_{\tilde{m},\tilde{\pi}}) \overset{!}{=} 0$$

$$(14a) \quad \frac{\partial L}{\partial \lambda} = \breve{R} - nm(\pi)\pi - (\bar{n} - n)\tilde{m}(\tilde{\pi})\tilde{\pi} \overset{!}{=} 0$$

solving for λ and $\breve{R}$ gives:

$$(11b) \quad \lambda = \frac{NR_\pi + NIB_\pi}{m(\pi)(1 + \eta_{m,\pi})}$$

$$(12b) \quad \lambda = \frac{\big(NR - N\tilde{R}\big) + \big(NIB - NN\tilde{I}B\big)}{m(\pi)\pi - \tilde{m}(\tilde{\pi})\tilde{\pi}} + \frac{n(NR_n + NIB_n) + (\bar{n} - n)NN\tilde{I}B_n}{m(\pi)\pi - \tilde{m}(\tilde{\pi})\tilde{\pi}}$$

$$(13b) \quad \lambda = \frac{N\tilde{R}_{\tilde{\pi}} + NN\tilde{I}B_{\tilde{\pi}}}{\tilde{m}(\tilde{\pi})(1 + \eta_{\tilde{m},\tilde{\pi}})}$$

$$(14b) \quad \breve{R} = nm(\pi)\pi + (\bar{n} - n)\tilde{m}(\tilde{\pi})\tilde{\pi}$$

The first order conditions [(11b)–(14b)] are now being used for determining the optimal values of n, π and $\tilde{\pi}$:

$$(15) \quad \frac{N\tilde{R}_{\tilde{\pi}} + NN\tilde{I}B_{\tilde{\pi}}}{\tilde{m}(\tilde{\pi})(1 + \eta_{\tilde{m},\tilde{\pi}})} = \frac{NR_\pi + NIB_\pi}{m(\pi)(1 + \eta_{m,\pi})}$$

$$(15a) \quad m(\pi) = \frac{NR_\pi + NIB_\pi}{N\tilde{R}_{\tilde{\pi}} + NN\tilde{I}B_{\tilde{\pi}}} \frac{(1 + \eta_{\tilde{m},\tilde{\pi}})}{(1 + \eta_{m,\pi})} \tilde{m}(\tilde{\pi})$$

or

$$(15b) \quad \tilde{m}(\tilde{\pi}) = \frac{N\tilde{R}_{\tilde{\pi}} + NN\tilde{I}B_{\tilde{\pi}}}{NR_\pi + NIB_\pi} \frac{(1 + \eta_{m,\pi})}{(1 + \eta_{\tilde{m},\tilde{\pi}})} m(\pi)$$

Thus (see 15a), in the welfare maximum money demand of a representative member country deviates positively from a non-member country

– the higher the relative elasticity of money demand with respect to inflation outside the monetary union; $\left(\frac{1 + \eta_{\tilde{m},\tilde{\pi}}}{1 + \eta_{m,\pi}}\right)$;
– the higher the reaction coefficient of net inflation tax revenues (NR_π) and of net integration benefits (NIB_π) with regard to inflation;
– the lower the reaction coefficient of net inflation tax revenues ($N\tilde{R}_{\tilde{\pi}}$) and of net non-integration benefits ($NN\tilde{I}B_{\tilde{\pi}}$) with regard to inflation outside the monetary union.

[8] *Revenues and costs of inflation outside the monetary union are not dependent on the number of members in the union nor on the number of countries outside the union, because each non-member earns its own inflation tax. This causes an asymmetry to equations (2) and (3), respectively. This statement does not contradict the content of footnote 4 as if non-members receive transfers of ordinary tax revenues, these, by definition, have not been raised in their own country.*

Inverse results hold for money demand outside the monetary union (see 15b). As both optimal money demands are negatively linked to the respective optimal inflation rates, one can easily deduct the corresponding impacts of the aforementioned influences on the optimal provision of the club good, π. Hence, (15a) and (15b) implicitly provide the *provision conditions* of our model[9].

In order to explore the membership condition we have to combine appropriately the necessary conditions for a welfare maximum:

Combining (11b) and (12b) leads to:

$$(16)\quad \frac{NR_{\pi}+NIB_{\pi}}{m(\pi)(1+\eta_{m,\pi})}=\frac{(NR-N\tilde{R})+(NIB-NN\tilde{I}B)}{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}+\frac{n(NR_n+NIB_n)+(\bar{n}-n)NN\tilde{I}B_n}{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}$$

$$(16a)\quad n^*=\frac{(NR_{\pi}+NIB_{\pi})\dfrac{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}{m(\pi)(1+\eta_{m,\pi})}}{NR_n+NIB_n-NN\tilde{I}B_n}-\frac{(NR-N\tilde{R})-(NIB-NN\tilde{I}B)-\bar{n}NN\tilde{I}B_n}{NR_n+NIB_n-NN\tilde{I}B_n}$$

And, finally:

$$(16b)\quad n^*=\frac{(NIB-NN\tilde{I}B)+(NR-N\tilde{R})}{NN\tilde{I}B_n-NR_n-NIB_n}-\frac{(N\tilde{R}_{\tilde{\pi}}+NN\tilde{I}B_{\tilde{\pi}})\dfrac{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}{\tilde{m}(\tilde{\pi})(1+\eta_{\tilde{m},\tilde{\pi}})}}{NN\tilde{I}B_n-NR_n-NIB_n}+\frac{\bar{n}NN\tilde{I}B_n}{NN\tilde{I}B_n-NR_n-NIB_n}$$

after consideration of (15b).

As (16b) shows, the number of participation in a monetary union will be the higher,

- the greater the difference between net integration and net non-integration benefits ($NIB - NN\tilde{I}B$);
- the greater the difference between net inflation tax revenues within (the monetary) and outside the monetary union ($NR - N\tilde{R}$);
- the higher the reaction coefficient of net inflation tax revenues within the monetary union vis-à-vis to the number of participants (NR_n);
- the higher the coefficient of reaction of net integration benefits vis-à-vis the number of participants (NIB_n);
- the higher the elasticity of money demand with respect to inflation outside the monetary union ($\eta_{\tilde{m},\tilde{\pi}}$);
- the lower (higher) the reaction coefficient of net inflation tax revenues ($N\tilde{R}_{\tilde{\pi}}$) and of net non.integration benefits ($NN\tilde{I}B_{\tilde{\pi}}$) with regard to inflation outside the monetary union for $m(\pi)\pi - \tilde{m}(\tilde{\pi})\tilde{\pi} > (<) 0$;

Combining (12b) and (13b) gives:

$$(17)\quad \frac{N\tilde{R}_{\tilde{\pi}}+NN\tilde{I}B_{\tilde{\pi}}}{\tilde{m}(\tilde{\pi})(1+\eta_{\tilde{m},\tilde{\pi}})}=\frac{(NR-N\tilde{R})+(NIB-NN\tilde{I}B)}{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}+\frac{n(NR_n+NIB_n)+(\bar{n}-n)NN\tilde{I}B_n}{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}$$

$$(17a)\quad n^*=\frac{(NIB-NN\tilde{I}B)+(NR-N\tilde{R})}{NN\tilde{I}B_n-NR_n-NIB_n}-\frac{(N\tilde{R}_{\tilde{\pi}}+NN\tilde{I}B_{\tilde{\pi}})\dfrac{m(\pi)\pi-\tilde{m}(\tilde{\pi})\tilde{\pi}}{\tilde{m}(\tilde{\pi})(1+\eta_{\tilde{m},\tilde{\pi}})}+\bar{n}NN\tilde{I}B_n}{NN\tilde{I}B_n-NR_n-NIB_n}$$

which is essentially the same as in (16b)!

2.3 General Equilibrium in the Case of Heterogenous Members: A Graphical Approach

2.3.1 The Provision of the Club Good

The idea to take the monetary union wide inflation rate as a club good provided to the members of the same currency area can be defended with several arguments: if we abstract from

[9] *Between the union-wide inflation rate and inflation rates of non-members purchasing power parity applies.*

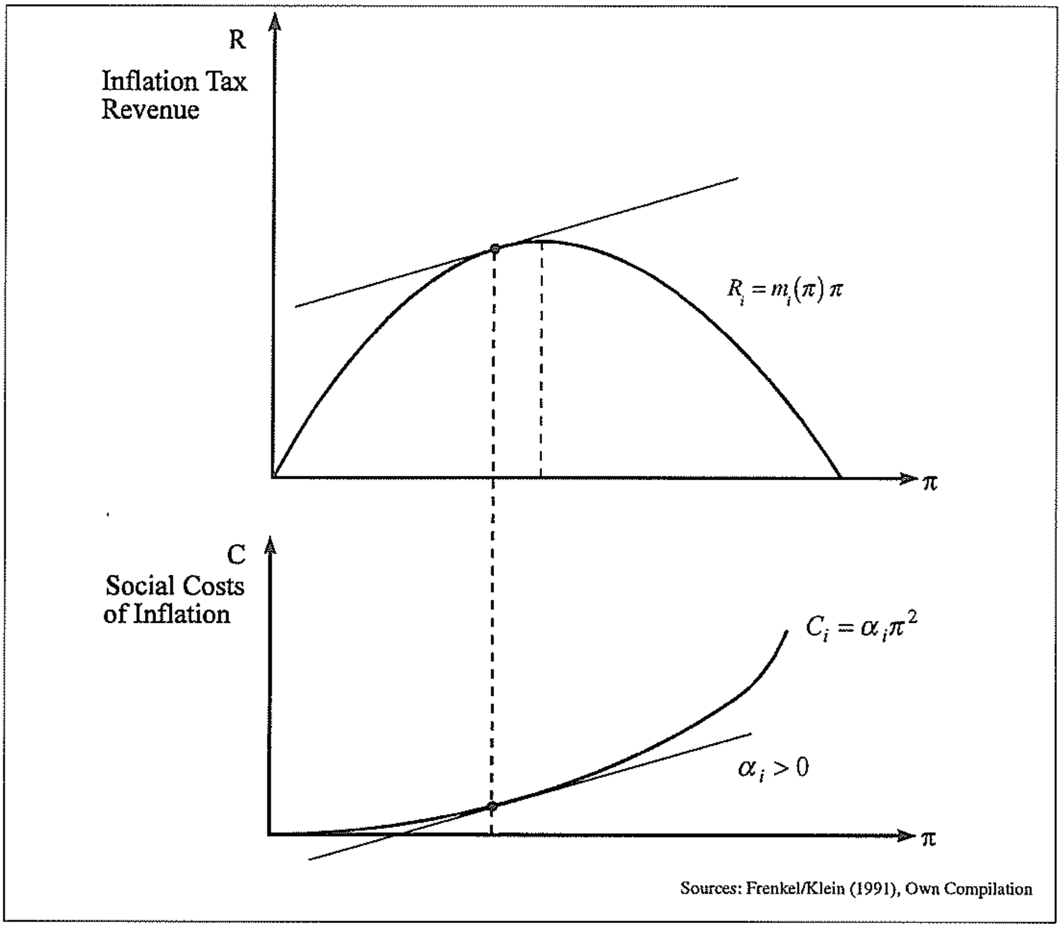


Figure 1. Optimal inflation rate of a country i (flexible exchange rates).

the rather academic zero-inflation position, positive inflation rates are to be expected when different countries join into a monetary union. Hence, inflation tax revenues will emerge and will have to be distributed among the member countries. Non-members are costlessly excluded by definition from the »utilisation» of inflation tax revenues. Also, the level and the (hopefully low) variance of the common inflation rate will contribute to the reputation of the monetary union. It is not only inflation and its »utilisation» alone which raises the interest to become a member of a monetary union, but also the status and the reputation that the new member of the monetary union may gain: As Tavlas (1993, 674) puts it, »the time inconsistency issue indicates that a nation's monetary policy credibility can be enhanced by attaching its monetary policy to that of a currency with a low – inflation anchor currency.»

First let us consider the question of the »optimal» rate of inflation from the standpoint of a *single country* ($n = 1$) assuming *flexible exchange rates* (see Figure 1): The upper graph shows a typical curve for inflation tax revenue, while the lower graph shows the total economic costs of inflation[10]. Inflation is costly because

[10] *In a recent article Kremers and Lane (1990, 777ff.) considered whether it would be possible now – years before EMU – to identify an aggregate money demand function for the countries participating in the intervention mech-*

– among other things – it decreases the value of real money balances (Bofinger and Frenkel, 1991, 173). The optimal rate of inflation from the standpoint of an individual country is to be located where the marginal revenue of inflation equals the marginal cost. Generally speaking, this rate of inflation is lower than it would be if inflation tax revenue were to be maximised (Frenkel and Klein, 1991, 415).

If we move from n = 1 to the case of a monetary union (n ≥ 2) with a *single currency issued by a union authority*, the following modifications must be made: each increase in the number of members will produce a new aggregate money demand function, with the result that the inflation tax curve will also be modified. It should be noted that in a monetary union »the condition of money market equilibrium does not apply to each country separately, but only at an aggregate level...» (Frenkel and Klein, 1991, 415ff.). Countries with low rates of price change over the years will have significantly more elastic money demand functions with respect to inflation. In other words, the more marked the experience with creeping inflation has already been, the lower the partial elasticity of the real demand for money with respect to the rate of inflation, ceteris paribus.[11] This differentiation seems more illustrating than the supposition of Frenkel and Klein (1991, 414) that in all countries the same »semielasticity of demand for money» will be obtained. What consequences does this have for the slope of the inflation tax revenue curve?

In the case of the inflation-prone countries, ceteris paribus, a higher inflation rate at the level of the maximum (see $\pi^{**} > \pi^{***} > \pi^{*}$ in the upper section of Figure 2) of the tax revenue curve is to be expected. Secondly, these countries are affected by an absolute decline in the revenue from the optimal inflation tax. The consequence is that the revenue curve is flatter and falls to zero at a much higher rate of inflation (see the upper section of Figure 2).

At the same time the costs of inflation in different countries will be assessed differently by these same countries: a varying aversion parameter α_i (> 0) and an increasing number of members produce various cost curves. α_i ($i = 1 \ldots n$) of less (more) than one will shift the inflation cost curve downwards (upwards). With a corresponding normalisation of the aversion propensity, an α_i of one could be defined as a »neutral aversion» and the empirical distribution of α_i for a very large n would probably approximate to a normal distribution. If the countries were of the same size and/or receive the same weight, the inflation cost curve would approach the relationship $C = \pi^2$. For finite and small n – like in the case of Europe – this will not hold. Here the distribution would best be represented by a curve that is skewed to the left (see Figure 3). Let us explore this point more in detail:

If a country that is averse to inflation ($\alpha_1 > 1$) unites with one that is inclined to inflation ($\alpha_1 < 1$) – an unlikely event in reality – the cost function $C = \pi^2$, which is not typical for any individual of the two countries, could (giving both countries the same weight) hold for the aggregate, possibly together with a »middling» inflation tax revenue curve with its maximum at π^{***} (see Figure 2).[12] It is, however, much more likely – and in the *theory of »total economy» clubs* even necessary – that all individuals are »ordered by the index i according to their preference for the club good» (Sandler and Tschirhart, 1980, 1487) – that similar countries will choose to unite, that is countries that are similarly adverse to inflation. Thus, we assume that countries can be »ranked» according to their preferences towards inflation. In the very much realistic case that the union is established

anism of the EMS (1979–87). A stable relationship was found to exist between the real demand for M_1 on the one hand and, on the other, real income, the rate of inflation, various interest rates, and the exchange rate of the ECU against the US dollar (ibid., 779).

[11] *This assertion is backed by extensive studies on inflation tax curves for Latin-American countries like Argentina, Brazil and Chile. See for example Fischer, Hiemenz and Trapp, 1985.*

[12] *One may argue that the phenomenon of divergent money demand functions is just a transitional one as – with a unique inflation rate – money demands tend to converge. However, the transition period may last quite long given divergent national histories and experiences with inflation in the past. Hence, we assume that there is a considerable inertia in money demand behavior.*

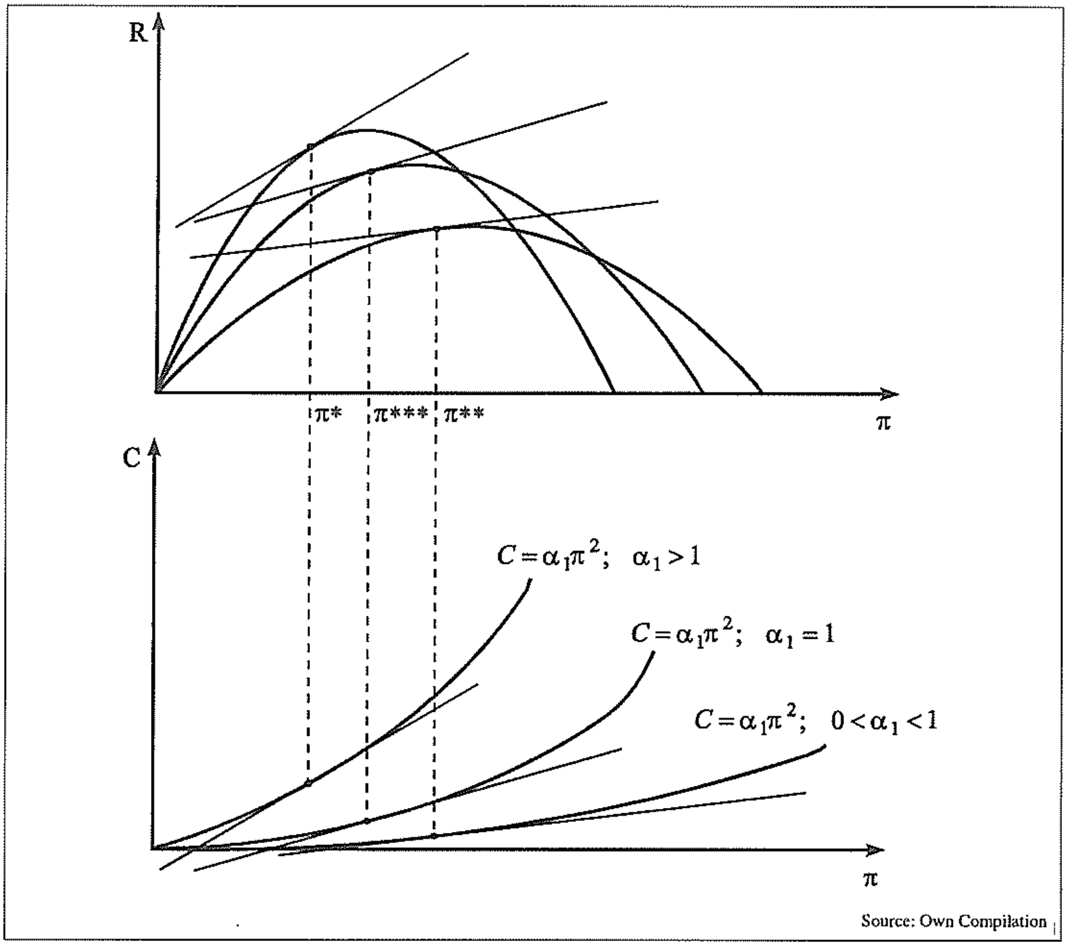


Figure 2. Optimal inflation rates at varying inflation tax revenue and social cost of inflation curves.

first by the stable economies, the common rate of inflation will gradually rise as the number of member states increases. Given the assumption made on the distribution of inflation rates (Figure 3) the likelihood for high-inflation countries to join the monetary union increases with the number of participants. These will tend to push up the union inflation rate. This would thus present a hysteresis-type effect on the union inflation.

In other words, the optimal rate of inflation for the monetary union can only be determined when the number of members is known. Hence, there do exist a number of possible inflation equilibria, corresponding to different club sizes. The functional relationship, $\pi = \pi(n)$, can – in a very simplified first approach – be taken to be linear and positively sloped as long as the stable economies form the center of the monetary union.

On the other hand, if the less stable economies set the ball rolling, the more low-inflation countries enter, the more the common inflation rate will tend to level off: the $\pi(n)$ curve then falls. As a result, there are *two* scenarios for the $\pi(n)$ function, assuming a *systematic* approach to monetary union, in the case of a *stochastic* approach, a priori no general statements with regard to the curve of the $\pi(n)$ function can be made.

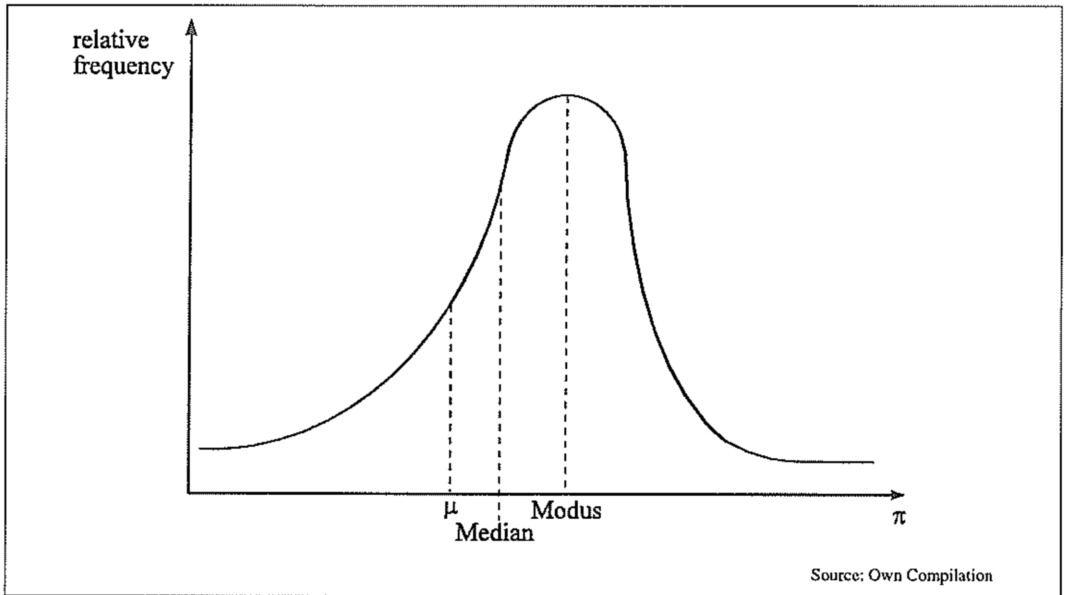


Figure 3. The distribution of inflation rates given a finite number of countries (The Case of Europe).

2.3.2 In Search of Membership Size

In a second step we shall now start with a situation where the union-wide inflation rate has been agreed upon by the partners and/or a *leading country has* predetermined the rate of inflation.[13] In Figure 4, for example, the German inflation rate serves as the benchmark: the integration costs for the monetary union are calculated as deviations from the German level of inflation.[14] The reasoning behind can be explained as follows: different inflation rates emerge from autonomous monetary policies and underlying preferences with regard to economic policy.[15] The more potential members' inflation rates differ from the anchor currency's rate, the more heterogeneous preferences between the hypothetical union members have to be harmonised following Kindleberger and Magnifico (see above): »decision theory suggests that the addition of a new member will raise the costs of finding agreement in a more than proportional manner» (Fratianni and Pattison, 1982, 252)[16].

Also, the likelihood for asymmetric shocks (Tower and Willett) increases with the number of members in a monetary union: presumably, »fiscal policy will be ... needed to reduce the adjustment costs in a monetary union.[17] This is because a monetary union reduces the speed of adjustment to asymmetric developments since one part of the process (exchange rates) have been removed ... Monetary union requires a greater degree of fiscal support and co-ordination (and possibly larger deficits) than other regimes» (Hallett and Vines, 1993, 36f.). As Hallett and Vines show in a two-country simulation exercise »fiscal activity has to be greater in both countries to compensate for the restrictions on

[13] *Thus, we develop further De Grauwe's point that »fixed exchange rate systems tend to end up with one leader and many followers» (1992, 121) as (more or less) fixed exchange rates often preceed monetary unions!*

[14] *Assuming that it can be always identified by its unique inflation rate (see below).*

[15] *»... the obvious main implication of a common currency is the loss of autonomy in monetary policy» (Ishiyama, 1975, 365).*

[16] *We believe this aspect to be relevant though – as the referee pointed out – the European Central Bank as planned should be able to avoid some of these problems since it is designed to be independent of the political sphere of EU.*

[17] *I owe this point to Assar Lindbeck during the discussion of my joint paper with L. Menkhoff and J. Stiefl at the Dublin conference (EEA, 1992).*

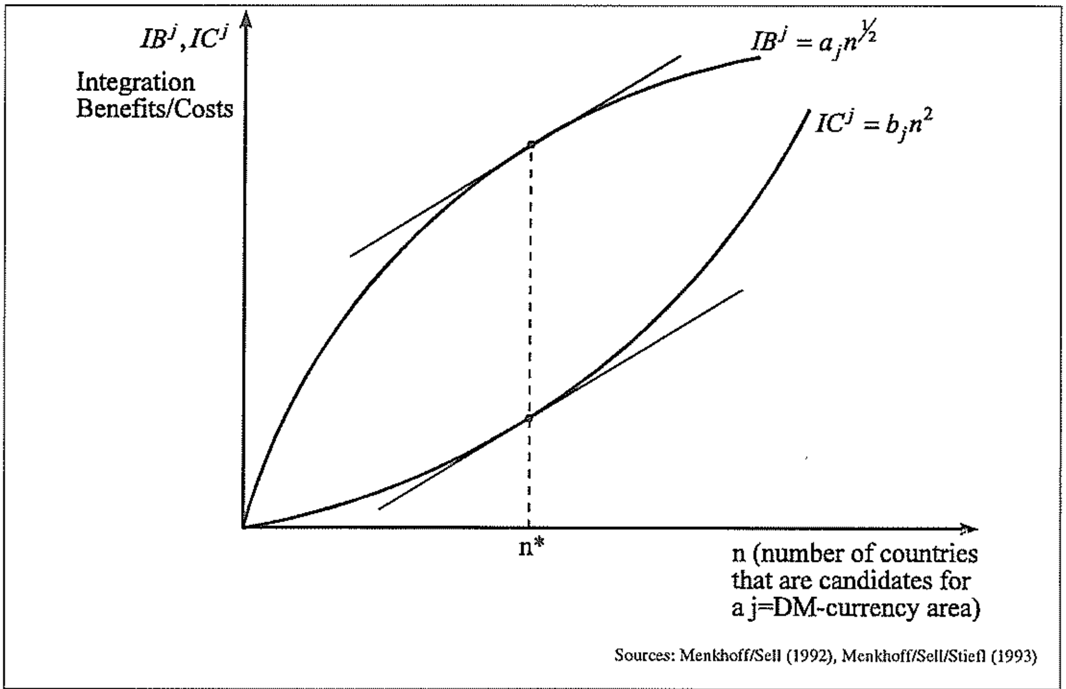


Figure 4. A cost-benefit-approach to determine an optimal DM-currency area.

relative monetary adjustments» (ibid., 42). Both aspects can be integrated into the concept of *integration costs* for the monetary union. If the countries joining are arranged in ascending order of inflation differentials to Germany, we obtain an upward-sloping curve such as represented by a neoclassical cost function.

If this sequence of countries is retained, each new member will contribute *integration benefits* to the monetary union (in terms of lowering information and transaction costs) which will be the higher the closer that country's trade relations are with other member countries. A standard measure here could be the trade figure as a proportion of total trade among the countries under consideration. Hence, McKinnon's degree of openness applies. Here too, an upward-sloping curve is to be expected,[18] although probably levelling off as we see in the case of the utility function in Figure 4.

The idea behind is that similar countries in terms of per capita income and their preferences,[19] (see above), will have quite intensive trade relationships. This is what we have basically learned by the *intra-industry-trade* insights. Thus, the abolition of exchange rate uncertainty will contribute significantly to reduce transaction and information costs within the monetary union. The latter may contribute to trade creation and ease in capital mobility by reducing risk, ceteris paribus. Also, »exchange rate stability encourages trade and investment according to comparative advantage or scale economies, and without any devaluation risk» (Hallett and Vines, 1993, 35).

However, different integration cost and integration benefit functions emerge once the common inflation rate (or the inflation rate of the anchoring currency for the monetary union) is altered. There do exist a number of equilibria in terms of an optimal number of club candi-

[18] *Calculations for European countries confirm the stylised curves presented in Figure 4 (See Menkhoff and Sell, 1992).*

[19] *Assuming that these two variables do also correlate highly between each other!*

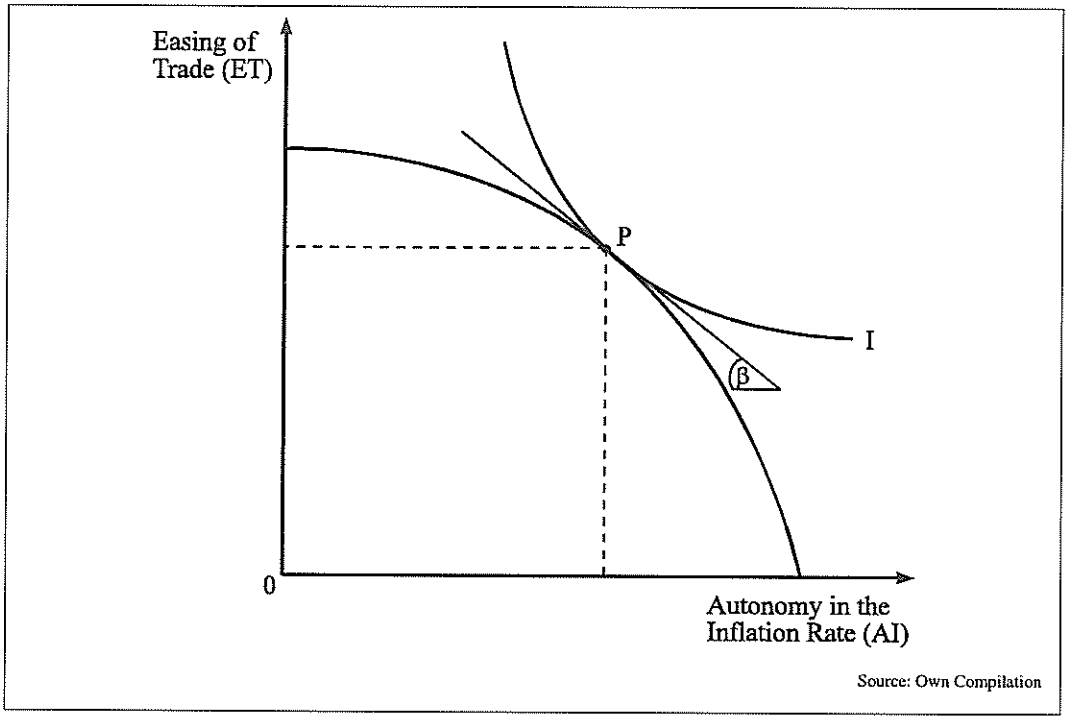


Figure 5. The optimization-problem for an anchor currency in a Monetary Union.

dates corresponding to different »core» inflation rates. In other words, the optimal number of club members, i.e. members of the monetary union, can only be determined, when the common inflation rate for the union as a whole is known!

The emerging function shall be labeled $n = n(\pi)$. For greater simplicity this function is also assumed to be linear and it has a positive slope. Why is the slope of the $n(\pi)$ function positive? The underlying assumption for finite numbers is that (see above) of a distribution of inflation rates of potential member states which is skewed to the left (see Figure 3). If countries with high rates of inflation are made anchors of the monetary union, a drastic rise in costs will follow at a comparatively late stage, namely with the inclusion of the few stable countries.

Because of the cost/benefit measures which cannot be compared directly, the optimal solution can, however, only be determined by means of a further comparative evaluation criterion. This would indicate how cost/benefit changes can be weighted against each other or, in other words, which trade concessions at the optimal point will justify what level of adjustment in the rate of inflation (Menkhoff and Sell, 1991, 579, see Figure 5).[20]

Assuming the existence of a »production possibilities frontier» with the choice of either maximising one's autonomy with regard to the inflation rate (at fully flexible exchange rates) or helping to make trade easier by abolishing exchange rate risk at the cost of giving away an autonomous monetary policy, the existence of an optimum requires a social preference function, hence a system of social indifference curves. In Figure 5 a single anchor country would choose the point P with the tangent of β equalling the marginal trade off rate between inflation rate autonomy and easing of trade.[21]

[20] *The trade off curve, in principle, may be convex, concave, or linear. In Figure 5 we restrict the discussion to the concave case.*

[21] *... pros and cons are extremely difficult to weigh. In a*

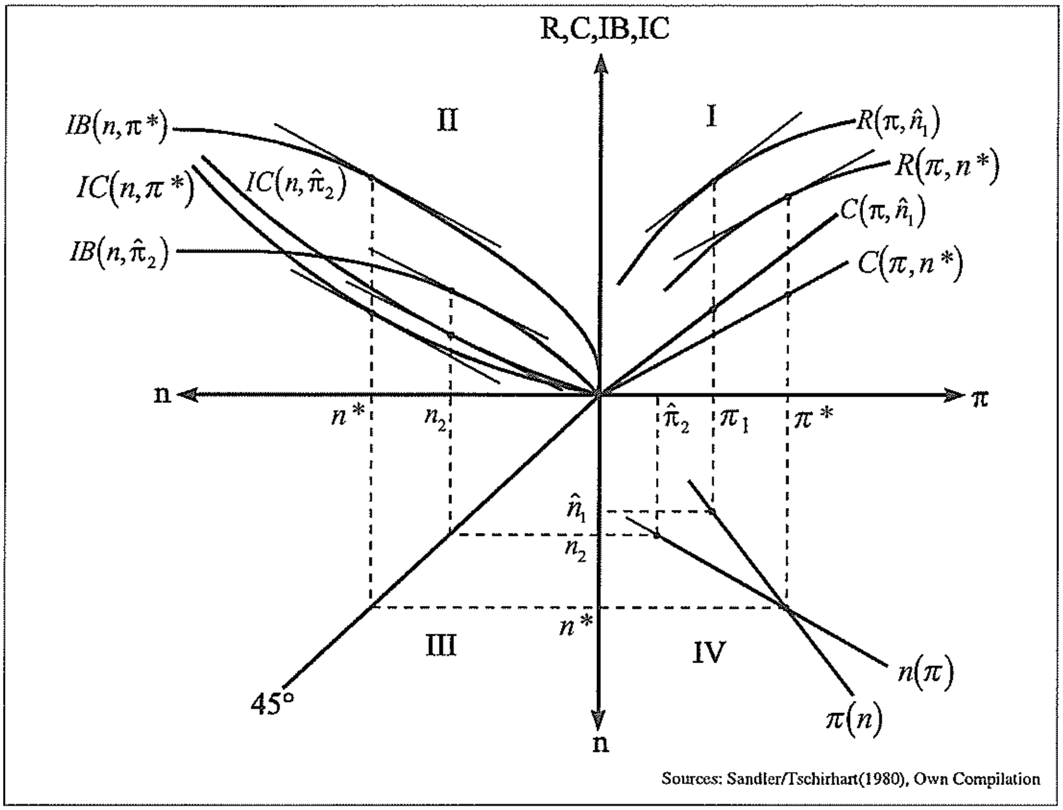


Figure 6. Optimal currency areas (basic model).

If the optimal currency area is established from the standpoint of other potential *anchor currencies*, this will in all probability produce other cost and benefit curves, because of their different optimal marginal trade off rates between integration costs and benefits, and a change in the number of member states. In general, the respective n^* will be higher, the higher the inflation rate of the *lead country*. Here too, a wide range of optima are possible in principle if the range of national inflation rates is sufficiently wide. In other words, the optimal number of countries in the monetary union can only be determined when the future common inflation rate has been established.

broader sense, the issue definitely falls into the realm of welfare economics, and the ultimate decision inevitably rests on strong political value judgements» (Ishiyama, 1975, 362).

2.3.3 *The Complete Graphical Solution and the Stability of Equilibrium*

In Figure 6, the $n(\pi)$ function is obtained from *quadrant II*, where different integration cost and integration benefit functions (at alternative inflation rates of the leading country) are used to optimise the respective number of member countries. Analogously, the $n(\pi)$ function is derived from *quadrant I*, where different inflation revenue and inflation cost functions (at alternative numbers of participating countries) are used to optimise the respective inflation rate. General equilibrium is achieved where the $n(\pi)$ and the $n(\pi)$ schedules intersect in *quadrant IV*.

Finally, we will now proceed to assess the stability of the equilibrium in the (European) case of heterogenous members:

(i) *Existence, Unambiguity*: in the case of both the rising $\pi(n)$ and the falling $\pi(n)$ curves of π/n combinations along which the marginal costs and marginal revenues of inflation are equal there will be an intersection with the $\pi(n)$ function. In the first case there is a low-inflation equilibrium (*P*), in the second a high-inflation equilibrium(*Q*). The intersections of the two curves draw closer together as the $n(\pi)$ function shifts to the right.

How are such shifts to the right to be explained? Let us assume, for example, that at P the DM is the anchor currency; ceteris paribus, the optimal DM currency area will be even greater if there is an exogenous shifting of the integration benefit curve (cost curve) upwards (downwards). This could come about as a result of a structural shift in favour of tradeables to the detriment of non-tradeable goods and/or a lower weighting of the inflation rate as a measure of preferences with regard to economic policy.

There is no possibility of two or more intersections between the $n(\pi)$ and the $\pi(n)$ functions: whilst the $\pi(n)$ function rises from a point on the ordinate above the origin at the level of the lowest inflation rate, the $n(\pi)$ function can only begin at the earliest at the origin of the dashed system of co-ordinates (see point R in Figure 7). According to the construction in Figure 2, the respective anchor currency itself is attributed neither costs nor benefits. These only arise for $n \geq 2$. The inflation rate of an anchor currency cannot, however, lie below the lowest for a single member state.

(ii) *Stability*: First let us observe points to the left (right) of the $n(\pi)_0$ function. If the inflation rate is as high as at P, the number of member states will be smaller (larger) than the optimal number. In this case the marginal integration benefits (costs) will be greater than the marginal integration costs (benefits). By raising (lowering) the number of member states n a more satisfactory solution would appear to be possible.

What holds for points above (below) the $\pi(n)$ or the $\pi(n)'$ function? With the same number of members as on the $\pi(n)$ or the $\pi(n)'$ function the actual (optimal) inflation rate exceeds the in comparison optimal (actual) inflation rate. This simply means that at such points the marginal benefits or revenues of inflation are less (greater) than the marginal costs. A lowering (raising) of the inflation rate appears to make an approach to optimal points possible. This leads us to the important conclusion that both high- and low-inflation equilibria are globally stable from the union as a whole point of view (see Begg, 1982, 33), as is indicated by Figure 7.

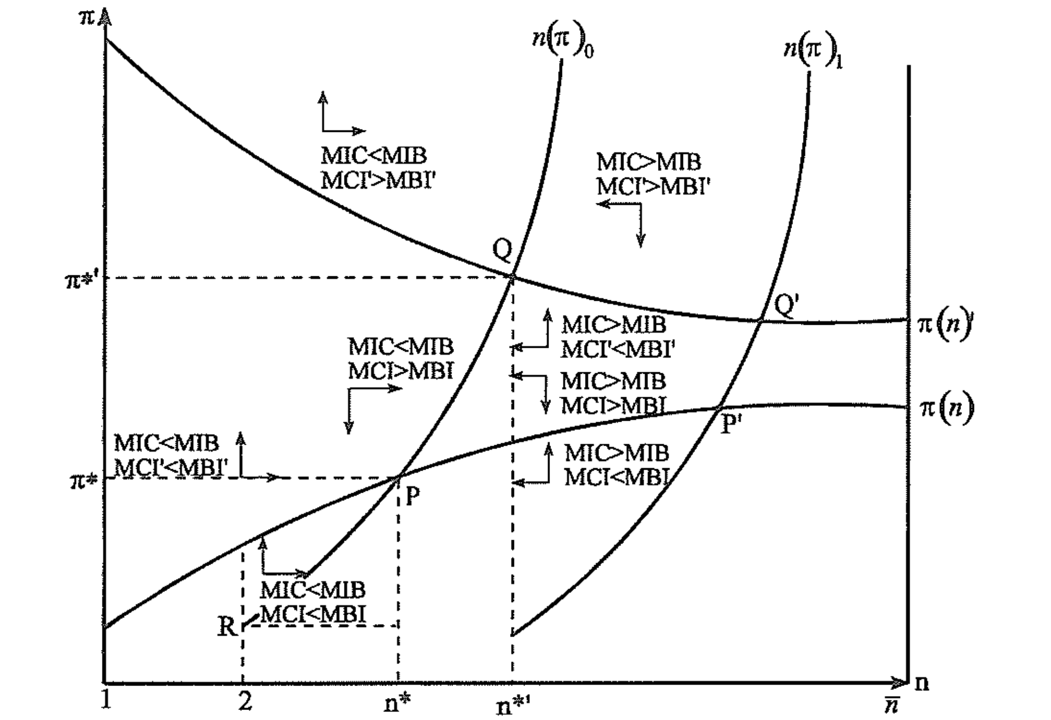
What is the significance of this result for economic policy? In the »*total economy model*» deviations from the optimal solution are only temporary and can be overcome by a readjustment of the common rate of inflation and/or a change in the number of member states.

From the »*within club model*» point of view there are more points to consider: In a monetary union, the overall level of inflation tax depends on, among other factors, the regulations governing the common central bank; the monetisation[22] of deficits will affect in any case the union as a whole (Wyplosz, 1991, 21). Member states must agree not only upon a rate of inflation, but also on their respective shares of the profit from coinage (Buiter and Kletzer, 1990, 11). In the language of club theory, members are here claiming their shares of inflation tax revenues.[23] This issue applies to every ordinary member of the club/monetary union. But, in reality, not all club members can be taken as of equal importance. There are »special members» or *hegemonies* within a club/ monetary union.

There is a question that has not been explicitly addressed in this paper so far: It concerns the incentives for the hegemon to participate in a monetary union. Obviously, it is less clear what the gains are for the anchor currency country. The answer could be that the union increases the benefits derived from other aspects of integration: Several explanations have been offered including the desire of the dominant country to promote its monetary leadership and its wish to decrease speculative capital

[22] *Such a situation could come about either because the ECB would lack formal independence or because, despite formal independence, the ECB would choose to lose a game of chicken with the budgetary authorities rather than causing a monetary and fiscal crisis by not giving in»(Buiter and Kletzer, 1990, 2ff.).*

[23] *»... the number of visits to the club each member is to be allowed»(Hearne, 1988, 200).*



π(n): Systematic Approach to the MU "from below"

π(n)': Systematic Approach to the MU "from above"

MIB: Marginal Integration Benefits

MIC: Marginal Integration Costs

MBI: Marginal Benefits of Inflation

MCI: Marginal Costs of Inflation

Source: Own Compilation

Figure 7. Phase diagram for the optimal currency area.

flows in order to enhance its control over domestic monetary conditions (Tavlas, 1993, 675). The issue involved concerns the »within club model» view of Buchanan, where the stability of a club is analysed considering the question of voluntary participation in the union by *all* the potential members, that is from the point of view of actually participating, non-participating, prospectively participating countries and, also, from the point of view of »special members», that is from the hegemon's point of view.

As has been shown elsewhere (Frenkel and Klein, 1991,1992) the stability of the monetary union *in terms of the participating countries* depends very much on the perceptions that the different member countries have of the common inflation rate (an optimised inflation rate for the union as a whole*): at a given number* of countries the distribution of shares in the inflation tax revenue must favourise those members with a relatively high aversion to inflation (ibid., 421/82). As Frenkel and Klein put it (1991, 422) »countries with an above-average aversion to inflation must reckon with an increase in their inflation rate on entering monetary union ... The only way in which they can be compensated for this is by increasing their share of inflation tax revenues».

With a rising recognition among the rest of the world, new potential members will become interested in joining the union: in »abolishing national monetary sovereignty by joining a union with a low inflation country ... the high inflation country immediately reaps the benefits of a low inflation reputation ...»(Tavlas, 1993, 674). Assuming that non-members can be excluded and/or that their coming in is bound to the condition of a welfare gain for the union as a whole, this will lead to a situation where non-members will have to struggle economically quite a bit *before* they can apply for membership. The reason is given by Bayoumi (1994, 22): »The entrant gains from lower transactions costs on trade with the entire existing union, while the incumbent regions only gain on their trade with the potential entrant».

As far as the interest of non-members to enter an existing club is concerned, Basu has shown that excess demand equilibria are possible and even very likely when the status rating of the club is in danger (ibid., 1989, 655). In the framework of a monetary union it is not only the inflation rate itself, but also the inherent inflation tax revenue and the derived reputation issue which may »suffer» from the entrance of new members. Individual countries that do not become members of the union may either remain with their own currencies or they may strive for the construction of another currency club. Regions outside the union will, however, most likely be affected by negative welfare effects: as Bayoumi explains, »... the gains from the union ... are limited to the members of the union, while the losses from the union, in the form of lower output due to the interaction between the common exchange rate» and existing nominal rigidities may affect everybody (1994, 22).

By analogy we may state that at *an optimised number of club members* there may be a tendency to change the *given union wide inflation rate* towards those countries that suffer from above average integration costs and are not compensated by additional integration benefits. This implies that those countries which give away a plenty of their autonomy in the field of price stability are or should be rewarded by intensified trade links: as trade links are to be taken as an endogenous variable, the compensation task will rest upon common funds. Hence, the model is able to explain why – in the case that the (European) monetary union will favour a high degree of price stability – (Southern European) countries with a lower than average propensity towards high price stability will probably claim strong financial support from the central (European) agencies.

Again, it is less clear what happens to the »*hegemon*»: »to the extent that the hegemon takes economic conditions in the peripheral countries into account, it is possible that the low inflation country will experience a reduction in reputation» (Tavlas, 1993, 675). In Figure 4 no direct integration costs or integration benefits have been assigned to the anchor currency (in our example Germany). This fact pinpoints to an element of fragility of the union also found by Alesina and Grilli: »Germany would like to appoint a European Central Bank even more anti-inflationary than its own preferences, if this arrangement were possible. However, France and Italy would vote against ... each country alone cannot appoint a Governor of the Central Bank with preferences different from the country's ones... Germany is just indifferent between joining the union or not» (ibid., 1993, 15). The conclusion which Alesina and Grilli reach is that »to keep Germany in concessions have to be made to this country, which can make the most credible threat of leaving the union» (19).

3. Summary

In this paper we have shown that the Maastricht convergence conditions fulfil some but by no means all criteria for the formation of optimal currency areas, namely factor mobility, financial integration, and harmonisation of preferences with regard to economic policy. Even the fulfilment of such criteria, however, will not in itself suffice to resolve in practice the problem of defining an optimal currency area in Europe.

The theoretical solution suggested here is to regard the formation of a (European) monetary union in the same way as the founding of a club, with both the number of members and the club good determined simultaneously and endogenously. The problem is first solved analytically for the case of homogenous club members and then graphically for the (European) case of heterogenous members; here a $\pi(n)$ function is produced which gives all combinations of members (n) and inflation rates (π) for which the marginal costs and benefits of inflation are equal (from the standpoint of the union). The $n(\pi)$ function gives all combinations of π and n for which the marginal costs and benefits of integration are, from the union's standpoint, equal. The intersection of the $n(\pi)$ and $\pi(n)$ function indicates the desired equilibrium, which is globally stable.

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