ECONOMIC COOPERATION AND CONFRONTATION BETWEEN EUROPE AND THE USA. A GAME THEORETIC APPROACH TO THE ANALYSIS OF INTERNATIONAL MONETARY AND TRADE POLICIES.

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Economic Confrontation and Cooperation between Europe and the USA. A Game Theoretic Approach to the Analysis of International Monetary and Trade Policies.*

by

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1. Introduction.

It has recently become common, and almost fashionable, to analyze problems of economic policy with the techniques of game theory. Research in this field has evolved from the assumption of rather simple types of strategies in a static framework, to more sophisticated applications of dynamic game theory.[1]

All authors that follow this approach in analyzing problems of international economic coordination, have always assumed --at least to our knowledge-- that the policy authorities either do or do not cooperate in the process of optimizing their objective functions. In the real world, however, we observe that countries cooperate in some fields or for certain purposes, while they go their own separate way in some other fields or for other purposes. A recent and striking example is the new wave of

cooperation that was expected to, and at least initially actually did, rise in international monetary affairs since the meeting of the Group of Five in September, 1985. While this was happening countries were and still are threatening to wage commercial war, and do not appear to have consistent views on who should and how reflate demand to eliminate trade imbalances and avoid an international recession. This confrontation in the real field, if it were to continue and get worse, might bring to a halt the process of international cooperation in the monetary field. Actually, there are signs that such may indeed be the case at the time of writing this paper. More intriguing, and more alarming, is the related possibility that monetary cooperation, unaccompanied by cooperation in other fields, may contribute to reinforce, rather than diminish, the forces that push behind confrontation in the real field. In other words, that uncooperative solutions may be superior to partially cooperative ones.

Clearly, economic analysis of these possibilities requires the abandonment of a dichotomic approach to the theory of international economic policy --cooperation vs. non cooperation-- and the identification of different layers of economic objectives, with the possible coexistence of cooperation at a layer with conflict at another.

In section 2 we present a model that is built around this idea, and is therefore suitable, even at its level of abstraction and simplification, to account for coexisting situations of cooperation and confrontation between groups of countries. We shall mainly deal with two groups of countries, labelled the "US" on one side, and the "EC" on the other. The EC is assumed to consist of two ideal countries --"Germany" and "Italy"-- that

generally cooperate between themselves at all layers of their objectives, except in some cases in which monetary cooperation takes place only between the US and Germany. In general, however, even when all three countries cooperate at the monetary level, the US and the EC are assumed to be in conflict at the real level.

Thus, in section 3, we identify a number of strategies and the resulting games that the two blocks and three countries may play in response to an exogenous shock, represented by a negative supply shift in all countries. We then compute the resulting effects on the endogenous variables and on the loss functions of the three countries, thereby identifying gains and losses resulting from the coexistence of cooperation and confrontation at different levels, as well as from the different trade and monetary arrangements that constrain the various solutions.

The trade constraints on which we concentrate our attention are due, in all cases, to the use of the "most favored nation" clause, whereby, if a tariff is used by a country on its imports, this does not discriminate as between exporting countries. The exception to this clause being that, in some of the games, the European countries apply a zero tariff to their reciprocal trade; moreover, in such games, the two European countries are constrained to use a joint tariff rate vis-à-vis the US. In other words, they form a customs union of the EC type, and not just a free trade area.

The monetary constraints result from the decision of the three countries to stabilize the main exchange rate in the system, i.e.: the DM/$ rate. In addition, the three countries, and in particular the two European ones, also wish to stabilize the intra-European exchange rate, i.e. the lira/DM rate, as in a

diluted form of the European Monetary System. Alternatively, the fact that all three countries care, albeit with different weights, about both exchange rates can be interpreted as expression of their aim to stabilize their individual effective exchange rate.[2]

The decision to manage the main exchange rate in the model (the DM/$) may be taken by all three countries together, or by a cooperative effort between the US and Germany only. Thus we attempt to reproduce, at a simplified level, recent tensions and problems that have arisen about the question of how large should be the group of countries involved in monetary consultation and coordination. After the initial meeting of the Group of Five countries in New York in September, 1985 (the G-5), some of the major industrialized countries, and in particular Canada and Italy, have been complaining for their exclusion from that Group. As a result, the G-5 was enlarged, at least for some purposes and at the official level, to the G-7. In this paper we attempt to model these situations and their possible consequences, by having games played by two (the G-2) or by all three countries (the G-3) cooperatively at the monetary level, while different cooperative or uncooperative aggregations or disaggregations of countries take place at the real level.

In section 4 we draw conclusions from the analysis of this paper and point out directions for additional research, some of which are the object of analysis of the companion paper referred to above.

2. The model.

Our three ideal countries[3] are labelled the US (country 1), Germany (country 2), and Italy (country 3). Their economic structure is specified with a static system of equations that are linear in the logarithms. All variables are expressed as difference from their equilibrium values. Each country is assumed to produce a homogenous product q , according to the following supply functions:

$$(1) \quad q_i = -\eta_i (w_i - p_i) + v_{si}$$

for i = 1,2,3

where w_i and p_i are the nominal wage and the deflator of domestic product in each country i, while the terms v_{si} represent possible exogenous shocks to the supply functions.

Supplies of labour are assumed to be perfectly elastic with respect to nominal wages up to the equilibrium level of employment, which corresponds to full employment. Nominal wages are downward rigid under unemployment conditions, but they react, through explicit or implicit indexation, to the consumers price index, which is a weighted average of the prices of domestic and foreign products:

$$(2) \quad w_i = \varsigma_i \left[\gamma_{ii} p_i + \sum_{j \neq i} \gamma_{ij} (p_j + e_{ij} + t_{ij}) \right] + v_{ti}$$
$$= \varsigma_i p_{ci}$$

for i,j = 1,2,3

where e_{ij} is the exchange rate between currency i and j and t_{ij} is the tariff rate applied by country i on imports from country j. The weights γ_{ij} add up to unity over all j. The parameters ς_i are the only source of monetary non-neutrality in the model: monetary policies are effective on real variables only

in so far as the values of the parameters ε_i are smaller than unity.

Aggregate demand for the product of a country is a function[4] of each country's output, of relative net prices, of tariff rates, and of the real rate of interest (equal to the nominal one in this static model):

$$(3)\quad q_i = \sum_j \delta_{ij} q_j + \sum_{j \neq i} \alpha_{iij} \theta_{ij} + \sum_{j \neq i} \alpha'_{iij} t_{ij} - \sum_{j \neq i} \alpha''_{iji} t_{ji} - \beta_i i_i + v_{di}$$

for i, j, k = 1, 2, 3

where the i_i are rates of interest (not in logarithms), the v_{di} are possible exogenous shocks on demand (e.g. changes in fiscal policy), while θ_{ij} are real bilateral exchange rates defined as:

$$(4)\quad \theta_{ij} = p_j + e_{ij} - p_i$$

Assuming static expectations and perfect substitutability of financial assets issued by different countries and in different currencies, interest rates stay at parity. Thus:

$$(5)\quad i_1 = i_2 = i_3$$

The money markets always clear, with demands for money assumed to be standard functions of the real product, its price level,[5] and the rate of interest, plus a possible exogenous shock:

$$(6)\quad m_i = p_i + \mu_i q_i - \lambda_i i_i + v_{m_i}$$

for i = 1,2,3

The system is closed by the objective functions that the authorities of the three countries try to optimize.

In the first set of games --that are used as standard of reference for the games examined in the second set-- these functions are attributed to a unique policy making authority within each country. In the second set of games the objective functions --which are additive in logarithms-- are split in two separate functions (corresponding to the two subsets of target and instrument variables) that are aimed at or controlled by the two different policy making authorities within each country.

At the "monetary" level, the authorities aim at minimizing deviations of the consumer price index from its equilibrium value. They also manage the DM/$ rate, trying to minimize deviations from its equilibrium value, possibly because of some international agreement along the G-5 type of cooperation. Similarly, they keep an eye on the lira/DM rate, either because this makes up, directly or indirectly through cross rates, their effective (weighted) exchange rate, or because --in the case of Germany and Italy-- they are specifically committed to a closer management of the intra-European exchange rate; or for both reasons. Their instrument is the control of the supply of money.

At the "real" level, the authorities aim at minimizing deviations of real product from its equilibrium value. The instruments used for optimizing the real objective function are tariffs on trade.

We thus assume the following basic objective functions:

$$(7)\quad L_i = -\left[\omega_{pi}\, p_{ci}^2 + \omega_{qi}\, q_i^2 + \omega_{DMi}\, e_{21}^2 + \omega_{Li}\, e_{32}^2\right]$$

for i = 1,2,3

which can be split into pairs of monetary and real objective functions:

$$(8)\quad M_i = -\left[\omega_{pi}\, p_{ci}^2 + \omega_{DMi}\, e_{21}^2 + \omega_{Li}\, e_{32}^2\right]$$

$$(9)\quad R_i = -\left[\omega_{qi}\, q_i^2\right]$$

for i = 1,2,3

The M-functions may be the object of cross-Atlantic cooperation, while the R-functions are more likely to be a field of Euro-American conflict, but also of cooperation within the EC.

As already hinted in the introductory section, splitting the objective functions into two additive components[6] prepares the ground for analyzing the possible consequences of limiting cooperation to monetary and exchange rate matters, or else of enlarging it to the real field. In fact, moves towards closer cooperation in the monetary and exchange rates field seemed to have been taken by the major industrialized countries after the 1980-85 period of strong appreciation of the dollar and highly differing inflation rates.[7] However, while these countries --or more precisely certain authorities among the countries' decision makers (e.g. central bankers and Treasury ministers)-- were still trying to cooperate in the monetary and exchange rates field, they were also threatening each other with protectionist moves and various means of commercial warfare in the real field.

This may happen because Government authorities other than monetary ones, or Parliaments as opposed to Governments, do not necessarily play in the real field the cooperative game that the monetary authorities within the same countries are trying to arrange in the monetary field. It may also happen because the countries that should cooperate in the real field are a larger or different set than the set of countries that cooperate in the monetary field; as when some of the G-5 or G-7 countries have to report their monetary decisions to their political partners --such as EC members not taking part in the G-n meetings-- and in the process possibly adapt them to the decisions that these may want to take in the real field.

3. Policy reactions to an exogenous shock.

In order to analyze the results of the reaction of the three countries' policy authorities under alternative strategies, and more specifically with a view to studying the possible consequences of partial international cooperation --i.e. of cooperation limited to either a subset of targets or a subset of countries, or both-- we compute numerical solutions of the model under the assumption that all three countries are hit by an exogenous 10% fall in the level of supply. This shock is designed to represent a type of deviation from full employment that the authorities should try to offset (a positive supply shock could hardly be interpreted as an event that the authorities may want to oppose), and it could result from an exogenous increase in the price of oil or other raw materials.

The authorities in the three countries are assumed to respond

to this shock according to policy strategies, and possibly under bonds of international economic alliances, that give rise to a large number of alternative games. Out of the numerous games that result even under the simple assumption that strategies are either cooperative or Cournot-Nash uncooperative, we list in Table 1 those that seem to us more interesting from the point of view of this paper; moreover, not all games listed in the table will be used in the discussion of the numerical results.

The first two sets of games in table 1 (games 1 and 2) are to be used as standard of reference for the sets of games 4 through 6. Games 1 and 2 are in fact characterized by optimization of a single objective function in each country; in other words, there is full cooperation between policy authorities within every country, and countries either do or do not cooperate internationally. Games 3 are an intermediate step towards splitting the objective function in two layers, monetary and real: here cooperation or confrontation is limited to the monetary level, but countries do not aim at objectives other than monetary ones. Games 4 through 6, instead, are characterized by the existence, within each country, of two centers of economic policy --monetary and real-- that, for reasons already explained, do not cooperate internally. These two policy authorities may or may not cooperate internationally with the corresponding authorities of one or both remaining countries.

When the two European countries cooperate at both levels, we refer to them as the EC; when they do so at the real level only, we refer to them as the EEC; when their level of cooperation is limited to the monetary one, we label them the EMS.

Our interest is mainly in games 4 through 6. In games 4 there is confrontation between Europe and the US in both fields:

monetary and real. Games 5 and 6 are designed to analyze the possible consequences of monetary cooperation --unmatched by real cooperation-- when the monetary agreements are obtained either within a restricted group of countries (here two, standing for the G-5) that do not coincides with the group where cooperation in the real field is discussed and possibly enforced (games 6), or when monetary cooperation is negotiated within a larger group of countries (here three, standing for the G-7) than those involved in real cooperation (games 5).

It may be useful to notice, in interpreting the results that follow, how trade-offs between objectives may have to be accepted by the different countries and in the different games, because of inadequacy of instruments with respect to objectives of economic policy. Thus, assume for a moment that exchange rates were not arguments of the objective functions, and that no policy instrument were to appear in them either. It would then follow that in game 1.3. the US would have two objectives --its price and output levels-- and one istrument --its money supply. The EC countries would have four objectives -- their price and output levels-- and two instruments --their two money supplies. Thus no country or block of countries could fully reach the best situation in terms of their objective functions.

Assume now that the DM/$ rate also is an argument of the objective functions; then in game 5.2.,for example, none of the three countries could reduce to zero its loss in terms of the M-function: there are four objectives (three consumers price indeces and the DM/$ exchange rate) that are pursued in cooperation, but with only three instruments, i.e. the three money supplies. Thus all three countries must carry a loss in some degree. In terms of the R-functions, however, the US could

theoretically reach the zero loss point: in fact it has one instrument (the tariff rate vis-à-vis the EC) for one objective (the level of its own real product), and the optimum can be reached, unless the instrument also enters the US loss function.[8] Germany and Italy, instead, could not reach their bliss points on the R-functions because of their committment to use a common external tariff in order to aim, cooperatively, at two objectives, i.e. their respective real products. In other words, even though in 5.2. they cooperate in their policy against the US, they have to pay the cost of having tied their hands with the formation of a customs union. However, adding another instrument --such as the tax on capital movements analyzed in Basevi, Kind, Poli (1986)-- to their tool kit, should allow also Germany and Italy to reach the bliss point, as they would then have two instruments for two objectives (unless, again, these instruments also enter their objective functions).

Finally, before interpreting the results, we should explicit our assumptions about the parameters of the model that characterize the structures of the three economies. We have used reasonable values, based on economic theory, actual size of the countries involved, and armchair reasoning about their likely structure. The parameters are reported in Table 2.

This shows, in the second row, that Italian wages are more responsive to consumers prices than US and German wages. From the main diagonal in the γ_{ij} matrix we also see that the US is the most closed economy of the three, with Italy the most open.

The lower part of the table presents the weights that the three countries attribute to targets (and to a policy instrument, the tariff rate) in their objective functions. Italy is the country least concerned with inflation, Germany the most. The

opposite is true for the output target. The weights of the tariff rates are roughly proportional to the openess of each economy to foreign trade. As for managing the exchange rates, Germany cares most about the DM/$ rate, while Italy looks mainly to the Lira/DM rate, although, by giving weight to the DM/$ rate, it also attributes a high implicit weight to the Lira/$ rate. In fact the weights implicitely used are proportional to the share that imports from the countries whose currency is exchanged against the domestic one have in the consumers price index. The main results of our numerical simulations are presented in Tables 3, 4, and 5. With reference to the list of games in Table 1, the simulations presented here exclude the set of games 2, as these have proven to give rise to unstable equilibria. We also omit games 3, whose results are intermediate, in terms of losses, between those of games 1 and games 4- 6. In all the tables the values of the loss functions are reported as already weighted by the respective country's GDP, in order to allow for welfare comparisons.

From table 3 we see that, keeping under unified control both monetary and real objectives, results in a better overall performance in each country, relative to splitting the two layers of objectives as in games 4-6, and also relative to games 3 (not reported here), where the real objectives are disregarded. However, from the point of view of the monetary objectives only, the M-loss functions have for all countries higher values in games 1 than in all other games. In other words, if coordination of monetary policy were to be left in the hands of monetary authorities that had their eyes on monetary objectives only, things would improve from such limited point of view, but deteriorate from the point of view of the overall loss

functions, and this even under games 3, where there is no active use of tariffs.

Within games 1, table 3 shows that, as it was to be expected, full cooperation is the most efficient policy from the point of view of the three countries together (yet, the bliss point cannot be reached for lack of a sufficient number of instruments). Notice, however, that Germany would fare better under confrontation between the EC and the US; yet, the US and Italy together get enough advantage from the cooperative situation to be able to compensate Germany for its relative loss. Notice also that confrontation between the US and the EC (game 1.3.) is preferable for all three countries to a fully uncooperative situation (game 1.2.).

In Table 4, we have reported the results of game 4.3. even though this seems an unlikely game, as it is not in accordance with the institutional predominance of the EEC over the EMS to assume that the European countries cooperate at the monetary level and not at the real level. Yet, in practice, this may have turned out to be often the case, because of the already mentioned stricter and easier links between monetary authorities relative to other authorities of economic policy. In any case, game 4.3. does not change the important rankings of the outcomes, to which we now turn.

Table 4 shows that European cooperation at the real level is the best game in this set, provided the European countries compensate the US for accepting such game. Monetary and real cooperation by the European countries is the second best, and is preferred to a super Nash game where all countries go their own way and do so separately at the real and monetary level (game 4.1.); this, however, requires Italy to make compensations in

order to induce the US and Germany to stay out of such a fully uncooperative game.

Notice how, in the games of table 4, the US tariff rate does not much depend on whether the European countries do or do not cooperate at the monetary and/or at real level: in all cases the rate is about 5.8%. On the other hand, European cooperation, when applied at the real level and possibly also at the monetary level (games 4.2., 4.4.) increases the tariff rate that Germany and Italy jointly impose on US exports, and this is particularly true of Italy. This result depends both on the fact that the higher EEC tariff in these games has to offset the zero tariff on intra-European trade, and on the lower weight that Germany attaches to this instrument relative to Italy: in fact, when European cooperation is only monetary (game 4.3.) the German and Italian duties fall back at the level they have in the game where there is no European cooperation at all (4.1.).

Table 5 is specifically addressed to the question of choosing the level of cooperation in terms of number of countries involved, whether two --the US and Germany-- or all three. By first comparing the rankings for the M-loss functions only, we see that, when things are left to the monetary authorities and we consider games 5 (the G-3 games) separately, then European cooperation at the real level (the EEC) is preserved mainly by Italy compensating Germany to make it accept game 5.2. --which is also preferred by the US-- instead of game 5.1. If all authorities within a country are called to the table of negotiations (i.e., if we consider the ranking of the L-function), it is again mainly Italy that must pay to have game 5.2. rather than 5.1., but the country to be convinced now is the US.

If we consider instead the G-2 games (games 6) separately, then, if things were left to the monetary authorities only, Germany gains enough from not having its hands tied by European cooperation to be able to induce the US to accept 6.1 instead of 6.2, unless Italy also comes in and, together with the US, compensates Germany for the reverse choice. If all authorities are at the bargaining table (ranking of the L-functions), then 6.1. prevails, i.e. a US-German club is formed at the monetary level, with no cooperation at all at the real level. The worrying but interesting result is that this game (game 6.1.) is the relatively preferred one even when we compare the sets of G-2 and G-3 games together (games 5 and 6 together). Thus we may conclude, on this ground, that splitting the problem of cooperation at the monetary and real levels separately contains the seeds of a situation in which European cooperation tends to fall apart because of the advantages that the two main countries reep from belonging to the exclusive G-2 club.

Notice also that, for Italy, a US-German monetary club accompanied by EEC cooperation at the real level (game 6.2.) is preferable to a G-3 club on monetary matters (game 5.2.) and this for both monetary and real authorities; the same holds in absence of EEC real cooperation (6.1. is preferred to 5.1.). This result may be suggestive of the scarce interest that Italian authorities of economic policy, and particularly the monetary ones, initially showed with respect to enlarging the G-5 to G-7 soon after the September 1985 meeting: it was only after a higher political point of view was taken that the Italian opposition to being left out was strogly expressed, with some inside Government criticism of the initial coldness on the part of the Italian Minister of the Treasury.

Comparing now Tables 3, 4 and 5, we notice that, when a centralized control of economic policy is enforced within all three countries (games 1.), the shock and the policy response produce relatively small changes in output but large fluctuations of exchange rates and prices. This is not much altered by international cooperation instead of confrontation, whether generalized or cross-Atlantic. When, however, monetary authorities explicitely shift their policy to stabilization of prices and exchange rates, with disregard of output, then the stabilization of prices and exchange rates takes place at the expense of output, which fluctuates relatively more, even when tariff rates are not used to wage a commercial war (games 3, here not reported). This may induce other authorities than the monetary ones to step in and use tariffs with even worse outcomes on output than the ones caused by the original supply shock (games 4-6). Again, coooperative vs. non cooperative monetary policy across the Atlantic or within Europe does not substantially alter this aspect of the picture.

It comes then natural to suspect, and worry, that the very declared objective of the monetary authorities to stabilize exchange rates with disregard, or at least in preference of, output may reinforce the temptation by other authorities within each country to engage in protective measures and possibly wage an outright commercial war.

4. Summary and conclusions.

In this paper we have built a model and performed numerical simulations on it, with the purpose of analyzing outcomes of strategic interplays that might result from two phenomena that appear to be of importance for analyzing current problems of international economic policy.

The first phenomenon is the fact that international economic policy is a multidimensional affair, and it could be played in at least two fields: a "monetary" one --controlling inflation and exchange rates, with monetary policy and exchange market interventions-- and a "real" field --controlling the level of activity and trade with fiscal and commercial policies. The "monetary" and "real" authorities that act in these two fields may coordinate their policies internationally or they may run into international conflicts. Thus, the traditional dichotomy between international cooperation and confrontation is unrealistic: the two approaches may coexist, with countries cooperating in some fields or for certain purposes, while going their own separate ways in some other fields or for other purposes. Moreover, because of the relative independence of monetary authorities within a country's political body, and the close and frequent relations that exist between Central Bankers and Treasury Ministers at the international level, monetary authorities are likely to be realatively more prone to international cooperation than real authorities. The latter, in fact, are the expression of both Governments and Parliaments, with slower and generally less consistent processes in formulating a national economic policy in their field. Moreover,

the institutional frameworks for international meetings of the real authorites are less developed than for monetary authorities. Thus, international cooperation in the "real" field is more likely to fail and leave room to international confrontation, or at least to require longer periods to be achieved than cooperation in the monetary field.

The second phenomenon arises from the fact that in a multicountry world, cooperation in the monetary field may either be generalized to a large group of major countries (e.g., the group of the major seven industrialized countries, the G-7) or be limited to the subset of these that, because of their economic or financial weight, has higher responsability for international monetary affairs (e.g., the G-5 or the recent "entente" between the US and Japan). In the real field, but possibly also in the monetary field, cooperation may take place within a regional set of countries (e.g., the EC countries, or the subset of them taking part in the EMS), and leave room either to confrontation in the real field with another set of countries (e.g., the US and Japan), or to strains within the regional group in the monetary field on the question whether going along with the decisions taken by the few members of that group (e.g., Germany and France for the EMS) that also belong to the more exclusive club (to which the other members are not part; e.g., Italy and the other EMS countries, or Canada with respect to the US).

Thus cooperation vs. confrontation are processes that cut across both different levels of economic policy and different sets of countries. The recent literature on international economic cooperation does not seem to have been aware of these phonomena.

Among the many results that could spring from a full exploitation of the possibilities arising from the combinations of

strategies that the authorities of the three countries in our model could follow, some appear most interesting.

A first general result is that monetary cooperation, unaccompanied by cooperation in the real field, may contribute to reinforce, rather than diminish, the forces that push behind confrontation in the real field and thus lead to protecionism in international trade. In other words, uncooperative solutions may be superior to partially cooperative ones. This general result is not surprising in the light of the theory of second best.

Second, if things were left to the monetary autorities alone, "Germany" would gain enough from not having its hands tied by European cooperation to be able to induce the "US" to form a G-2 club at the monetary level, with no European cooperation at the real level: the EEC would fall apart, unless "Italy" (the three countries are ideal ones for purpose of theoretical illustration) were to compensate Germany for choosing a G-2 with the US accompanmied by EEC cooperation at the real level.

Third, a worrying but interesting result is that a G-2 club between the US and Germany with non EEC cooperation at the real level is the relatively preferred arrangement, when the choice is made on the basis of both the monetary and the real objective functions. Moreover, it is preferred even when we compare the sets of G-2 and G-3 (when all three countries cooperate at the monetary level) outcomes together. Thus, dealing with the problem of cooperation at the monetary and real levels separately contains the seeds of a situation in which European cooperation tends to fall apart because of the advantages that the two main countries reap from belonging to the exclusive G-2 club.

A fourth interesting result is that for Italy a US-German monetary club accompanied by EEC cooperation at the real level is

preferable to a G-3 club on monetary matters, with or without cooperation within the EEC at the real level. This result may be suggestive of the scarce interest that Italian authorities of economic policy, and particularly the monetary ones, initially showed with respect to enlarging the G-5 to G-7 soon after the September 1985 meeting: it was only after a higher political point of view was taken that the Italian opposition to being left out was strongly expressed.

The results, clearly, are dependent on the theoretical model used, on the structural parameters assumed, and on the set of strategies that we have selected. While on the first two grounds further research should be addressed at making the model more realistic, and in particular at introducing dynamics into it (with the resulting need to model sequential games), on the strategies selected the analysis calls for extensions in the direction of games of leadership and of explaining more deeply the formation of clubs and relative importance of different layers of authorities in different fields of economic poliy.

Basevi, Kind, Foli

Appendix

The purpose of this appendix is to derive formally the expressions given in the text for the deviations in the levels of aggregate demand from their equilibrium values.

Let the demand for the output of country i be given by

$$(A.1) \qquad Q_i = \gamma_{ii} A_i + \sum_{j \neq i} \gamma_{ij} \frac{E_{ij} P_j}{(1+t_{ji}) P_i} A_j + G_i \qquad (i, j = 1, 2, 3, 4)$$

where A_i denotes the level of private aggregate expenditure in country i measured in terms of domestic output Q_i, γ_{ij} is the share of A_i falling on the products of country j, E_{ij} is the nominal exchange rate between country i and country j (i.e., the units of currency i per unit of currency j), P_i is the domestic currency price of one unit of domestic output Q_i, t_{ji} is the tariff imposed by country j on the imports from country i, and G_i is the sum of all countries' government expenditures on the products of country i.

At the original steady state equilibrium we assume that each country's net asset position, trade balance, government expenditures and taxes are all zero, and the value of private aggregate expenditures A_i is thus equal to the steady state

equilibrium level of output $\bar{Q}_i$. It follows that, at the steady state,

$$\text{(A.2)} \qquad \bar{Q}_i = \gamma_{ii}\bar{Q}_i + \sum_{j\neq i} \frac{E_{ij}P_j}{P_i}\bar{Q}_j \qquad (i,j = 1,2,3,4)$$

and, letting $w_{ji} = E_{ij}P_j\bar{Q}_j/(P_i\bar{Q}_i)$ denote the relative size of countries j and i, for each i we have

$$\text{(A.3)} \qquad 1 - \gamma_{ii} = \sum_{j\neq i} w_{ji}\gamma_{ji}$$

Totally differentiating (A.1) around its steady state equilibrium (A.2) and dividing through by $\bar{Q}_i$ we obtain

$$\text{(A.4)} \qquad q_i = \gamma_{ii}\,da_i + \sum_{j\neq i} w_{ji}\gamma_{ji}da_j + d\gamma_{ii} + \sum_{j\neq i} w_{ji}\,d\gamma_{ji} + \sum_{j\neq i} w_{ji}\gamma_{ji}(\theta_{ij} - t_{ji}) + dG_i/\bar{Q}_i$$

where q_i, da_i, θ_{ij} respectively represent the percentage deviations of Q_i, A_i, and the real exchange rates net of tariffs (i.e., $E_{ij}P_j/P_i$) from their equilibrium values. As to the percentage changes in private expenditures, da_i, one can show from the solution of a representative individual's intertemporal utility maximization problem*, that these will in general depend positively on the changes in current and present discounted value of future disposable income, negatively on the

changes in the real rate of interest measured in terms of the domestically produced good, and either positively or negatively on the expected rates of change in the relative prices of foreign goods, depending on the concavity of the individual's instantaneous utility function (i.e., on whether the elasticity of intertemporal substitution is greater or less than one). As in the present model we assume static expectations, disregarding the effects of future changes in prices, we then write

$$(A.5) \qquad da_i = c_i y_i - \beta_i r_i$$

where c_i denotes the marginal propensity to consume out of changes in current disposable income y_i, β_i is the semi-interest rate elaticity of aggregate consumption, and r_i is the deviation of country i's real rate of interest from the steady state level $\bar{r}$. Assuming that individuals discount all future tax liabilities, the percentage change in current disposable income will then be given by

$$(A.6) \qquad y_i = q_i - \left[g_i - \sum_{j \neq i} \gamma_{ij} t_{ij}\right]$$

where $\left[g_i - \sum_{j \neq i} \gamma_{ij} t_{ij}\right]$ represents the excess of country i's government spending over tariff revenues as a percentage of domestic income $\bar{Q}_i$.

In order to simplify our final expressions, two assumptions can now be made. First, we will assume that in each country all tariff revenues are spent by the government and that all government's spending falls entirely on the domestic product.

Second, we will assume a unitary elasticity of substitution in the private sector's instantaneous utility function, so that, aside from exogenous shifts in tastes (which may represent another possible source of external shock in the model), all expenditure shares γ_{ij} are independent of relative prices (i.e. $d\gamma_{ij} = 0$).

Under these assumptions, and substituting (A.5) and (A.6) into (A.4), we then obtain:

$$
\begin{aligned}
q_i = {} & \gamma_{ii} c_i q_i + \sum_{j \neq i} w_{ji} \gamma_{ji} c_j q_j - \gamma_{ii} \beta_i r_i - \sum_{j \neq i} w_{ji} \gamma_{ji} \beta_j r_j \\
& + \sum_{j \neq i} w_{ji} \gamma_{ji} \vartheta_{ij} + \sum_{j \neq i} \gamma_{ij} t_{ij} - \sum_{j \neq i} w_{ji} \gamma_{ji} t_{ji} \\
& + (1 - \gamma_{ii} c_i) \tilde{g}_i - \sum_{j \neq i} w_{ji} \gamma_{ji} c_j \tilde{g}_j
\end{aligned}
\tag{A.7}
$$

where $\tilde{g}_i$ represents the excess of government spending over tariff revenues. Alternatively, assuming that the semi-interest rate elasticity of private expenditure, β_i, is the same in all countries, we have (using (A.3))

$$
\begin{aligned}
q_i = {} & \gamma_{ii} c_i q_i + \sum_{j \neq i} w_{ji} \gamma_{ji} c_j q_j - \beta r_i - \beta \sum_{j \neq i} w_{ji} \gamma_{ji} (r_j - r_i) \\
& + \sum_{j \neq i} w_{ji} \gamma_{ji} \vartheta_{ij} + \sum_{j \neq i} \gamma_{ij} t_{ij} - \sum_{j \neq i} w_{ji} \gamma_{ji} t_{ji} \\
& + (1 - \gamma_{ii} c_i) \tilde{g}_i - \sum_{j \neq i} w_{ji} \gamma_{ji} c_j \tilde{g}_j
\end{aligned}
\tag{A.7'}
$$

where, under the assumptions of stationary expectations, the linkage between the real rate of interest in the different countries is given by

$$
r_i = r_j \tag{A.8}
$$

Finally, the fourth country can be taken as the residual

country (i.e., the rest of the world) with:

a) an exogenously given level of output (i.e., $q_4 = 0$); or

b) an exogenuosly given level of output and expenditures (i.e., $q_4 = 0$ and $da_4 = 0$); or

c) an exogenously given level of demand for all imported goods (i.e., $d\left[\gamma_{4i} \frac{E_{i4}P_4}{P_i} A_4\right] = 0$).

In all three cases it is obvious which are the terms in (A.7) or (A.7') that will drop out, paying a little attention to the effect of interest rate changes when (A.7') is used, as under both assumptions (b) and (c) $\beta_i \neq \beta_4 = 0$.

Notes

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1. Many contributions have appeared in this area after the path-breaking work by Hamada (1976) (revisited in Hamada (1985)). Except for the most recent ones, they have been surveyed by Cooper (1984). The volume by Buiter and Marston (1985) mainly deals with the dynamic aspects of the theory. The present paper continues in the line of research followed by Canzoneri and Gray (1985), Giavazzi and Giovannini (1985), Melitz (1985), Oudiz (1985), Canzoneri and Henderson (1986). Our paper is written in the spirit of the criticism that Kenen (1986) addresses to this literature as being too often detached from institutional and policy oriented problems.

2. In Basevi, Kind, Poli (1986) we pay more attention to problems of the European Monetary System, particularly with respect to the use of controls (taxes) on capital movements within and without the EMS, as instruments of economic policy additional to the monetary and commercial ones discussed here.

3. In the numerical simulations of the model that are the basis of this paper the set of countries is extended to four, the fourth one being the rest of the world. This enters with the price of its product assumed to be set exogenously but denominated in dollars: thus its price changes endogenously in terms of marks or lire when these currencies' exchange rate changes vis-à-vis the dollar. The consumers prices of the three countries depend also on the share spent on the product of the fourth one and on its dollar price. Moreover, the real bilateral exchange rates against the fourth country also affect the demand for the products of the three endogenous countries.

4. For the theoretical derivation of aggregate demand from consumer's theory see the Appendix. As explained in footnote 3, demands for products are also affected by the real exchange rates vis-à-vis a fourth residual country (the rest of the world).

5. Deflating the nominal quantity of money with the consumers' price index does not substantially alter the results of our analysis.

6. In Alesina and Tabellini (1986) there is also a game involving more than one policy authority, but this game remains internal to a country and is played among monetary authorities, fiscal authorites and wage setters. In Rogoff and Sibert (1986), the game is between the current and the incumbent government of a country. In contrast, our model is designed to describe situations in which the policy authorities of a country may not cooperate internally while at the same time each of them may

coordinate its actions internationally with the corresponding authorities of another country or set of countries.

7. Particularly since the G-5 meeting of September 1985 in New York, the G-7 summit of May 1986 in Tokyo, and more recently (October 1986) the informal agreement between the US and Japan to the effect of limiting further depreciation of the dollar vis-à-vis the yen. Unfortunately, our three countries model cannot deal more realistically with the problems arising from confrontation or cooperation among at least three blocks of countries, such as the US, the EC and Japan, unelss we were to abandon the focus on intra-EC relations. A more extended model in terms of countries would clearly give rise to a much larger set of possible games. Yet, even the simplified three countries model here used, and the consideration of cooperative or Cournot-Nash uncooperative games only, allows a much larger number of combinations than those presented and analysed in this paper.

8. In order to get stability of the games played in this model, it must be assumed that the tariff rates enter with enough weight the objective functions of the countries that use such instruments. The equilibrium solutions obtained with zero-cost tariffs are unstable.

9. See P. Kind (1986).

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Table 1 - Alternative games played by the U.S., Germany, and Italy

1. A single objective function in each country.
   - active instruments: money supplies only

   1.1. All three countries cooperate
   1.2. No country cooperates: overall Nash game
   1.3. European countries cooperate: Nash game EC vs. US

2. A single objective function in each country.
   - active instruments: money supplies and tariff rates
   - cross-Atlantic confrontation

   2.1. No country cooperates: overall Nash game
   2.2. European countries cooperate: Nash game EC vs. US

3. Two objective functions in each country.
   - only the monetary objective functions are optimized
   - active instruments: money supplies only

   3.1. All three countries cooperate
   3.2. No country cooperates: overall Nash game
   3.3. European countries cooperate. Nash game EMS vs. US

4. Two objective functions in each country.
   - monetary and real objective functions optimized separately
   - active instruments: money supplies for M-functions
     tariff rates for R-functions
   - cross-Atlantic monetary and real confrontation

   4.1. No country cooperates, either at the M- or the R-level
   4.2. European countries cooperate at the R-level: EEC vs. US
   4.3. European countries cooperate at the M-level: EMS vs. US
   4.4. European countries cooperate at M&R levels: EEC+EMS vs. US

5. Two objective functions in each country.
   - monetary and real objective functions optimized separately
   - active instruments: money supplies for M-functions
     tariff rates for R-functions
   - cross-Atlantic monetary cooperation: G-3
   - cross-Atlantic real confrontation

   5.1. All countries cooperate at M-level, none at R-level
   5.2. All countries cooperate at M-level, EEC vs. US at R-level

6. Two objective functions in each country.
   - monetary and real objective functions optimized separately
   - active instruments: money supplies for M-functions
     tariff rates for R-functions
   - cross-Atlantic monetary cooperation: G-2
   - cross-Atlantic real confrontation

   6.1. US-German coop. at M-level, no coop. at R-level
   6.2. US-German coop. at M-level, EEC vs. US at R-level

Tab. 2 - Parameters of the model with "realistic" values

		U.S.A.	Germany	Italy	ROW
	η_i	0.75	0.75	0.75	-
	Σ_i	0.5	0.5	0.7	-
USA	γ_{ij}	0.75	0.10	0.02	0.13
Ger		0.13	0.65	0.10	0.12
Ita		0.15	0.15	0.55	0.15
USA	α_{ij}	-	0.065	0.025	-
Ger		0.20	-	0.05	-
Ita		0.12	0.30	-	-
USA	α'_{ij}	-	0.10	0.02	-
Ger		0.13	-	0.10	-
Ita		0.15	0.15	-	-
USA	α''_{ij}	-	0.065	0.025	-
Ger		0.20	-	0.05	-
Ita		0.12	0.30	-	-
	β_i	0.5	0.5	0.5	-
USA	δ_{ij}	0.6375	0.0552	0.0212	-
Ger		0.17	0.5525	0.0425	-
Ita		0.102	0.255	0.4675	-
	μ_i	1.0	1.0	1.0	-
	λ_i	1.0	1.0	1.0	-
Weights:					
relative GDP		0.3	0.15	0.05	0.5
	w_{pi}	0.4	0.5	0.25	-
	w_{qi}	0.47	0.29	0.55	-
	w_{ti}	0.02	0.04	0.05	-
	w_{DMi}	0.086	0.136	0.03	-
	w_{Li}	0.024	0.034	0.12	-

Notes: - α_{ij}, α'_{ij}, α''_{ij}, δ_{ij}, are combinations of structural parameters as shown in the Appendix and in Kind (1986).
- ROW = rest of the world

Table 3 - Responses to a 10% overall fall of aggregate supply

Games:		1.1.	1.2.	1.3.
USA	$ effective rate	0.73	1.41	1.06
	output deflator	4.72	3.83	3.90
	c.p.i.	4.16	3.42	3.46
	output	-1.81	-3.34	-3.20
	money supply	1.80	-1.40	-1.10
	L-loss function	49.23	58.75	56.44
	M-loss function	40.14	28.32	28.53
	R-loss function	9.09	30.43	27.91
Germany	DM/$ rate	-0.76	-1.50	-1.19
	output deflator	4.35	3.05	3.26
	c.p.i.	3.72	2.41	2.64
	output	-2.26	-4.17	-3.91
	money supply	1.00	-3.00	-2.44
	L-loss function	24.62	23.95	23.64
	M-loss function	20.29	9.42	10.86
	R-loss function	4.33	14.53	12.78
Italy	Lira/DM rate	0.22	0.50	0.79
	output deflator	5.10	3.66	4.13
	c.p.i.	4.02	2.81	3.34
	output	-2.91	-4.68	-4.37
	money supply	1.09	-2.89	-2.02
	L-loss function	8.43	13.52	12.87
	M-loss function	3.91	2.02	2.81
	R-loss function	4.52	11.50	10.06

Rankings (loss functions weighted by countries' GDP)

L-loss functions

USA: 1.1.>1.3.>1.2.
Ger: 1.3.>1.2.>1.1.
Ita: 1.1.>1.3.>1.2.

Note: among these three games
- full cooperation (1.1.) with compensation to Ger is 1st best
- Nash confrontation between US and EC (1.3.) is 2nd best
- overall Nash confrontation (1.2.) is 3rd best

Table 4 - Responses to a 10% overall fall of aggregate supply

Games:		4.1.	4.2.	4.3.	4.4.
USA	$ effective rate	-0.39	-0.32	-0.36	-0.30
	output deflator	-0.31	-0.32	-0.32	-0.34
	c.p.i.	0.22	0.23	0.21	0.22
	output	-11.38	-11.46	-11.41	-11.49
	money supply	-18.94	-18.93	-19.00	-19.00
	tariff rate	5.81	5.85	5.82	5.86
	L-loss function	331.70	336.08	333.24	337.89
	M-loss function	0.21	0.18	0.17	0.16
	R-loss function	331.49	335.90	333.06	337.73
Germany	DM/$ rate	0.29	0.32	0.28	0.30
	output deflator	-1.36	-1.37	-1.38	-1.39
	c.p.i.	-0.36	-0.43	-0.37	-0.45
	output	-13.94	-13.85	-13.98	-13.89
	money supply	-22.95	-22.74	-23.03	-22.84
	tariff rate	3.42	4.55	3.43	4.57
	L-loss function	149.77	149.01	150.56	149.93
	M-loss function	0.27	0.32	0.26	0.34
	R-loss function	149.50	148.69	150.30	149.59
Italy	Lira/DM rate	0.60	0.04	0.42	0.00
	output deflator	-2.32	-1.60	-2.47	-1.66
	c.p.i.	-0.69	-0.35	-0.86	-0.41
	output	-16.15	-14.54	-16.24	-14.60
	money supply	-26.52	-23.78	-26.82	-23.93
	tariff rate	1.55	4.55	1.56	4.57
	L-loss function	123.54	102.45	124.93	103.20
	M-loss function	0.17	0.03	0.21	0.05
	R-loss function	123.37	102.42	124.73	103.15

Rankings (loss functions weighted by countries' GDP):

M-loss functions

USA: 4.4.› 4.3.› 4.2.› 4.1.
Ger: 4.3.› 4.1.› 4.2.› 4.4.
Ita: 4.2.› 4.4.› 4.1.› 4.3.

R-loss functions

USA: 4.1.› 4.2.› 4.3.› 4.4.
Ger: 4.2.› 4.1.› 4.4.› 4.3.
Ita: 4.2.› 4.4.› 4.1.› 4.3.

L-loss functions

USA: 4.1.› 4.3.› 4.2.› 4.4.
Ger: 4.2.› 4.1.› 4.4.› 4.3.
Ita: 4.2.› 4.4.› 4.1.› 4.3.

Note: among these three games, after internal "compensation", and with reference to L-functions:
- 4.2. is 1st best, with compensation to the US
- 4.4. is 2nd best, with Italy compensating US and Ger
- 4.1. is 3rd best

Table 5 - Responses to a 10% overall fall of aggregate supply

Games:		5.1.	5.2.	6.1.	6.2.
USA	$ effective rate	-0.29	-0.25	-0.33	-0.27
	output deflator	-0.37	-0.39	-0.22	-0.35
	c.p.i.	0.18	0.19	0.29	0.22
	output	-11.51	-11.60	-11.62	-11.52
	money supply	-19.24	-19.24	-18.55	-19.06
	tariff rate	5.87	5.91	5.72	5.87
	L-loss function	338.92	343.67	322.47	339.19
	M-loss function	0.12	0.11	0.28	0.15
	R-loss function	338.80	343.56	322.19	339.05
Germany	DM/$ rate	0.24	0.25	0.23	0.25
	output deflator	-1.46	-1.48	-1.28	-1.43
	c.p.i.	-0.44	-0.54	-0.31	-0.50
	output	-14.12	-14.04	-13.75	-13.94
	money supply	-23.35	-23.17	-22.54	-22.96
	tariff rate	3.46	4.61	3.38	4.57
	L-loss function	153.57	153.08	145.91	150.97
	M-loss function	0.32	0.45	0.20	0.40
	R-loss function	153.25	152.62	145.71	150.57
Italy	Lira/DM rate	0.35	0.03	0.56	0.08
	output deflator	-2.63	-1.75	-2.24	-1.65
	c.p.i.	-1.01	-0.47	-0.67	-0.38
	output	-16.43	-14.73	-15.94	-14.62
	money supply	-27.30	-24.25	-26.10	-23.96
	tariff rate	1.58	4.61	1.53	4.57
	L-loss function	127.61	104.97	120.60	103.42
	M-loss function	0.27	0.06	0.15	0.04
	R-loss function	127.34	104.91	120.45	103.38

Rankings (loss functions weighted by countries' GDP):

M-loss functions

USA:	5.2.› 5.1.› 6.2.› 6.1.
Ger	6.1.› 5.1.› 6.2.› 5.2.
Ita:	6.2.› 5.2.› 6.1.› 5.1.

R-loss functions

USA:	6.1.› 5.1.› 6.2.› 5.2.
Ger:	6.1.› 6.2.› 5.2.› 5.1.
Ita:	6.2.› 5.2.› 6.1.› 5.1.

L-loss functions

USA:	6.1.› 5.1.› 6.2.› 5.2.
Ger:	6.1.› 6.2.› 5.2.› 5.1.
Ita:	6.2.› 5.2.› 6.1.› 5.1.