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THE INDETERMINACY OF THE EURO CONVERSION RATES. WHY IT MATTERS AND HOW IT CAN BE SOLVED

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Centre for Economic Policy Research

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ABSTRACT

The Indeterminacy of the Euro Conversion Rates. Why it Matters and How it can be Solved.*

The Maastricht Treaty and the Madrid Council decision severely restrict the choice of the euro conversion rates. In practical terms the authorities can only select the Ecu rates prevailing in the market the day before conversion. The market will lack a fixed point, however, so that infinite possible Ecu rates (and thus euro rates) could emerge. This indeterminacy problem is not solved by announcing fixed bilateral conversion rates in advance. The indeterminacy of the euro rates will spill over into an indeterminacy of the exchange rates of outside currencies with the EMU currencies (e.g. the dollar/DM rate). As a result, turbulence in these foreign exchange markets is likely during the approach to EMU. The emergence of speculative bubbles cannot be excluded. We discuss the possible solutions to this problem. They all involve steps towards providing an anchor in the foreign exchange markets.

JEL Classification: F33, F36, F42
Keywords: monetary integration, Maastricht Treaty, exchange rate, euro

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NON-TECHNICAL SUMMARY

On 1 January 1999 conversion rates of the euro into the national currencies of the EMU countries will be fixed irrevocably. Two conditions have been attached to this conversion process. First, the Maastricht Treaty stipulates that the adoption of the irrevocably fixed conversion rates should not modify the external value of the Ecu. Second, at the Madrid Summit Meeting of December 1995 it was decided that at the time of conversion one euro should equal one Ecu. These two conditions severely constrain the choices available for setting these conversion rates for stage three. In a nutshell, the constraint is that the euro conversion rates used on 1 January 1999 must equal the market rates of the Ecu observed at the end of the previous day. In addition, it will not be possible to announce in advance the euro conversion rates that will be applied on 1 January 1999. The reason is that the Ecu rates of the participating currencies will continue to fluctuate until the last day because the Ecu contains non-participating currencies (e.g. sterling). This will create problems. In particular, if the authorities rely on the market to decide these conversion rates an indeterminacy problem will arise (see Begg *et al* (1997) and De Grauwe and Spaventa (1997)). This can be described as follows. The Ecu rate of, say, the Deutsche mark (DM) before conversion time will be determined by the expectations the market has about the future euro conversion rate of the DM. The latter, however, will be equal to the last day's Ecu rate of the DM. As a result, any movement of the Ecu rate will be self-validating since it determines the choice of the euro conversion rate. The market has nothing to anchor its beliefs to.

This problem can only partially be avoided if it is decided that euro conversion rates should be set indirectly, by first determining the bilateral rates and then deriving the implied euro rates. Under this scenario it would be possible to announce bilateral conversion rates in advance. If the commitment towards these bilateral conversion rates is credible, market rates will converge to the bilateral conversion rates before the latter are irrevocably set (see Begg *et al* (1997) and De Grauwe and Spaventa (1997)). This solution does not eliminate the problem of indeterminacy of the *euro*-conversion rates, however. Because the euro-conversion rates selected on 1 January 1999 must equal the Ecu rates reached the previous day, there will be infinite possible euro rates that the market could select. In other words, the market will lack an anchor for determining the Ecu rates that will be used as euro conversion rates.

The indeterminacy problem involving the euro conversion rates will also spill over into the foreign exchange markets involving outside currencies and the

'in' currencies. Because the market has no way of forecasting the euro conversion rate of, say, the DM, it cannot forecast the dollar/DM exchange rate beyond conversion time either. This indeterminacy can create turbulence in these foreign exchange markets. In particular, as speculators are aware that every move in the market is self-validating the conditions for the development of speculative bubbles in the dollar/DM market, for example, will be met. Put differently, since on the last day before the start of EMU there are infinite possible solutions, there is no fixed point to tie down expectations. A speculative bubble may therefore start during the interim period, which guarantees substantial profits for all speculators jumping on the speculative bubble path.

This feature of the euro conversion process creates risks. First, if a speculative bubble arises, it may destabilize the price level in the euro area during the early phase of EMU. But even if the occurrence of speculative bubbles can be prevented, the indeterminacy of the euro conversion rates can create turbulence in the foreign exchange markets. It is therefore important that the flaws in the euro conversion process are corrected.

This paper proposes several possible solutions for the problem of providing an anchor in the markets. A first solution consists of announcing fixed euro rates in advance of the start of EMU. This solution necessitates a change to the currency composition of the Ecu in response to exchange rate movements of the currencies not participating in EMU (e.g. sterling). This solution may create legal problems since the Treaty forbids changes to the currency composition of the Ecu. The paper discusses a scheme for circumventing this legal problem, which implies that the Ecu is split into two parts so that the market can price them differently.

A second solution consists of fixing the dollar/DM exchange rate during the interim period (May–December 1998), or alternatively keeping this exchange rate within some band of fluctuation. This solution could be facilitated by a (temporary) agreement between the US and the German monetary authorities, although it is not clear that this could be done politically. The US monetary authorities might be convinced of the wisdom of doing so, however, once they realise that in the absence of such an agreement the dollar exchange rates with important European currencies could become quite turbulent.

A third solution does not require an agreement with the US authorities. It consists of interpreting the Maastricht Treaty provision that the Ecu should not change its external value at the start of EMU to mean that only the outside currencies (e.g. dollar, sterling) should not change their value against the Ecu.

This would allow the European authorities to announce that they will choose the euro conversion rate of, say, the DM in such a way that the dollar/DM rate remains within a given band of fluctuation at conversion time. This announcement would provide an anchor and stabilize expectations. The problem with this solution is that it may require realignments between the currencies in the EMU and the outside currencies that have decided to join ERM II.

One of these solutions must be chosen to avoid the risk of EMU running into great difficulties at the start because of excessive turbulence of the exchange rates of EMU currencies with those outside.

1. INTRODUCTION

On January 1, 1999 the conversion rates of the euro into the national currencies of the EMU-countries will be fixed irrevocably. Two conditions have been attached to this conversion process. First, the Maastricht Treaty stipulates that the adoption of the irrevocably fixed conversion rates should not modify the external value of the Ecu. Second, at the Madrid Summit Meeting of December 1995 it was decided that at conversion time one Euro should be equal to one Ecu. These two conditions severely constrain the choices about how to set these conversion rates for stage three. In a nutshell, the constraint is that the euro conversion rates used on January 1, 1999 will have to be the market rates of the ecu observed at the end of the previous day. In addition, it will not be possible to announce in advance the euro conversion rates that will be applied on January 1, 1999. The reason is that the ecu rates of the participating currencies will continue to fluctuate until the last day because the ecu contains non-participating currencies (e.g. the pound sterling). This will create problems. In particular, if the authorities rely on the market to decide about these conversion rates an indeterminacy problem will arise (see Begg, et al. (1997) and De Grauwe& Spaventa (1997)). This can be described as follows. The Ecu rate of say the DM before conversion time will be determined by the expectations the market has about the future Euro conversion rate of the DM. The latter, however, will be equal to the last day's Ecu rate of the DM. As a result, any movement of the Ecu rate will be self-validating since it determines the choice of the Euro-conversion rate. The market has nothing to anchor its beliefs on.

This problem can only partially be avoided if it is decided to set the euro conversion rates indirectly, by first determining the bilateral rates and then deriving the implied euro-rates. In that case it is possible to announce bilateral conversion rates in advance. If the commitment towards these bilateral conversion rates is credible, market rates will converge to the bilateral conversion rates before the latter are irrevocably set (see Begg, et al. (1997) and De Grauwe & Spaventa (1997)). This solution, however, does not eliminate the problem of indeterminacy of the euro-conversion rates. In addition, the indeterminacy of the euro-conversion rates spills-over into the exchange markets of the in-currencies with outside currencies.

In section 2 we analyse the nature of this indeterminacy. In the next sections we propose solutions to the problem.

2. THE FUNDAMENTAL INDETERMINACY OF THE EURO CONVERSION RATES

We illustrate the indeterminacy problem involving the euro conversion rates as follows. Suppose that of the N currencies belonging to the ecu basket I are of in-countries while N-I are of out-countries, not joining the single currency at the outset.

From the basket definition of the Ecu we know that:

$$(1) \qquad Ecu_i = \sum_{j=1}^{I} a_j S_{ji} + \sum_{k=I+1}^{N} a_k S_{ki}$$

where Ecu_i = the value of the Ecu in terms of currency i ($i = 1...I$); a_j, a_k = the amounts of currency j ($j = 1...I$) and of currency k ($k = I+1...N$) in the Ecu basket; S_{ji}, S_{ki} = the exchange rate of currency j ($j = 1...I$) and of currency k ($k = I+1...N$) in terms of currency i (units of currency i per unit of currency j and of currency k).

Let us now assume that the bilateral conversion rates S_{ji}^* are fixed in advance. This has been proposed by Bean, et al (1997) and De Grauwe & Spaventa (1997) to solve the indeterminacy problem involving the **bilateral** conversion rates. We want to show that fixing bilateral rates still keeps the euro-rates indeterminate. In addition, this indeterminacy problem spills over into an indeterminacy in the determination of the exchange rates between the in-currencies and the outside currencies.

We rewrite equation (1) as follows:

$$(2) \qquad Ecu_i^t = \sum_{j=1}^{I} a_j S_{ji}^* + \sum_{k=I+1}^{N} a_k S_{ki}^t$$

where S_{ji}^* are the fixed bilateral conversion rates that the authorities have announced; the superscript t refers to time.

Let us take the dollar as the prototype external currency, we can rewrite (2) in the following way:

$$(3) \qquad Ecu_i^t = \sum_{j=1}^{I} a_j S_{ji}^* + S_{\$i}^t \left(\sum_{k=I+1}^{N} a_k S_{k\$}^t \right)$$

where $S_{\$i}^t$ is the price of the dollar in units of currency i (an inside currency) and $S_{k\$}^t$ is the price of currency k (an outside currency) in units of dollars. Note that in (3) we have used the triangular arbitrage condition $S_{ki}^t = S_{k\$}^t S_{\$i}^t$.

Equation (3) can also be rewritten as follows

$$(4) \qquad Ecu_i^t = A + S_{\$i}^t \bar{S}_{\$0}^t$$

The first term on the right hand side is a constant and is determined by the chosen fixed bilateral conversion rates. The second term consists of the product of the dollar rate of currency i (an inside currency) and a weighted sum of dollar rates of the currencies not participating in EMU (the out-currencies). The latter can be considered as an exogenous variable.

Let us apply equation (4) to the last day before the start of EMU. We call this day *T-1*. To focus the attention suppose currency i is the DM. We then have

$$(5) \qquad Ecu_{DM}^{T-1} = A + S_{\$DM}^{T-1} \bar{S}_{\$0}^{T-1}$$

In order to determine the value of the Ecu in terms of the DM on day *T-1* agents need to know the dollar rates of the outside currencies and of the DM. We concentrate our attention on the determination of the latter. (The former are exogenous from the point of view of the euro conversion process). We use a well-known model of exchange rate determination which allows us to write the dollar/DM exchange rate in period *T-1* as follows

(6) $S_{\$DM}^{T-1} = (1-\beta)Z^{T-1} + \beta E_{T-1} S_{\$DM}^{T}$

where Z^{T-1} is the fundamental variable driving the exchange rate in period $T-1$, and β is a discount factor. The closer we come to period T (conversion time) the closer β approaches 1.

On day T the euro will be introduced and the euro conversion rates will be fixed. This will affect the dollar/DM rate. This can be seen from the following triangular arbitrage condition

(7) $S_{\$DM}^{T} = S_{\$E}^{T} S_{E.DM}^{T}$

where $S_{E.DM}^{T}$ is the euro conversion rate of the DM, and $S_{\$E}^{T}$ is the exchange rate of the dollar in units of euros that will prevail at time T. Thus, in order to be able to forecast the future dollar/DM rate the agents must forecast the future euro conversion rate of the DM and the euro/dollar exchange rate. Given the constraint imposed by the Treaty and the Madrid Council decision both the euro-DM conversion rate and the euro/dollar exchange rate at time T will be determined by the market Ecu rate of these currencies at the end of period $T-1$. Thus

$$S_{E.DM}^{T} = Ecu_{DM}^{T-1}$$

(8) and

$$S_{\$E}^{T} = \frac{1}{Ecu_{\$}^{T-1}}$$

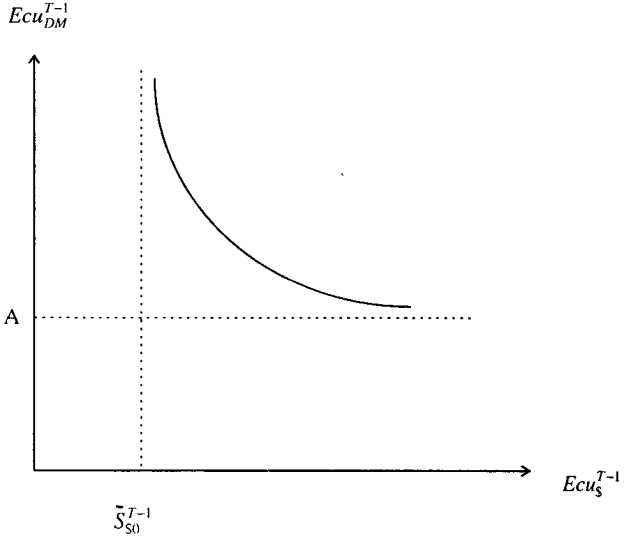
where we have made the period $T-1$ small enough (e.g. the last second before closing time) so as to move arbitrarily close to period T (e.g. the first second after the opening of the market on day T). Substituting (7) into (6), using (8) and taking into account that as we move closer to T, β approaches 1, we obtain

$$(9) \quad Ecu_{DM}^{T-1} = A + \frac{Ecu_{DM}^{T-1}}{Ecu_{\$}^{T-1}} \bar{S}_{\$0}^{T-1}$$

The solution is given by the following expression

$$(10) \quad Ecu_{DM}^{T-1} = A\left[\frac{Ecu_{\$}^{T-1}}{Ecu_{\$}^{T-1} - \bar{S}_{\$0}^{T-1}}\right]$$

Graphically, the solutions lie on the hyperbole represented in figure 1.[1]



Equation (10) makes clear the nature of the indeterminacy problems: there are infinitely many solutions to this (non-linear) equation. Any choice made by the market will be self-validating. There is nothing that will tie down this choice. This feature can lead to turbulence in the exchange markets. In particular, it will necessarily spill over into the dollar/DM market. This can be shown as follow. Triangular arbitrage ensures that

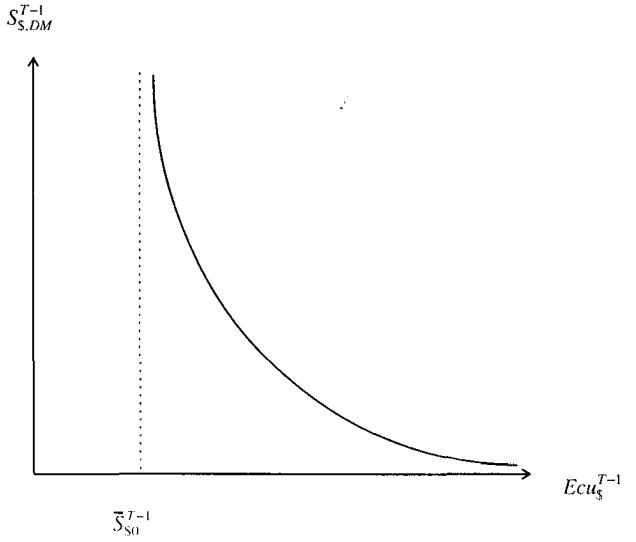
[1] Note that we restrict the solution to lie in the positive quadrant.

$$(11)\quad \frac{Ecu_{DM}^{T-1}}{Ecu_{\$}^{T-1}} = S_{\$DM}^{T-1}$$

Dividing (10) by $Ecu_{\$}^{T-1}$ and using (11) yields the solution for the dollar/DM rate at time *T-1*.

$$(12)\quad S_{\$DM}^{T-1} = A\left[\frac{1}{Ecu_{\$}^{T-1} - \bar{S}_{\$0}^{T-1}}\right]$$

The infinitely many solutions for $S_{\$DM}^{T-1}$ and $Ecu_{\$}^{T-1}$ must lie on the hyperbole shown in figure 2.



We conclude that the indeterminacy of the euro-rates of the DM and of the dollar are automatically reflected into an indeterminacy of the dollar/DM rate as we approach conversion time. This feature is likely to create turbulence in the dollar/DM market (and in the other exchange markets involving in-currencies and outside currencies). It also has another implication, i.e. that it creates the scope for the occurrence of speculative bubbles.

3. EURO INDETERMINACY AND SPECULATIVE BUBBLES

In the previous section we showed that on the last day before the start of EMU there are infinitely many solutions for the Ecu-rates that can be used as Euro conversion rates on the next day. This means that before the start of EMU there will be no fixed point to tie down expectations. When speculators will be aware that every move in the market is self-validating the conditions for the development of speculative bubbles are met. A speculative bubble may therefore start during the interim period which guarantees substantial profits for the speculators jumping on the speculative bubble path. Whatever the point reached by the speculative bubble on December 31, 1998 it will be validated by the authorities.

In order to illustrate how self-fulfilling speculative bubbles can arise we performed the following simulations. We allowed the dollar/DM rate to move along many different speculative bubble paths. On each such path speculators expect the next period's dollar/DM rate to increase (decrease) at a constant rate. By varying that rate we obtain a multiplicity of speculative bubble paths. We then plugged the values of the dollar/DM rates into the definition of the Ecu rate of the DM according to formula (4). We assumed that the dollar rates vis a vis the outside currencies follow a random walk[2]. We show some examples of these simulations in figures 3 and 4. The end values we obtain are all consistent with the conversion rules as specified in the Treaty and in the Madrid Council decision.

The question that arises then is how likely the development of such speculative bubbles is. The fact that they <u>can</u> occur does not mean that they will necessarily develop. There is a co-ordination problem that must be solved for a bubble to arise, i.e. speculators must jointly be expecting, say, an increase of the dollar of x % each period to generate an incentive for speculators to join the bandwagon. In order to answer the question of whether a speculative bubble is likely we have to solve an interpretation problem of the Treaty. Article 109 l 4 says that "at the starting date of the third stage, the Council shall (...) adopt the conversion rates at which their currencies shall be irrevocably fixed and at which irrevocably fixed rate the Ecu (the euro) shall be substituted for these currencies, and the Ecu (the euro) will become a currency in its own right. This measure shall by itself not modify the external value of the Ecu". How should this last sentence be interpreted? The problem can be analysed by starting from the triangular arbitrage condition (11). On day T the Council adopts the euro conversion rates. This should not change the external value of the Ecu. Let

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[2] It was assumed that Denmark, Greece, Italy and the UK are out-currencies.

us assume first that this sentence implies that the Ecu rates of the DM and the dollar should not change. (This is the assumption we have used up to now). Thus, the euro conversion rate of the DM is set equal to Ecu_{DM}^{T-1} (the numerator in (11)), and the the euro/dollar rate is set equal to the ecu/dollar rate of the previous day. But suppose that at that very moment of announcing the euro-conversion rate of the DM, the dollar/DM rate drops in the market. We can see from (11) that this must also lead to an immediate increase in the euro/dollar rate. Thus, at that very moment the external value of the Ecu is not maintained. What should the ECB do? Does the Treaty imply that it should prevent the increase of the euro/dollar rate? And if so, for how long? Just a few minutes, or just during the first day? All this is quite important because it can influence the risk of speculative bubbles. If the ECB guarantees a fixed euro/dollar rate during, say, the first day, it will have to intervene in the foreign exchange market. The ECB could then become a "money machine" making the occurrence of a speculative bubble very likely.

To see this, consider the following example. Take the bubble in figure 3 where the dollar/DM increases from 1.7 to 2.8 on day T-1. The corresponding dollar/Ecu rate on day T-1 is 2.4. Speculators who have bought the dollar at a rate of, say, 2 DM will be able to sell dollars on day T against the euro at the rate of 2.4 euro per dollar. (This is the rate the ECB is guaranteeing on day T based on the Ecu rate achieved on the previous day). Speculators will then be able to sell these euros for DM at the irrevocably fixed exchange rate, allowing them to cash in 2.8 DM. The implication of this is that the ECB will function as a "money machine" selling euros to speculators at an inflated price so that the latter can cash in their profit. If this happens, speculators know that there can be no crash on the day of conversion. This by itself will increase the probability of the occurrence of a speculative bubble.

We conclude that the ECB has a rather uncomfortable choice. Either it does not intervene to guarantee the external value of the Ecu (in terms of dollars) on day T. In that case the probability that speculative bubbles arise is reduced, but then the Treaty provision that the external value of the Ecu must be maintained is a theoretical one. Alternatively, the ECB backs up this provision by interventions (say, on the first day of EMU) but then it increases the likelihood that speculative bubbles arise.

There is another possible interpretation of the Treaty provision, however. In this interpretation "external" means non-EMU currencies. This means that on conversion day, the Council would be free to select any euro-conversion rate of the in-currencies independent from the previous day Ecu market rates. The practical implication can again be

seen from the triangular arbitrage condition (11). It would mean that on day T the euro conversion rate of the DM could be devalued relative to the previous day's Ecu rate of the DM. Given that the denominator is fixed, this would imply that the dollar/DM rate is devalued in the same proportion. This would be equivalent to organising a crash, if the dollar/DM had experienced an upward bubble before. Therefore, this interpretation of the Treaty would reduce the risk of a bubble. We return to this interpretation in the last section.

We conclude that the likelihood of speculative bubbles very much depends on how the treaty provision about the conversion is organised in practice. In any case, something should be done to prevent the occurrence of such speculative bubbles. The need to do something is made more intense because at the start of EMU the national currencies will still be in existence. If this were not the case, one could argue that these speculative bubbles don't really matter. For, in that case, all that would happen is that on conversion time a different euro-conversion rate would exist, the choice of which is arbitrary any way..

The trouble arises because the DM will continue to exist for three years after conversion time. Thus, if an upward bubble of the dollar/DM rate has developed prior to the start of EMU, a strong upward pressure on the DM-prices will be set in motion, leading to a situation where the EMU would start with strong inflationary pressures. Since the euro and the DM will be tightly linked, this upward pressure would be felt both on the euro- and the DM price levels[3]. Of course, if a bubble has occurred prior to the start of EMU, it is likely that a correction will be set in motion after the start of EMU. In that case the euro would appreciate. This would then put downward pressure of the euro price level. In any case the strong volatility of the dollar rates prior and after the start of EMU would make the stabilisation of the euro price level more difficult.

From the preceding analysis we conclude that the euro-conversion process has serious flaws. Even if large scale speculative bubbles can be prevented, the fundamental indeterminacy of the euro conversion rates can generate exchange rate volatility prior to the start of EMU and to price level instability afterwards.

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[3] Conversely, if the speculative bubble that occurs prior to conversion time leads to a decline of the dollar against the DM, it would generate a downward pressure on the price level expressed in euro and in DM after the start of EMU. This would not be a good way to start EMU.

Figure 3

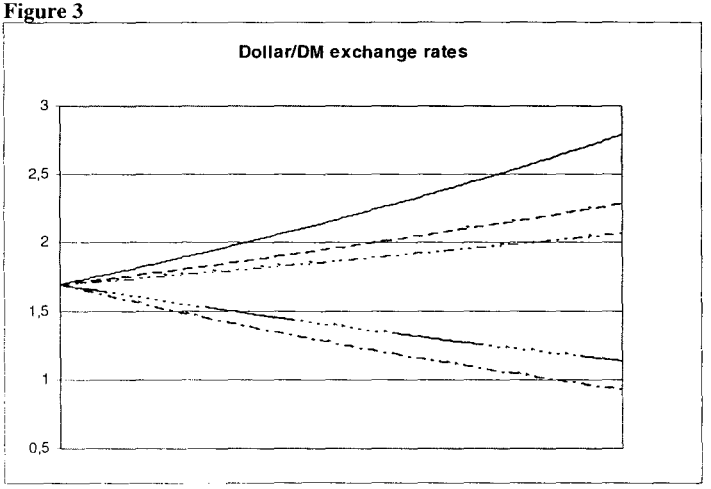
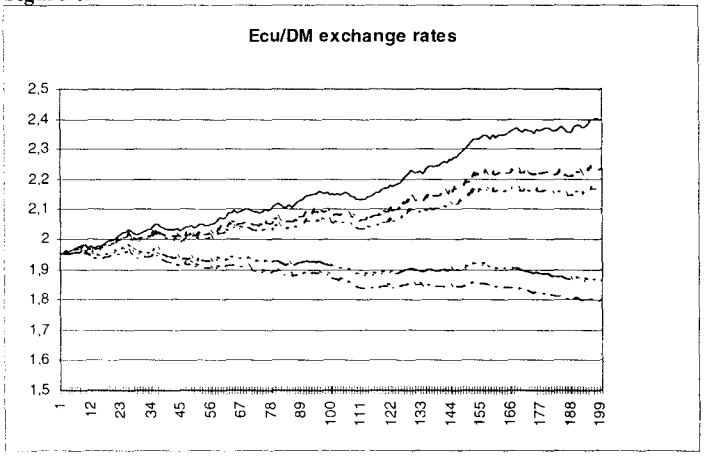


Figure 4:



The question we analyse in the next sections is how these problems can be solved. All the proposals we formulate involve providing an anchor in the exchange markets. In sections 3 and 4 we discuss a solution which involves fixing euro rates in advance and we analyse the condition under which this can be done. In section 5 we discuss a solution involving fixing

the dollar/DM exchange rates. Finally, in section 7 we propose the simples possible solution which implies interpreting the Treaty in such a way that on conversion time the euro/DM conversion rate can be arbitrarily reset.

4. FIXING EURO CONVERSION RATES IN ADVANCE

Suppose the authorities announce in advance fixed euro rates to be applied at the start of stage three (time T). Under what conditions can this be done? Call these pre-announced euro-rates $Euro_i^*$. The Madrid Council resolution now implies that on January 1, 1999 $Ecu_i^T = Euro_i^*$. In addition the Treaty requires that $Ecu_i^T = Ecu_i^{T-1}$. Triangular arbitrage ensures that, by fixing the Euro/Ecu rates, the bilateral exchange rates for the in-currencies are also fixed, i.e.:

$$(13) \quad S_{ji}^* = \frac{Euro_i^*}{Euro_j^*}$$

We rewrite equation (1) filling in these announced conversion rates (euro and bilateral rates). We set the values of the bilateral rates of the outside currencies equal to S_{ki}^t. These could be the central rates of these currencies or any other value (e.g. the market value of these currencies at time t).

$$(14) \quad Euro_i^* = \sum_{j=1}^{I} a_j S_{ji}^* + \sum_{k=I+1}^{N} a_k S_{ki}^t$$

It can immediately be seen that the euro conversion rates cannot be kept fixed because the bilateral exchange rates of the outside currencies will continuously change. Put differently, from the moment of the announcement, the market Ecu rates will tend to diverge from these euro-conversion rates because the currencies of the non-participating countries will fluctuate continuously. The difference between the euro conversion rates and the market Ecu rates on day $T-1$ will be given by the following expression.

$$(15)\quad Ecu_i^{T-1} - Euro_i^* = \sum_{j=1}^{I} a_j \left(S_{ji}^{T-1} - S_{ji}^*\right) + \sum_{k=I+1}^{N} a_k \left(S_{ki}^{T-1} - S_{ki}^t\right)$$

If the market is confident that the bilateral conversion rates will be applied the bilateral market rates will converge to these values on day *T-1*, i.e. $S_{ji}^{T-1} = S_{ji}^*$. We obtain

$$(16)\quad Ecu_i^{T-1} - Euro_i^* = \sum_{k=I+1}^{N} a_k \left(S_{ki}^{T-1} - S_{ki}^t\right)$$

Under what conditions can we make sure that the market rates of the ECU on day *T-1* also converge towards the conversion rates, i.e. $Ecu_i^{T-1} = Euro_i^*$. At first sight this seems impossible to achieve since on day *T-1* there is no reason why $S_{ki}^{T-1} = S_{ki}^t$. One can, however, achieve this result if one is willing to adjust the amounts of the currencies in the basket. This can be done in the following way. We return to equation (14) but we now consider the amounts a_j as variables changing over time. This yields

$$(17)\quad Euro_i^* = \sum_{j=1}^{I} a_j^t S_{ji}^* + \sum_{k=I+1}^{N} a_k S_{ki}^t$$

It can now be seen that we can allow a_j^t to vary so as to compensate the variations of S_{ki}^t. The following expression tells us how these a_j^t must vary (given that $\Delta Euro_i^* = 0$).

$$(18)\quad \sum_{j=1}^{I} \Delta a_j^t S_{ji}^* = - \sum_{k=I+1}^{N} a_k \Delta S_{ki}^t \qquad \text{for i = 1, ... I}$$

In words, all we have to do is to adjust the amounts a_j of the in-currencies in such a way that these changes equal the weighted average of the changes of the out-currencies exchange rates. Note that although there are I equations in (18) these are not independent. In fact it can be shown that there is only one independent equation in (18) (see appendix). As a result, one equation suffices to determine the necessary adjustments in the a_j's. Since there is only one equation to determine the a_j's there is plenty of choice. We could for example, choose one in-currency (say the DM) to be adjusted in the basket, keeping all the

other a_j's constant. Alternatively, one could impose that all the a_j's be adjusted in the same proportion. This is the choice we make here. This then yields the following solution.

$$(19) \quad x_I^t = -\sum_{k=I+1}^{N} \frac{b_k}{b_I} y_{ki}^t$$

where x_I^t is the (common) rate of change of the amounts a_j's of the in-currencies; y_{ki}^t is the rate of change of the exchange rate of out-currency k vis-à-vis the in-currency i (note that $y_{ki}^t = y_k^t$ for all i); b_k is the share of the out-currency k in the ECU-basket and b_I is the total share of the in-currencies in the basket. (In appendix this formula is derived explicitly).

An example will clarify the formula. Suppose the only outside currency is the pound sterling. (In any case it will be the most important one). If on day *T-1* the pound has appreciated by say 20% against the initial value used to compute the euro conversion rates, the required adjustment in the amounts a_j of the in-currencies is equal to - (b_{UK}/b_I) 20%. The term between brackets is likely to be small as the share of the pound in the Ecu is small relative to the total share of the prospective in-currencies.

This result can also be interpreted as follows. When the out-currencies appreciate relative to the in-currencies this tends to increase the value of the Ecu against the in-currencies. In order to keep the Ecu rates equal to the announced euro-rates the value of the Ecu must be reduced. This is achieved by reducing the amounts a_j in the basket. The opposite occurs when the out-currencies depreciate against the in-currencies. It should be stressed, however, that these adjustments are likely to be small because the shares of the out-currencies are most likely going to be a small fraction of the shares of the in-currencies in the basket.

Note also that the adjustments in the a_j's could be done on a continuous (say daily basis) instead of doing this at the last day before EMU starts.

We conclude that it is technically possible to announce fixed euro-conversion rates before the start of the third stage of EMU without coming into conflict with the external value constraint and the requirement that on January 1, 1999 1 Ecu must be exchanged for one euro. Such an announcement, if credible, would also make it possible to avoid the indeterminacy problem and the ensuing risk for speculative bubbles.

5. THE LEGAL PROBLEM

The proposal formulated in the previous section to change the composition of the Ecu-basket in response to fluctuations of the exchange rates of the out-currencies may lead to a legal problem. According to article 109g of the Treaty "The currency composition of the Ecu basket shall not be changed". This article was introduced into the Treaty because it was felt that the five year adjustments of the currency composition of the Ecu which existed prior to 1991, introduced too much uncertainty about the value of the Ecu. Paradoxically, the freezing of the currency composition decided at Maastricht, may exacerbate volatility in the exchange markets in the run-up towards stage three of EMU. The question that arises is then whether this Treaty provision can be circumvented so as to achieve the goal of greater exchange rate stability during the transition towards EMU. In this section we formulate a proposal that achieves this.

The proposal consists in stripping the Ecu into two components, an "insider" Ecu defined as the sum of the amounts a_j of the insider currencies and an "outsider" Ecu defined as the sum of the amounts a_k of the outsider currencies. The sum of these two new Ecu's is equal to the old Ecu, i.e.

(20) $Ecu = EcuI + EcuO$

The authorities now commit themselves to always convert *1 EcuI + 1 EcuO* into 1 Ecu. At the same time they announce that they will fix the euro-conversion rates in the way defined by equation (14). Given the constraints imposed by the Treaty (external value constraints on the Ecu) and the one to one conversion requirement of the Ecu into the euro this announcement amounts to fixing the Ecu-rates of the insider currencies. We obtain

(21) $Ecu_i^* = EcuI_i + EcuO_i$ for i = 1, ... I

where $EcuI_i = \sum_{j=1}^{I} a_j S_{ji}$

$EcuO_i = \sum_{k=I+1}^{N} a_k S_{ki}$

The fixing of the euro conversion rates, however, also means that the bilateral conversion rates are fixed. This implies

$$(22)\quad EcuI_i^* = \sum_{j=1}^{J} a_j S_{ji}^*$$

and is to be interpreted as the officially fixed price of the insider Ecu. Since Ecu_i^* is fixed (by the announcement) and since $EcuO_i$ is fluctuating continuously the market value of $EcuI_i^*$ must be able to fluctuate. Arbitrage will make sure that this happens. Call P_i the market value of $EcuI_i^*$, one obtains

$$(23)\quad Ecu_i^* = P_i EcuI_i^* + EcuO_i$$

Taking first differences yields

$$(24)\quad \Delta P_i = -\frac{1}{Ecu_i^*}\Delta EcuO_i$$

The market value of the inside Ecu adjusts so as to offset the fluctuations of the exchange rates of the out-currencies. Thus, for example, if sterling appreciates the market value of the inside Ecu declines. This decline achieves the same result as the reduction of the amounts a_j in the basket which we analysed in the previous section. In fact it can be shown that the proportional change in the amounts a_j is the same as the proportional change in the market price P_i. It implies that this change in the market price of the inside Ecu following movements of the exchange rates of the out currencies are likely to be small.

In the previous paragraphs we have argued that arbitrage can be relied upon to create the same effects as changing the currency composition of the Ecu. There is another arbitrage activity that could operate in the scheme we propose here. This can be described as follows. When the market price of the inside Ecu, P_i, deviates from 1 there will be an incentive to bundle or unbundle the inside Ecu. For example, suppose P_i is less than 1. In that case it will be profitable to buy the inside Ecu cheaply in the market and then to unbundle it so as to sell the different constituent currencies. If this arbitrage works perfectly, P_i will always be equal to 1. This is very unlikely to happen, however. There is a lot of evidence that arbitrage through bundling and unbundling the Ecu has not worked well, producing relatively large deviations between the market value of the Ecu and its theoretical value (see Gros and Thygesen(1992), and Pacheco and Steinherr(1996).

6. FIXING THE DOLLAR/DM EXCHANGE RATE

In the previous sections we argued that it is technically possible to fix euro-conversion rates in advance. The legal problem may, however, necessitate creating new sub-units of the Ecu, which in turn requires the creation of new markets for these new currencies. It is not clear whether this can be done in such a short period of time.

There is another solution to the indeterminacy problem, however, requiring no technical or institutional changes. This consists in an agreement between the European and the American authorities to fix the dollar/DM exchange rate during the transition period to EMU. From an analytical point of view this is the most obvious solution. It can immediately be seen from equation (12) that if $S_{\$DM}^{T-1}$ is fixed, this ties down $Ecu_{\$}^{T-1}$. By equation (10) this also ties down Ecu_{DM}^{T-1}. Thus by fixing the dollar/DM exchange rate an external anchor is provided so that the Ecu_{DM}^{T-1} is also safely anchored.

Several points should be stressed. First, the fixing of the dollar/DM does not mean that the Ecu/DM rate will not vary prior to conversion time. It will, as can be seen from equation (12), because the outside currencies will continue to vary against the dollar. However, the indeterminacy problem (i.e. the existence of infinitely may solutions for the Ecu rates) will disappear. At the same time the scope for great turbulence is also reduced. Second, the fixing of the dollar/DM exchange rate may take the form of defining a band of fluctuation within which the exchange rate floats freely. All the markets need is some anchor to fix their beliefs. Third, the agreement would only hold for the interim period between May and December 1998, so as to provide an anchor for this crucial exchange rate during the approach into EMU. After the start of EMU, the dollar/DM exchange rate would again be left free.

Although this solution is technically easy, the question remains whether such an agreement is politically feasible between the US and Europe. If unfeasible, an alternative solution would consist in an agreement between the EMU participants and the UK to fix the pound/DM exchange rate. This would provide for an equivalent anchor allowing the market to find a fixed point in their forecasts of the future euro-rates.

7. INTERPRETING THE EXTERNAL VALUE CONSTRAINT

The final solution we consider involves giving a particular interpretation to the external value constraint. As will be remembered, the Treaty stipulates that the conversion process should not change the external value of the Ecu. Up to now we have interpreted this to mean that the Ecu value of all currencies (i.e. in- and out-currencies) should not jump from the close of the market on December 31, 1998 to January 1, 1999. There is another interpretation possible, however (see P. Kenen(1995), and Arrowsmith(1996) on this). The Treaty provision can also be interpreted to mean that only out-currencies' exchange rates (e.g. sterling, dollar) vis a vis the Ecu should not jump from T-1 to T. There could still be a discrete adjustment in the Ecu- and thus Euro-rates of the in-currencies. We propose that this would be the interpretation given to the external value constraint. This would make it possible to avoid the occurrence of speculative bubbles from arising. In order to show this consider the triangular arbitrage condition (11) which we repeat here:

$$(11) \quad \frac{Ecu_{DM}^{T-1}}{Ecu_{\$}^{T-1}} = S_{\$DM}^{T-1}$$

Suppose that a speculative bubble has brought the dollar/DM exchange rate to, say, 2.8 and the Ecu/DM rate to 2.4 (These are the numbers generated by one of the speculative bubbles simulated in figures 3 and 4). By (11) this implies an Ecu/$ rate of 1.167. The authorities now only guarantee that the latter will not change on January 1, 1999. In this interpretation of the Treaty provision, nothing prevents the authorities from choosing a euro conversion rate for the DM different from 2.4. They can set this conversion rates at, say, 1.5 (or any other number). This implies by (11) that the dollar/DM rate on January 1, 1999 is reduced in the same proportion compared to its level reached on the previous day.

If the authorities make clear in advance that this is what they intend to do, speculative bubbles will not start off. Speculators know then with great certainty that the bubble must crash on day T. Since they know the exact time of the crash we can apply a reasoning developed to show that a deterministic bubble can never start off. The reasoning is as follows. Since everybody knows when the crash will occur, everybody has an incentive to jump off the bubble an instant before the crash, say the day before. Since this is common knowledge, speculators have an incentive to jump off still earlier. We can repeat the argument until we come to the conclusion that the bubble will never get off the ground.

One way the authorities could make their announcement is by promising that the euro/DM conversion rate will be such as to keep the dollar/DM rate between a given band of fluctuation. Equation (11) shows us that the authorities can do this. This announcement, therefore, is very similar to the fixing of the dollar/DM rate discussed in the previous section. The difference, however, is that the European authorities can do this without American co-operation. All they need to do is to choose the appropriate euro/DM conversion rate that will keep the dollar/DM rate within the pre-announced band.

There is a problem with this solution, however[4]. Every adjustment in the euro/DM rate which leads to a change in the dollar/DM rate on day T implies a similar change in the exchange rate of the DM against all outside currencies, including those that are in the basket. Thus, if say the dollar has moved up against the DM prior to conversion time, and the authorities therefore devalue the dollar on day T, they will also devalue the pound sterling and the lira (if that currency stays out of EMU). This would be quite awkward since day T coincides with the start of ERM II. Thus, this new exchange rate regime would start with realignments of all the currencies not participating in EMU. In addition, these realignments may have nothing to do with fundamental developments of these currencies.

8. CONCLUSION

In this paper we have analysed issues relating to the procedure for setting euro conversion rates at the start of EMU. The constraints imposed by the Maastricht Treaty and by the Madrid Council decision lead to two problems. One is that the euro conversion rates will only be known at the closing of the markets on December 31, 1998. Second, and more importantly, there will be an indeterminacy problem in the selection of these euro conversion rates. Because the euro conversion rates selected on January 1, 1999 must be equal to the ecu rates reached the previous day, there will be infinitely many possible euro rates that the market may select. In other words, the market will lack an anchor for determining the Ecu rates that will be used as euro conversion rates. This problem is not solved by announcing fixed bilateral conversion rates in advance of the start of EMU.

The indeterminacy problem involving the euro conversion rates will also spill over into the foreign exchange markets involving outside currencies and the in-currencies. Because the

[4] The problem was pointed out to me by Luigi Spaventa.

market has no way to forecast the euro conversion rate of, say, the DM, it cannot forecast the dollar/DM exchange rate beyond conversion time either. This indeterminacy can create turbulence in these foreign exchange markets. In particular, as speculators are aware that every move in the market is self-validating the conditions for the development of speculative bubbles in for example the dollar/DM market will be met. Put differently, since on the last day before the start of EMU there are infinitely many solutions, there is no fixed point to tie down expectations. A speculative bubble may therefore start during the interim period which guarantees substantial profits for all the speculators jumping on the speculative bubble path.

This feature of the euro conversion process creates risks. First, if a speculative bubble arises, it may destabilise the price level in the euro-area during the early phase of EMU. But even if the occurrence of speculative bubbles can be prevented, the indeterminacy of the euro-conversion rates can create turbulence in the foreign exchange markets. It is therefore imperative that the flaws in the euro conversion process be corrected.

In this paper we have proposed several possible solutions aiming at providing an anchor in the markets. A first solution consists in announcing fixed euro-rates in advance of the start of EMU. This solution necessitates changing the currency composition of the Ecu in response to exchange rate movements of the currencies not participating in EMU (e.g. sterling). This solution may create legal problems since the Treaty forbids changing the currency composition of the Ecu. We discussed a scheme that can circumvent this legal problem. It would imply that the Ecu is stripped into two parts so that the market can price them differently.

A second solution consists in fixing the dollar/DM exchange rate during the interim period (May-December 1998), or alternatively to keep that exchange rate within some band of fluctuation. This solution would be facilitated by a (temporary) agreement between the US and the German monetary authorities. It is not clear that this can be done politically. The American monetary authorities, however, could be convinced to do so when they realise that in the absence of such an agreement the dollar exchange rates with important European currencies could become quite turbulent.

A third solution does not require an agreement with the US authorities. It consists in interpreting the Maastricht Treaty provision that the Ecu should not change its external value at the start of EMU to mean that only the outside currencies (e.g. dollar, sterling) should not change their value against the Ecu. This would allow the European authorities

to announce that they will choose the euro conversion rate of, say, the DM in such a way that the dollar/DM rate remains within a given band of fluctuation at conversion time. This announcement would have the effect of providing an anchor and to stabilise expectations. The problem with this solution is that it may require realignments between the currencies in the EMU and the outside currencies that have decided to join the ERM II.

One of the previously formulated solutions will have to be chosen if one wants to avoid the risk that the start of EMU runs into great difficulties because of excessive turbulence of the exchange rates of EMU-currencies with outside currencies.

APPENDIX

In this appendix we first show that the system of I equations (18) has only 1 independent equation. Rewrite (18) in matrix form as follows:

$$\text{(A1)}\quad \begin{bmatrix} 1 & S_{21}^* & \cdots & S_{I1}^* \\ S_{12}^* & 1 & \cdots & S_{I2}^* \\ \vdots & \vdots & & \vdots \\ S_{1I}^* & S_{2I}^* & \cdots & 1 \end{bmatrix} \begin{bmatrix} \Delta a_1^t \\ \Delta a_2^t \\ \vdots \\ \Delta a_I^t \end{bmatrix} = -a_{I+1} \begin{bmatrix} \Delta S_{I+1,1}^t \\ \Delta S_{I+1,2}^t \\ \cdots \\ \Delta S_{I+1,I}^t \end{bmatrix} + \cdots - a_N \begin{bmatrix} \Delta S_{N1}^t \\ \Delta S_{N2}^t \\ \cdots \\ \Delta S_{NI}^t \end{bmatrix}$$

It can now be shown that the matrix of the cross rates has rank 1. We first note that triangular arbitrage ensures that

$$\text{(A2)}\quad S_{ij}^* = \frac{1}{S_{ji}^*} \qquad \text{or} \qquad S_{ij}^* S_{ji}^* = 1$$

Next, we multiply the 2nd row by S_{21}^*, the 3th row by S_{31}^*, ... the Ith row by S_{I}^*, and use (A2). This yields the following matrix

$$\text{(A3)}\quad \begin{bmatrix} 1 & S_{21}^* & \cdots & S_{I1}^* \\ 1 & S_{21}^* & \cdots & S_{I1}^* \\ \vdots & \vdots & & \vdots \\ 1 & S_{21}^* & \cdots & S_{I1}^* \end{bmatrix}$$

This implies that there is only one independent equation in (A1).

In addition, the right hand side variables in (A1) are identical for each equation. This can also be shown by multiplying the second entry in each vector by S_{21}^*, the third entry by S_{31}^*, etc. ... This yields

$$(A4)\quad -a_{I+1}\begin{bmatrix}\Delta S^t_{I+1,1}\\ \Delta S^t_{I+1,1}\\ \vdots\\ \Delta S^t_{I+1,1}\end{bmatrix}\cdots -a_N\begin{bmatrix}\Delta S^t_{N1}\\ \Delta S^t_{N1}\\ \vdots\\ \Delta S^t_{N1}\end{bmatrix}$$

Thus one equation, say, the first one describes the whole system (A1).

We can now derive formula (19). Take the first equation in (A1)

$$(A5)\quad \Delta a^t_1 + S^*_{21}\Delta a^t_2 + \cdots S^*_{I1}\Delta a^t_I = -a_{I+1}\Delta S^t_{I+1,1}\cdots -a_N\Delta S^t_{N1}$$

This can also we rewritten as

$$(A6)\quad a^t_1\left(\frac{\Delta a^t_1}{a^t_1}\right) + S^*_{21}a^t_2\left(\frac{\Delta a^t_2}{a^t_2}\right)\cdots + S^*_{I1}a^t_I\left(\frac{\Delta a^t_I}{a^t_I}\right) = -a_{I+1}S_{I+1,1}\left(\frac{\Delta S^t_{I+1,1}}{S^t_{I+1,1}}\right)\cdots -a_N S^t_{N1}\left(\frac{\Delta S^t_{N1}}{S^t_{N1}}\right)$$

We now assume that the rates of change in the amounts a_j are the same for all in-currencies. Thus

$$(A7)\quad \frac{\Delta a^t_i}{a^t_i} = x^t \qquad \text{for all i = 1, ... I}$$

Substituting (A7) into (A6) yields

$$(A8)\quad \left(a^t_1 + S^*_{21}a^t_2\cdots S^*_{I1}a^t_I\right)x^t = -a_{I+1}S^t_{I+1,1}y^t_{I+1}\cdots -a_N S^t_{N1}y^t_N$$

where y^t_k is the rate of change of the exchange rate of currency k against the in-currencies.

This yields the expression (19) in the text where

$$b_I^t = a_1^t + S_{21}^* a_2^t \cdots S_{I1}^* a_I^t$$

and $b_k^t = a_k S_{k,1}^t$

b_I^t is to be interpreted as the share of the I in-currencies in the Ecu-basket, and b_k^t as the share of the out-currency k in the Ecu basket

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