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Why the Euro will be Strong: an Approach Based on Equilibrium Exchante Rates

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RÉSUMÉ

Depuis quelques années un regain d'intérêt s'est fait jour pour les approches macro-économiques des taux de change d'équilibre. Des pays en transition et en développement ont, en effet, adopté des régimes de change fondés sur des ancrages plus ou moins souples à des devises-clés ou à des paniers de devises. De son côté la perspective de l'UEM suscite des interrogations, voire des inquiétudes, sur la valeur externe de l'euro, dont on peut craindre qu'il soit excessivement fort. Une estimation des taux de change réels d'équilibre est indispensable pour porter un jugement éclairé sur ces questions.

La théorie du taux de change réel d'équilibre a été stimulée par l'incapacité de la parité des pouvoirs d'achat à servir de guide à l'évolution des taux de change. A moyen terme des facteurs structurels agissent sur les taux de change réels : les productivités, les rythmes d'innovation, les comportements d'épargne, l'endettement extérieur net. Les différents modèles sont des variantes d'une approche stock-flux qui définit le taux de change réel d'équilibre comme celui qui rend compatible l'équilibre interne et l'équilibre externe. Notre étude utilise un modèle dynamique de ce type et en déduit un équilibre de point-selle qui permet d'identifier les variables dont dépend le taux de change réel.

Du modèle théorique on a déduit des équations réduites qui se prêtent au traitement économique : une équation de long terme estimée à partir des tests de cointégration entre les variables ; une équation dynamique de court terme estimée dans un modèle à correction d'erreurs.

On a d'abord cherché à estimer l'évolution des taux de change réels d'équilibre du deutschemark, du franc français et de la lire italienne par rapport au dollar. Les trois taux de change ont été estimés simultanément. Les résultats économétriques sont satisfaisants et font apparaître l'influence prépondérante de deux variables sur les mouvements des taux de change réels d'équilibre : les évolutions relatives entre les prix de gros et les prix de détail d'une part, les balances courantes cumulées d'autre part.

Ces résultats ont été appliqués à l'euro défini d'une manière approchée comme une pondération du deutschemark, du franc français et de la lire italienne. L'évolution du taux de change réel d'équilibre du dollar contre l'euro a été simulée à partir de l'équation simultanée. Un renversement de tendance marqué peut être décelé : appréciation réelle du dollar de 1979 à 1985 due principalement à une forte baisse relative des prix industriels aux Etats-Unis, une dépréciation réelle du dollar depuis le milieu des années 80 due essentiellement à l'endettement extérieur croissant des Etats-Unis et à la capacité de financement de l'Europe. Comme cette dernière tendance est peu susceptible d'être renversée dans les prochaines années, il existe des raisons sérieuses pour conjecturer que l'euro sera une monnaie forte.

Références JEL : F31

SUMMARY

For the last few years macroeconomic analysis of equilibrium exchange rates has been rejuvenated. Transition and developing countries have linked their exchange rates more or less loosely to key-currencies or baskets of currencies. Besides the prospect of EMU entails hopes or fears about the external value of the Euro Assessing equilibrium real exchange rates is the way to bring some insight into the matter.

The theory of equilibrium real exchange rate has been spurred by the failure of PPP to provide any guidance as regards to the proper evolution of exchange rates. In the medium run, structural forces impinge upon real exchange rates: productivity, innovation, saving behaviour, net foreign assets. To embodying these factors a range of models have been developed which are modulations of a basic stock-flow approach. The equilibrium real exchange rate is the one, which makes internal and external equilibria compatible. Our study uses a dynamic model and derives the relevant explanatory variables for the real exchange rates from the saddle-point equilibrium embedded into the dynamics.

Two reduced-form equations have been sorted out of the theoretical model for econometric testing: a long-run equation between cointegrated variables on one hand, a short-run error correction model on the other hand.

The equilibrium real exchange rates for the DM, French Franc, Italian Lira against the Dollar have been estimated first in a simultaneous equation. Econometric results are satisfactory and depict the paramount influence of two variables on real exchange rate changes: the trend in wholesale prices relative to retail prices on one hand, the cumulative current account balances on the other hand.

The regression coefficients have been applied to generate the evolution of the equilibrium real exchange rate between the Dollar and the Euro. The latter has been proxied as a weighted average of the DM, the French Franc and the Italian Lira. A significant trend reversal is exhibited. Between 1979 and 1985 a real appreciation of the equilibrium exchange rate of the Dollar, though of much less magnitude than that of the market exchange rate, is chiefly due to the much steeper fall of industrial prices relative to consumer prices in the US than in Germany. Since the mid-80's a real depreciation of the dollar is mainly due to the increasing foreign indebtedness in the US against the rise in net foreign assets in Europe. As much as this tendency is not expected to be reversed in the near future, there are strong reasons to surmise that the Euro will be a strong currency from the start.

Why the euro will be strong: an approach based on equilibrium exchange rates

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1. INTRODUCTION

A number of recent studies agree in showing that exchange rates are governed over the long run by fundamental determinants, even though they may diverge significantly from those determinants over the short run. Such fundamental determinants behave as stabilising forces acting to bring exchange rates back to so-called "equilibrium" values.

There are a number of different approaches. International institutions such as the IMF have undertaken the most advanced work on the issue. One can readily understand how the concept of an equilibrium exchange rate might incorporate a normative dimension of use to international bodies in the evaluation of exchange rate "misalignment". If a model were available for the identification of divergence between exchange rates and long-run fundamentals, this could yield information useful for international co-operation on exchange rates. The work of Williamson (1985, 1994) on FEER (*Fundamental Equilibrium Exchange Rate)* was the pioneer and the starting point of a series of other studies. Subsequently, the DEER was introduced (*Desirable Equilibrium Exchange Rate)*, and Stein (1994, 1995, 1996) has taken a more positive view with his approach based on NATREX *(Natural Real Exchange Rate).* More recent IMF studies by MacDonald (1995a, 1995b, 1997) and Faruqee (1995) also seem to be adopting a positive stance.

In European countries, the imminent arrival of the irrevocable fixing of currency parities is generating extensive research around the issue of what the "right" exchange

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rates might be for entry into EMU. In France, Joly, Prigent and Sobzsack (1996), along with Borrowski, Couharde and Thibault (1997), have looked at the question of how to quantify equilibrium exchange rates for the franc and European currencies. Crouy-Veyrac and Saint-Marc (1997) have applied the NATREX method to the quantification of the equilibrium exchange rate of the euro. Kaufman and Vannelle (1997) have also adopted the NATREX approach to estimate equilibrium exchange rates for European currencies in the context of the future fixing of parities.

Most of these studies (with the exception of Crouy-Veyrac and Saint-Marc, 1997) deal with real effective exchange rates. However, while effective exchange rates are important for overall competitiveness, it is difficult to derive from them any indication as to a bilateral rate. The present paper attempts to estimate bilateral equilibrium rates for three European currencies against the dollar: the German mark, the French franc and the Italian lira. A proxy of the equilibrium exchange rate of the euro against the dollar is then computed. After some unsuccessful attempts based on NATREX, we turned toward a bilateral exchange rate model in line with recent work by MacDonald on effective exchange rates.

The rest of the paper is structured as follows. Section two draws the main lessons to be learned from recent studies on this topic, highlighting the similarities and differences between the various approaches. The third section puts forward a model for long-run equilibrium exchange rates and for dynamic adjustment of rates around such targets, an approach close to MacDonald's work (1995, 1997). The fourth section contains an empirical application of this model to the estimation of equilibrium exchange rates between the dollar, on the one hand, and the mark, franc and lira on the other. The fifth and final part deduces from this an estimation of the euro exchange rate against the dollar.

2. THE LESSONS TO BE LEARNED FORM RECENT STUDIES

Purchasing power parity (PPP) is generally not verified in the usual samples. Froot and Rogoff (1995) and McDonald (1995a) have carried out a general survey of recent studies on the PPP hypothesis and have arrived at that conclusion. Even in the few cases where PPP can be adopted as a condition for long-run equilibrium, the adjustment shown by the dynamic exchange rate equations seems to be very slow. To obtain robust results, historical time-series over the last century have to be used, or even over the last several centuries. The interpretation of the results becomes highly problematic in this case since such lengthy periods cover highly disparate monetary regimes and terms of trade. In any event, the lessons to be learned from the long historical perspective cannot be applied to the horizons typical of economic policy. The best way forward is to make use of the more homogeneous data from the period of floating which began in 1973, identifying the real forces acting on real exchange rates over long periods of time.

Recent work has been done in that spirit at the IMF by Stein (1996) on the real effective exchange rate of the dollar against the G7 currencies, and by MacDonald (1995a, 1995b, 1997) on the effective exchange rates of the dollar, the mark and the yen, once again against the G7 currencies. In Europe, the most thorough studies have been conducted at the EMI by Fell (1996) estimating both separate equations for the G7 currencies and an equation using stacked data for several currencies.

All the above studies share the same objectives, have the same theoretical referential framework, and use similar equations and explanatory variables. They seek to capture the structural determinants of exchange rates in order to detect and to quantify current rate misalignments in relation to estimated equilibrium exchange rates. The goal is not to explain every aspect of exchange rate fluctuations. Speculative phenomena and the effects of purely financial shocks leading to the restructuring of portfolios are left to one side. The assumption is here that the effects of such factors can be considered to fade over periods much shorter than those required for an exchange rate to adjust back to its equilibrium value.

The time dimension is therefore explicitly divided into nested phases. The very short run is not analysed. In the short run, dynamic adjustments bring the exchange rate back toward its equilibrium rate. Over the long run, structural determinants act on the equilibrium exchange rates. In the very long run, there is convergence towards a theoretical single price situation (PPP) or towards a cancelling out of capital flows (current account equilibrium). Econometric studies focus on the long-run estimation of the equilibrium exchange rate. They then estimate error correction models in order to evaluate the adjustment of the exchange rate towards its equilibrium level.

In all these studies, the model of reference is identical. It combines two types of influence on equilibrium real exchange rate: firstly, the trend of the relative price for traded goods against non-traded goods, and secondly, the exogenous variables acting on the current account within the twin constraints of internal balance and net external balance sustainability. The equilibrium exchange rate is dependent on these two sets of variables. It is the exchange rate, which would prevail if speculative and cyclical factors were not present. Different choices may be made in the formulation of the requirement for the sustainability of external balances. These choices lead to two closely related approaches, one based on DEER and the other on NATREX.

The DEER and the NATREX approaches define internal balance in the same way. The level of production is equal to that which permits the full utilisation of production capacity or alternatively the unemployment rate is equal to its NAIRU level. External balance is defined as the position in which the balance of payments is sustainable. However, this condition does not define one single state of external balance. For DEER, external balance has been achieved when the net external account equates to the desired value. The latter is not necessarily constant over time and the equilibrium exchange rate will therefore follow a trajectory. In the NATREX approach, Stein (1996) does not refer to any desired level for the net external balance, but rather to a portfolio balance at which asset yield are equal at the margin. The equilibrium real exchange rate can then be deduced from the equality between the nation's current account and its net financial savings, when output is at full production capacity. In this approach, the real exchange rate is a function of the time preference of the population, since savings depend on it. The higher the preference for the present, the greater the depreciation of the country's equilibrium exchange rate.

One controversial influence is that of real interest differentials on equilibrium real exchange rates. In theory, this differential should impinge upon the adjustment between the current exchange rate and the equilibrium exchange rate, and not on the determination of the equilibrium exchange rate as such. As national and foreign assets are imperfect substitutes, the yield differential shapes portfolio adjustments over the short run until equilibrium is found at the point where margins are equal. The interest rate differential will, in theory, have disappear when the exchange rate have reached its equilibrium level and this equilibrium rate is not expected to change.

This is confirmed statistically by the observation that the real exchange rate is I(1). Its first-order difference, and therefore also the anticipation of that difference, is stationary. The non-covered interest parity, which also holds in real terms when subtracting expected inflation from both sides, requires that the real interest differential is equal to the expected depreciation of the real exchange rate. Consequently, the real interest differential is also expected to be stationary and therefore can explain the long run behaviour of the equilibrium real exchange rate varies over time. Most empirical tests confirm the absence of real interest differential in the cointegration relationships revealing the determinants of the equilibrium real exchange rate. However, real interest differentials are sometimes found I(1)) and introduced as explanatory variables in the equilibrium real exchange rate.

3. A MODEL FOR EQUILIBRIUM EXCHANGE RATE

The first step is the decomposition of the real exchange rate to bring out the effect of relative prices. The model then incorporates the conditions governing the equilibrium real exchange rate.

3.1. Real exchange rate and relative prices

The economy is divided into two sectors: one for traded goods, represented by the index *T*, and the other for non-traded goods, indexed *N*. These two sectors generally show differing movements in productivity. The internal demand price in a country (country 1) can be formulated as follows:

(1) $$p = bp_T + (1-b)p_N$$

where p_i denotes the price index for sector *T* or *N*, *p* denotes the general price index expressed as a logarithm and *b* the weight of sector *T* in the country's internal demand.

In the reference foreign country (country 2), whose variables are indicated by the superscript "*", the same equation applies:

$$p^* = b^* p^*_T + (1-b^*)p^*_N$$

The real exchange rate *q* for the first country is defined by means of the price in domestic demand:

(2) $$q = p - e - p^*$$

where *e* denotes the nominal**,** indirectly quoted exchange rate of country 1 (as a logarithm). The real exchange rate *q* of country 1 is here defined as a direct quotation (as a logarithm). Therefore, an increase in the real exchange rate signifies an appreciation.

The real exchange rate may also be defined using the traded goods price:

(3) $$q_T = p_T - e - p_T^*$$

The real exchange rate *q* may be expressed as a function of q_T and the relative prices of *T* and *N* using the definition of *p* and p^* :

(4) $$q = q_T - (1-b)(p_T - p_N) + (1-b^*)(p_T^* - p_n^*)$$

Or:

(5) $$q = q_T - (1-b)\left[(p_T - p_N) - (p_T^* - p_N^*)\right] + (b - b^*)(p_T^* - p_N^*)$$

When the relative price between sectors *T* and *N* rises faster (or falls less rapidly) in the country 1 than in the foreign country, the real exchange rate as measured using the internal demand price will depreciate. The elasticity of this relationship is the contribution of sector *N* to the domestic demand of the country 1. The last term is not significant for variation in equilibrium exchange rates unless the domestic demand structures differ greatly between the countries and the relative price shows a sharp rise.

If the prices for traded goods were consistent with the law of one price, q_T would be constant at the equilibrium and relative prices would be the sole determinants of the trend of the real exchange rate. The non-stationarity of q_T evidences the existence of other fundamentals acting on the equilibrium exchange rate.

3.2. The equilibrium real exchange rate and the balance of payments

The model adopted here includes a stock-flow adjustment of the net external position as in Faruqee (1995), MacDonald (1995). The domestic equilibrium condition is supposed to be fulfilled in the long run, as there is a full capacity utilisation in the long run. The external equilibrium condition relies on the sustainability of the current account.

The net current account balance $\dot{F}$ is broken down in two components: the commercial account balance and the flows of interests paid on the net external position *F* invested at the foreign interest rate *r**.

(6) $$\dot{F} = \epsilon(z - q) + r^* F$$

The commercial account negatively depends on the real exchange rate and positively on a variable *z*, which summarises the non-price competition factors. It is not affected by business cycle variables, such as differential output gaps, since it is a long run relation.

The domestic equilibrium condition is supposed to hold, therefore output gaps, which are by definition cyclical, should be zero.

The desired net flow of foreign assets $\dot{F}^{d}$ depends on two terms: a long run adjustment to the desired stock of foreign assets and the differential of interest rates.

(7) $$\dot{F}^{d} = u\left(F^{d} - F\right) - a\left(r - r^{*}\right)$$

The first term is the stock-flow adjustment, where F^{d} is the desired long-term stock. The second corresponds to the impact of interest rates differential on capital flows.

The current account balance equals the desired flow of foreign assets:

(8) $$\dot{F} = \dot{F}^{d}$$

The uncovered interest rate parity is supposed to hod. It can be written in real terms, if expected inflation is subtracted from both sides of the equation:

(9) $$r - r* = E_t\left(\dot{q}\right)$$

These four equations can be rewritten as a set of two differential equations describing the dynamics associated with the exchange rate and the net external position:

(10) $$a\, E_t\dot{q} = e\, q - \left(r^{*} + u\right)F - e\, z + u\, F^{d}$$
$$\dot{F} = -e\, q + r^{*}F + e\, z$$

This system of equations shows a stable-state saddle point trajectory, which satisfies the sustainability condition. It captures the adjustment dynamic toward the equilibrium:

(11) $$q_t - \overline{q}_t = t\left(F_t - \overline{F}_t\right)$$

$\overline{q}_t$ denotes the equilibrium real exchange rate and $\overline{F}_t$, the long run desired net external position. The long run equilibrium variables $\overline{z}_t$ and $\overline{F}_t$ are moving averages of the expected future values of z_t and F_t. Their exact specification can be calculated by solving the system (10) and is given in Faruqee (1995).

The real equilibrium exchange rate is defined by the following relationship:

(12) $$\overline{q}_t = \overline{z}_t + \frac{r^{*}}{e}\overline{F}_t$$

The equation (12) suggests the existence of a relation over the long run between the real exchange rate, the non-price competition indicator and the stock of net foreign assets.

If such a cointegration relation exists between the I(1) variables, the $q_t - \overline{q}_t$ dynamic may be estimated using an error correction model.

4. Equilibrium exchange rates for European countries

The empirical studies mentioned above have yielded interesting results for effective exchange rates insofar as their models has evidenced the impact of some fundamentals on the real exchange rates. The indicator for relative price of traded goods against non-traded goods and the net external position are significant explanatory variables for the equilibrium real exchange rate in nearly all the papers. No other variables are unanimously retained.

Stein found a significant effect for the time preference in the United States in the determination of the real effective exchange rate of the dollar, using the NATREX approach. Where real interest differentials are concerned, all three models theoretically assume that real interest rates average out between countries over the long run; there is therefore no reason for the interest rates differentials to be included in the long-run equation. MacDonald does however introduce them into the long-run equation for the equilibrium real exchange rates. Stein does so only in the adjustment equation in order to explain divergence from equilibrium. This variable appears to be a rather ambiguous one in Fell (1996). The separate equations for each currency include the real interest differentials as an explanatory variable for the effective real exchange rates of the dollar, the mark, the franc and the lira. But no significant effect for real interest differential was found in the cross-section equation, which determines simultaneously the exchange rate system using the same explanatory variables. Similarly, cycle variables, as output gaps should not be included in the long-run equation since these are, by their nature, short-term variables.

4.1. The chosen long-run equation

The aim of this study leads to the definition of the real exchange rate in a bilateral form rather than the calculation of effective exchange rates. The real exchange rates of European currencies considered are those against the dollar. The lessons of the empirical studies and the results provided by the models described above lead to an estimation of the reduced-form equations for equilibrium real exchange rate incorporating relative prices and net external position as explanatory variables. Our previous work on foreign trade (Aglietta - Baulant 1994) also suggests the use of non-price competition factors to explain equilibrium real exchange rate. The variables representing time preference for the present were removed after initial testing since they were not shown to be significant. The equilibrium real exchange rate is therefore dependent on three terms: relative prices, cumulative current account balance and a third term representing non-price competition.

The estimated long-run equation is formulated as follows:

$$q^i_t = a^i_1\, RAPRI^i_t + a^i_2\, F^i_t + a^i_3\, Z^i_t + c^i + e^i_t \,,\ i = A, F, I. \tag{13}$$

where q^i_t denotes the real bilateral exchange rate between the dollar and the currency of country *i*, deflated by consumer prices and then expressed as a logarithm. An increase of q^i_t corresponds to a real appreciation of the dollar against currency *i*; $RAPRI^i_t$ is the ratio between the prices for traded goods and the prices for non-traded goods in the United States divided by the same ratio with country *i*, and expressed as a logarithm. These ratios are between the wholesale and consumer price indices.

F^i_t is the ratio of net foreign assets to GDP of the United States less that of country *i*. Net foreign assets are obtained by computing the cumulative total of current account balances since 1970

Z^i_t is a non-price competition variable, represented here by the ratio of expenditures in research and development (R&D) related to GDP in the United States less the same ratio in country *i*.

The relative prices of traded and non-traded goods is a common variable which appears in most of the studies in this area. When this ratio rises faster or falls less quickly in country 1 than in country 2, the real exchange rate of country 1 versus country 2 tends to depreciate. This is open to a number of interpretations. The most conventional (the Balassa effect) attributes the sharper rise in the prices of non-traded goods in one country compared with another to greater disparity of rates of growth in productivity between the traded and non-traded goods sectors in the country concerned when compared with the other. Another interpretation emphasises an income effect. When income rises faster in one country than in another, the demand in the non-traded goods sector is greater in that country. The shift of capital to that sector to increase market supply at the rate required by the demand is encouraged by a greater rise in the relative price for non-traded goods in the country where total income is rising faster. According to one last possible interpretation, the influence of the relative price on the real exchange rate is merely a statistical artefact caused by the definition of the real exchange rate on the basis of retail prices or a domestic price index. Since the difference from PPP is greater for internal prices than for international prices, the relative price automatically affects the real exchange rate to an extent dependent on the importance of non-traded goods in domestic demand.

Net foreign assets can be seen to be a fundamental determinant for the equilibrium exchange rate. It is defined as the cumulative current account balance in order to exclude valuation effects. The more a country has accumulated surpluses in the past, the higher its net foreign position, and the greater the appreciation of its equilibrium real exchange rate. Conversely, as a country's level of indebtedness to foreign creditors rises due to accumulated past deficits, the greater the depreciation of its real exchange rate. This linkage stems from the condition requiring sustainability over the very long run, which entails the stationarity of net foreign assets. To meet this condition, a country, which has been in surplus in the past, must be in deficit in the future, a situation that can be brought about by the appreciation of its real exchange rate. A country, which has been in deficit, must make surpluses in the future, which can be brought about by the depreciation of its real exchange rate.

Most studies leave aside indicators of non-price competitiveness, although these are important in explaining foreign trade performance. Theories of external trade take into account non-price factors such as vertical product diversification and endogenous creation of comparative advantage through innovation. An improvement in non-price competitive effectiveness will lead to an appreciation in the equilibrium real exchange rate. The empirical problem here is to find the right variable to represent this phenomenon, since it involves numerous factors which are frequently dependent on the degree of sectoral aggregation and which therefore cannot be used at macroeconomic level. The R&D expenditures can be considered as a non-price competition indicator, which raises no data aggregation problems. R&D improve the effectiveness of non-price competition over the long term since knowledge produced in this way generates percentage yields, which increase over time. Accumulation of such yields generates flows of innovation and facilitates product diversification.

4.2. Unit root and cointegration tests – estimation country-by-country

The variables used are quarterly-based and taken from a sample covering the period from 1973, 1st quarter to 1996, 4th quarter for three European countries: Germany, France and Italy. The exact sources are given in an appendix to the present paper.

The unit root tests were based on the method of Dolado-Jenkinson and Riveiro (1990), which supplies an algorithm for selection of the appropriate model, with or without constant and trend. Seasonal dummies were added. The tests detailed in Table 1 give the p-values for the Dickey-Fuller and Phillips-Perron statistics. The results demonstrate that real exchange rates are I(1). Purchasing power parity is therefore not verified over the long run for this sample. This confirms the results of much previous research (for a survey, see Rogoff [1990]). The relative price variables (relatively to the United States) are I(1) for Germany, France and Italy. The tests do not reject the null hypothesis for the unit root. The same holds true for the R&D variables. Where the cumulative current balances are concerned, the results are mixed. The tests do not reject the unit root for the first-order difference series for France and Italy and are ambiguous in the case of Germany. The cumulative current balance can be considered as I(2). Nevertheless, we have preferred to consider these series as I(1) for the sake of simplicity.

The Johansen and Juselius cointegration tests were applied to the four variables in equation (13). The results show that there is one cointegration relation between these four variables for each of the three countries (see Table 2). The long-run relation was then estimated with the ordinary least square method, which supplies the cointegration vector. Given that the regressions are applied to cointegrated I(1) variables, there is a need to correct possible bias in the Student t values in order to test the degree of significance of each variable. We used the correction method recommended by Saikkonen (1991), Philips and Loretan (1991) which has also been described by Hamilton (1994), reestimating the equation using variables lagged and advanced by 4 periods. The stationarity of the residuals was then verified using Dickey-Fuller tests, which should be compared with the confidence levels supplied by Phillips and Ouliaris [1990] that are applied to the residues of spurious regressions.

All these variables are appropriately signed and significant, with the exception of research and development in France, which was subsequently eliminated from the regression (see Table 3). The residues are stationary at a confidence level of 90% for Germany but marginally lower for France and Italy. In any event, these long-run linkages appear to be genuine for three reasons. Firstly, they result from a least ordinary squares estimation of variables for which cointegration has been verified. Secondly, the coefficients are shown to be significantly far from zero by the results of the corrected Student tests. Thirdly, the regression residues are highly significant when introduced into the error correction model.

The short-run dynamic of the exchange rate as it adjusts towards its equilibrium rate can be captured by an error correction model formulated as follows:

(2) $\Delta q^{i}_{t} = b^{i}_{1} \Delta q^{i}_{t-1} + b^{i}_{2} \Delta RAPRI^{i}_{t} + b^{i}_{3} \Delta F^{i}_{t} + b^{i}_{4} \Delta r^{i}_{t} - b^{i}_{5} \varepsilon^{i}_{t-1} + c^{i} + u^{i}_{t};$

where r_t denotes the real long-term interest differential between the United States and country *i* and ε^{i}_{t-1} denotes the estimation residue of equation (1) obtained for country *i*, that is to say the "misalignment" of the exchange rate in the preceding period.

The results set out in Table 4 show that each of these variables is significant for all three countries. As would be expected, in real interest differentials play a role in the formation of real exchange rates in the short run. Furthermore, it is interesting to note that the misalignment observed for the preceding period (ε^{i}_{t-1}) is also important. The real exchange rate observed adjusts to its long-run equilibrium rate by depreciating if it is overvalued and by appreciating if it has been undervalued.

4.3. Simultaneous estimation of the three European countries

The above equations show responses of differing amplitudes to the fundamentals on the part of the exchange rate. Specifically, the relative price coefficient seems to be abnormally high in Germany. There is however, on the face of it, no reason why these coefficients should differ from country to country. It is therefore preferable to reestimate equation (1) simultaneously for the three countries. Another argument, quoted by Fell (1996), militates in favour of simultaneous estimation. This is that the sample covers a relatively short period of time and equilibrium is supposed to be reached over the long run. Strictly, with a sample limited to a very short time series, the equilibrium point may not be reached, and it will be difficult to use regression to estimate it. Simultaneous estimation will multiply the chances of encountering within the sample exchange rates at their equilibrium point. This allows a more effective estimation to be obtained.

The estimations are applied to equation *(1')*, in which coefficients a_i are identical for all the countries.

(1') $q^{i}_{t} = a_1 RAPRI^{i}_{t} + a_2 F^{i}_{t} + a_3 Z^{i}_{t} + c^{i} + \varepsilon^{i}_{t}$

The regression applied is based on the SUR *(Seemingly Unrelated Regression)* approach. The results are set out in Table 5. All three variables are shown to be significant in the regression procedure. The relative price coefficient now comes out as nearer to -1 and is therefore more satisfactory. The residues may be considered to be stationary. Moreover, they are shown as being highly significant in an error correction model such as equation *(2)*. These are the estimations that we shall use in the next part of the present paper.

4.4. Interpretation of the results

The equilibrium real dollar/mark exchange rate thus estimated is seen as inherently much more stable than the current exchange rate (see Graph 1). It follows observed movements in current rate in part, while evidencing major misalignments, particularly in 1984 in 1985. The equilibrium real exchange rate thus displays an initial period of weakness in the dollar from 1973 to 1979, and subsequently, over the period 1979 to 1985, the dollar's equilibrium exchange rate appreciates, serving to explain in part the currency's phase of increasing strength. However, the misalignment grows in size from 1983 on. The real overvaluation of the dollar/mark exchange rate thus exceeds 40% by 1985. This indicates that the exchange rate is influenced by many factors other than the fundamentals, such as for example interest rate differentials and, no doubt in this instance, the presence of a speculative bubble. Since 1986, the equilibrium real exchange rate of the dollar and the mark shows a slight downward trend.

Graph 2 showing relative contributions allows us to determine what forces are at work behind this equilibrium exchange rate. The impact of research and development, although significant, is very weak. In actual fact, two main factors were driving the movement in the equilibrium real exchange rate between the dollar and the mark**:** relative prices and the current account balance. In any given period one or other of these will play the dominant role.

- From 1978 to 1985, wholesale prices fell relative to consumer prices much more in the United States than in Germany. The sharp relative drop in industrial prices in the United States explains the strength of the dollar against the mark, since in Germany over this period industrial prices were rising virtually as fast as other prices. Given that industrial goods still account for the largest share of international trade, the relative fall in industrial prices in the United States allowed the dollar to appreciate without too great a loss of competitiveness for American industrial products.

- Between 1986 and 1990, relative prices stabilise between the two countries. The main factor now becomes the accumulation of current account deficits in the United States, which drags the equilibrium real exchange rate downwards.

- Since 1990, or German reunification, German deficits have been exerting a steady downward pressure on Germany's net external position. Germany now finds itself in a comparable position to that of the United States where current account deficit is concerned. Relative current balance therefore no longer influences the dollar-mark exchange rate. In Germany, reunification has also had an inflationary effect on prices in sheltered sectors whereas international competition has been forcing industry to adjust its cost levels. Relative prices for German industrial goods have therefore fallen more than those of the United States. It is this factor which explains the downward trend in the equilibrium real dollar/mark exchange rate over the period 1991 to 1996.

Where France is concerned, the equilibrium real exchange rate of the franc has been tending to rise steadily against the dollar since 1987 (see Graph 3). This is largely due to the deterioration in the net external position of the United States and the recovery of French foreign trade (see Graph 4). The equilibrium real exchange rate of the Italian lira does not follow the upward phase of the dollar from 1979 to 1985 (see Graph 5). The reason for this is that if the dollar's real equilibrium rate rises against the mark and the franc over the period, it is because relative industrial prices were falling more in the United States than abroad. However, comparatively speaking, this was not the case in Italy. Relative industrial prices fell even further in Italy than in the United States (see Graph 6). The overvaluation of the dollar between 1983 and 1985 thus appears much greater against the lira.

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Graph 1: Real equilibrium exchange rate of the dollar/mark

Graph 2 : Contributions

Graph 3 : Real equilibrium exchange rate of the dollar/franc

Graph 4 : Contributions

Graph 5 : Real equilibrium exchange rate of the dollar/lire

Graph 6 : Contributions

5. THE CONSEQUENCES FOR THE EURO

The deduction from these estimations of information on the euro exchange rate is a problematic exercise naturally surrounded by considerable uncertainty. Nevertheless, the above representations of the equilibrium exchange rates for European currencies can give us some useful indications as to the role played by the fundamental factors.

5.1. How should the euro be presented

A proxy for the euro exchange rate can be constructed by aggregating the chosen three European currencies according to their weighting in the ECU. The conflation of ECU and euro seems to be legitimate given the 1:1 ECU/euro conversion rate.

The real exchange rate of the euro, written q^E_t , can be represented by the following indicator:

$$(3) \qquad q^E_t = \Pi_i \, {q^i_t}^{\alpha_i}$$

where the α_i variables denote the weighting of currency *i* in the ECU expressed as a ratio to the sum of the weightings of all three countries.

We have here $\alpha_A = 0.53$, $\alpha_F = 0.34$, $\alpha_I = 0.13$,

where the indices *A*, *F* and *I* denote Germany, France and Italy respectively.

The three countries chosen account for 61% of the currencies in the ECU as weighted according to their importance in the basket of currencies. This indicator is therefore a representative one, despite the fact that it leaves aside the other currencies, since it must be borne in mind that certain currencies included in the ECU basket will not be in the euro — at the outset at least. This is the case for the British pound (the weighting of which in the ECU is 11.1%), the Danish krone (2.7%) and the drachma (0.5%). If we take out these three currencies, our chosen three currencies — i.e. the mark, the franc and the lira — account for 71% of the euro currencies, thereby providing a satisfactory approximation.

Cointegration tests are applied in order to check that there does in fact exist a long-run relation between the euro and the European fundamental variables. The European variables are obtained by aggregating all three European countries. European relative prices are constructed in the same way as the real exchange rate by aggregating the relative prices with a geometric mean weighted by the contribution the three currencies in the ECU. The variable $RAPRI^E$ is then constructed as before by means of the ratio between American relative prices and European relative prices. Real interest rates are obtained in the same way. Conversely, for the two other variables, which are expressed in percentages of GDP, this does not seem the best representation given that the weight in the ECU of these currencies does not correspond exactly with the weight of those same countries in total GDP. It therefore seems more appropriate to add the external net positions of these three countries in order to obtain a proxy for the net external position of this European grouping as a whole, and then to relate the latter to the sum of all the GDPs. The same method is used for expenditure on research and development. The Johansen tests show that there is indeed cointegration of the euro exchange rate, thus arrived at, and the explanatory variables of the long-run relation (see Table 2).

The equilibrium exchange rate for the euro is then calculated using a geometric mean of the equilibrium exchange rates of the three currencies as they appear in the stacked regression. This mean is calculated as in equation (4). The same procedure is followed for the calculation of the relative contributions.

5.2. The euro’s equilibrium exchange rate

By definition, the variables acting on the equilibrium real exchange rate of the euro against the dollar are the same as for the European countries considered: the ratio between prices, net external position and expenditure on research and development. The euro's equilibrium exchange rate and the contributions of these variables can be seen in graphs 7 and 8. The equilibrium exchange rate for the euro comes out as more stable than that of the European countries. This is because movements in relative prices, between Germany and Italy for example, tend to cancel out at European level; the same consideration applies to current balances.

Relative prices fall in the United States compared with Europe over the period 1979 to 1985, and then increase, a fact which partly explains the rise of the dollar, followed by its fall, over this same period. The same movement can be seen in relation to the German mark, but in a less accentuated form since in Italy, the fall in industrial prices compared with other prices was greater than in the United States (see Graph 9). Companies in the Italian industrial sector made major gains in productivity, whereas the sheltered sector was not subject to the same pressures. Moreover, movements in salaries in the sheltered sector tended to move parallel to those in industry, due to the size of the public sector. All in all, the relative price factor provides a partial explanation for the rise in the dollar against the euro between 1979 and 1985, but plays a smaller role than in the case of the dollar/mark rate.

Cumulative current balances have played a role in the downward trend in the equilibrium real exchange rate of the dollar against the euro since 1985. During the 1980s, the German surplus improved the net external position of Europe, helping strengthen the euro, particularly over the period 1983 to 1990. In the 1990s, France and Italy have taken over from Germany in this respect; the net external position of Europe is now improved by the current account surpluses of these two countries (see Graph 10).

Non-price competitiveness, as measured by the yardstick of expenditure on research and development, favours the dollar between 1977 and 1986, and then becomes unfavourable to that currency. In the 1990s, the effort expended on research and development has diminished in all countries, but especially in Germany and the United

States. This reduction is smaller in France and Italy, a fact that contributes to the strength of the euro (see Graph 11).

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Graph 7 : Real equilibrium exchange rate of the dollar/euro

Graph 8 : Contributions

Graph 9 : Relative Prices

Graph 10 : Cumulated current account in % of GDP

Graph 11 : Expenditures in R & D, in % of GDP

5.3. The outlook for the euro

Over the next few years, the factor most likely to exert the greatest influence will be cumulative current balance. This is because the gap will continue to exist between the United States, continuing in deficit, and Europe, which should continue to generate a surplus. This factor is therefore likely to help make the euro a strong currency and, conversely, exert downward pressure on the dollar. On this analysis, the inclusion of Italy in EMU would contribute to the strength of the euro given its high current account surpluses[4].

The present analytical conclusion that the euro will be strong derives from reasoning focused on real exchange rates. The analytical outcome is even clearer when nominal exchange rates are considered: the inflation rates of the three European countries have now converged to levels below 2%, whereas the United States has a slightly higher inflation rate. OECD forecasts in fact announce inflation of 2.2% in 1997 and 2.4% in 1998 in the United States, compared with 1.7% for Europe, reduced in the present instance to Germany, France and Italy. If the real exchange rate of the euro is driven upwards, the nominal exchange rate will be likely to rise all the more.

6. Conclusion

This study confirms the existence of two fundamental determinants governing the formation of equilibrium exchange rates: relative prices and net external position. It also contains two improvements on previous work. The first is that it shows that equilibrium exchange rate can be estimated bilaterally and that real exchange rates adjust over the short run to absorb the bilateral misalignments thus highlighted. The second is that equilibrium exchange rates may be dependent on non-price competition factors; expenditure on research and development, because it drives innovation, can be seen to be a factor likely to strengthen a currency’s real exchange rate over the long term. The application of this to the euro demonstrates that the euro should be a strong currency against the dollar over the coming years.

[4] The Italian current account balance is estimated by the OECD at 3.4% of that country's GDP for 1997 and at 3.2% in 1998, compared with deficits of 0.8% of GDP in Germany.

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Table 1 : Unit root tests

All variables are taken as the one of the United States minus the one of the considered European countries, as in equation (13). Columns *(diff)* give the tests for the series taken in first differences. Quarterly are added in each model. Estimation period: 1973-1 à 1996-4

1. P-value of the augmented Dickey Fuller test in the model with trend and constant.
2. P-value Philips-Perron test in the model with trend and constant.
3. Existence of a trend, = 1 if the Student test on the trend indicates significance to a confidence threshold of 95%, =0 otherwise. The test is not implemented if the series is stationary in the model with trend and constant.
4. P-value of the augmented Dickey Fuller test in the model without trend and with constant.
5. P-value Philips-Perron test in the model without trend and with constant.
6. Existence of a constant, = 1 if the Student test on the constant indicates significance to a confidence threshold of 95%, =0 otherwise. The test is not implemented if the series is stationary in the model with constant.
7. If the constant is significant, the unit root hypothesis is again tested with a Student test. If it is not significant, one has to stop the process because of quarterly dummies.
8. Optimal lags in the retained model.

9.Order of integration.

Table 2 : Johansen cointegration trace tests between variables q, RAPRI, F and Z

	Germany	France	Italy	Europe
H0 : r=0	47,8 (0.06)	30,2 (0,01)	56,1 (0,01)	58,0 (0,01)
H0 : r<=1	24,7 (0,23)	11,3 (0,75)	18,1 (0,62)	30,0 (0,07)
H0 : r<=2	10,2 (0,42)	3,32 (0,80)	3,65 (0,89)	11,1 (0,35)
H0 : r<=3	3,6 (0,33)	0,70 (0,46)	0,01 (0,80)	0,13 (0,79)
Optimal lag *	1	5	4	5

Estimation period: 1973-1 à 1996-4
The figures in brackets are the p-*values* (probabilities of being wrong in rejecting H0). Quarterly dummies are added in the regressions. All variables are taken as in equation (13) in difference relatively to the US.
* Akaike criteria, in setting the maximum to 8 lags.

Table 3 : Long term regression

$q^{i}_{t} = a^{i}_{1}\, RAPRI^{i}_{t} + a^{i}_{2}\, F^{i}_{t} + a^{i}_{3}\, Z^{i}_{t} + c^{i} + e^{i}_{t}$, *i= A, F, I.*

	Mark	Franc	Lire
a^{i}_{1}	-4,29 *(-5,2)*	-3,2 *(-7,9)*	-0,74 *(-0,1)*
a^{i}_{2}	0,42 *(6,2)*	0,56 *(10,6)*	0,27 *(2,2)*
a^{i}_{3}	0,16 *(2,6)*	-	0,37 *(3,1)*
corrected R2	0,67	0,71	0,54
DW	0,43	0,31	0,79
A Dickey- Fuller on residuals (*)	-4,38	-2,90	-2,79

Estimation period: 1973-1 à 1996-4, OLSQ.
Student test in braclets are corrected using the Saikkonen method. Their value can be compared with the usual Student tables (significance at 95% level : 1,96, 90% : 1,645).
(*) Critical values of tests to be applied to the residuals of a "spurious" cointegrating regression with 3 explicative variables, with constant and without trend : at 95% : -4,11, at 90% : -3,83.

Table 4 : Short-run estimation

- Mark:

$$\Delta q_{At} = 0,33 \Delta q_{At-1} - 1,64\, \Delta RAPRI_{At} + 0,31\, \Delta F_{At-1} + 0,03\, \Delta r_{At-1} - 0,19\, \varepsilon_{tA-1}$$

-(3,3) (-2,7) (1,8) (2,5) (-3,4)

R2 = 0,29.

- Franc :

$$\Delta q^{F}_{t} = 0,19 \Delta q^{F}_{t-1} - 1,86\, \Delta RAPRI^{F}_{t} + 0,42\, \Delta F^{F}_{t-1} + 0,02\, \Delta r^{F}_{t} + 0,02\, \Delta r^{F}_{t-1} - 0,19\, \varepsilon^{F}_{t-1}$$

(2,0) (-4,2) (1,8) (2,5) (2,7) (-3,4)

R2 = 0,40.

- Lire :

$$\Delta q^{I}_{t} = 0,28 \Delta q^{I}_{t-1} - 1,14\, \Delta RAPRI^{I}_{t} + 0,01\, \Delta r^{I}_{t} - 0,15\, \varepsilon^{I}_{t-1}$$

(2,9) (-3,4) (2,0) (-3,3)

R2 = 0,27.

Estimation period: 1973-2 à 1996-4, OLSQ.

Table 5 : Simultaneous regression for the three countries

- Long term equation : $q^{i}_{t} = a_1\, RAPRI^{i}_{t} + a_2\, F^{i}_{t} + a_3\, Z^{i}_{t} + c^{i} + \varepsilon^{i}_{t}$

a1	-1,72 (-13,2)
a2	0,21 (8,6)
a3	0,12 (3,3)

	Mark	Franc	Lire
corrected R2	0,62	0,65	0,47
A Dickey-Fuller for the residuals (*)	-2,90	-2,67	-2,80

Estimation period: 1973-1 à 1996-4, SUR (*Seemingly Unrelated Regressions*).

- Short-run estimation :

$$\Delta q^{i}_{t} = 0,21 \Delta q^{i}_{t-1} - 0,85\, \Delta RAPRI^{i}_{t} + 0,25\, \Delta F^{i}_{t-1} + 0,01\, \Delta r^{i}_{t-1} - 0,07\, \varepsilon^{i}_{t-1}$$

(3,6) (-4,7) (4,3) (2,0) (-3,0)

R2 Allemagne : 0,08 ; R2 France : 0,33 ; R2 Italie : 0,35.

Estimation period: 1973-1 à 1996-4, SUR (*Seemingly Unrelated Regressions*).

APPENDIX: STATISTICAL SOURCES

1. Real exchange rates

* Nominal exchange rates for the German mark, the franc and the lira were taken from the Banque de France database (as based on Currency Exchange Department indicative market rates at 2.30 p.m.).

* Consumer price indices were derived from OECD gross quarterly series for consumer prices (*Main OECD Indicators*). These series are expressed directly in terms of a 1990 baseline.

* Real bilateral exchange rates relate the American consumer price to the price for each country under consideration (Germany, France and Italy) before conversion into dollars at the current exchange rate.

2. Explanatory variables

* The wholesale price data series were taken from the monthly series of the BIS. German wholesale prices are for West Germany alone.

* The current account balance data series are those of the OECD (quarterly series). The French series shows a break in continuity in the fourth quarter of 1972.

* GDP value series were taken from the OECD quarterly database for the United States, France and Italy.

German GDP figures were taken from two GDP series from the BIS: reunified Germany over the years 1991 to 1997 and West Germany for the period prior to 1991. This latter series is available for the years 1970 to 94.

The GDP for reunified Germany has been retropolated by dividing the older West German series by the last known point and multiplying the same series by the first point in the series for reunified Germany.

* Research and development data was taken from the "OECD Sciences and technology indicators" database. This information relates to internal research and development expenditure expressed as a percentage of GDP. The data, available on an yearly time base, was then reworked to obtain a quarterly time base.

* The long-term interest rate series were taken from OECD quarterly series.

American long-term interest rates relate to "government bonds at more than 10 years".

German long-term interest rates relate to "public sector bonds at 7 to 15 years". This German series has a break in continuity in the fourth quarter of 1972.

French long-term interest rates are represented by the rates for "public- and semi-public sector bonds".

Finally, Italian long-term interest rates relate to "long-term government bonds".

* The inflation rates used to deflate long-term interest rates correspond to an exponential smoothing of consumer prices with weighting of 0.9 for the smoothed prices for the earlier period and 0.1 for contemporary prices.

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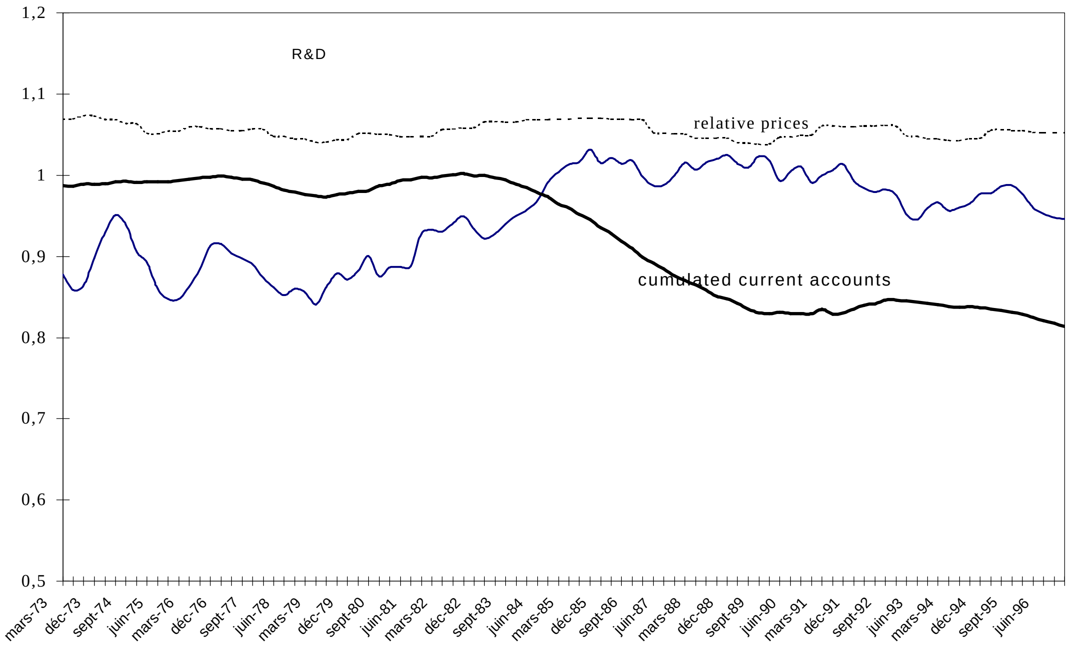
GERMANY	Real exchange ratel	*diff*	Relative prices	*diff*	Cumulated current account	*diff*	R&D	*diff*
1. P.value DF,C,T	0,47	0,00	0,96	0,00	0,12	0,62	0,24	0,00
2. P.value Philips-Perron	0,72	0,00	0,97	0,00	0,91	0,40	0,54	0,00
3. Existence of a trend	0	-	0	-	0	0	0	-
4. P.value DF without trend, with cst	0,19	-	0,57	-	0,83	0,31	0,20	-
5. P.value PhP without trend, with cst	0,32	-	0,78	-	0,95	0,12	0,24	-
6. Existenceof a constant	0	-	0	-	1	1	0	-
7. If cste, p-value of Student T on ro	-	-	-	-	0,54	0,06	-	-
8. Optimal lag	-3	-2	-2	-2	-8	-7	-6	-2
9. Order of integration	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**
FRANCE								
1. P.value DF,C,T	0,45	0,00	0,94	0,00	0,20	0,28	0,74	0,00
2. P.value Philips-Perron	0,58	0,00	0,74	0,00	0,79	0,34	0,78	0,00
3. Existence of a trend	0	-	0	-	0	0	0	-
4. P.value DF without trend, with cst	0,22	-	0,78	-	0,96	0,19	0,83	-
5. P.value PhP without trend, with cst	0,25	-	0,51	-	0,99	0,20	0,83	-
6. Existenceof a constant	0	-	1	-	1	0	0	-
7. If cste, p-value of Student T on ro	-	-	0,40	-	0,99	-	-	-
8. Optimal lag	-3	-2	-6	-6	-7	-6	-4	-3
9. Order of integration	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**0**
ITALY								
1. P.value DF,C,T	0,28	0,00	0,70	0,00	0,12	0,62	0,84	0,00
2. P.value Philips-Perron	0,53	0,00	0,10	0,00	0,80	0,48	0,90	0,00
3. Existence of a trend	0	-	0	-	0	0	0	-
4. P.value DF without trend, with cst	0,16	-	0,66	-	0,92	0,33	0,66	-
5. P.value PhP without trend, with cst	0,26	-	0,13	-	0,98	0,23	0,69	-
6. Existenceof a constant	0	-	1	-	0	0	0	-
7. If cste, p-value of Student T on ro	-	-	0,175	-	-	-	-	-
8. Optimal lag	-3	-2	-7	-6	-7	-6	-2	-2
9. Order of integration	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**0**


R&D
relative prices
cumulated current accounts
1,2
1,1
1
0,9
0,8
0,7
0,6
0,5
mars-73
déc-73
sept-74
juin-75
mars-76
déc-76
sept-77
juin-78
mars-79
déc-79
sept-80
juin-81
mars-82
déc-82
sept-83
juin-84
mars-85
déc-85
sept-86
juin-87
mars-88
déc-88
sept-89
juin-90
mars-91
déc-91
sept-92
juin-93
mars-94
déc-94
sept-95
juin-96