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**High Real Interest Rates:
the Consequence of a Saving-Investment Disequilibrium
or of an Insufficient Credibility of Monetary Authorities?**

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Apparent real interest rates have reached very high levels in the eighties, which still broadly prevail today. In some cases (France, for instance), short term real interest rates have even been persistently higher in the eighties than in any other decade of the century.

In the literature, the prevalent view is that the main cause driving this sharp rise was a disequilibrium between ex-ante investment demand and desired savings, even if there is a great divergence as regards the respective role of savings and investment in this disequilibrium: some see the decline in savings, and particularly public savings, as the ultimate source of the surge in real interest rates; others argue that a dramatic improvement in profitability is the driving source of this rise.

This paper argues that monetary policy cannot be dismissed, contrary to conventional wisdom, as an important factor behind the evolution of real interest rates by the channel of credibility which affects both variables. In a little theoretical model developed in the paper, the fear that monetary authorities use an implicit escape clause in the future to accommodate shocks if these shocks were to be too large is shown to lead to an increase in both short and long term interest rates.

Empirical evidence based on the estimation of an econometric model for the "world" real interest rates supports this view. Contrary to previous works which focus mainly on short term interest rates, the focus is put here mainly on long term interest rates, with a peculiar attention to the measure of inflation expectations. Specification and exogeneity tests then confirm my contention about the role of credibility.

The plan of the paper is the following. The first part presents an overview of the previous literature on the topic. The second part describes my methodology. The third part deals in more details with the theoretical influence of credibility on real interest rates. The fourth part describes the data used. The fifth part presents the econometric results concerning the "world" real interest rates. Part six concludes.

1. Explaining empirically the high level of real interest rates: an overview.

In their famous 1984 paper, Blanchard and Summers give five possible sources of the high level of real interest rates observed at this time: a reduction in savings; an increase in business profitability; the tightening of monetary policies; an increase in risk premium; nominal illusion (the two last explanations being grouped in their paper under the generic term "portfolio shifts").

The last explanation has not received widespread attention in the literature, mainly because the lack of rationality it assumes is not theoretically appealing. Neither has the preceding one, in part because risk premia are very difficult to identify. The third one, which was already rejected by Blanchard and Summers themselves, has been since then dismissed any role. At first sight indeed, the long run neutrality of money is one of the very seldom economic laws that no economist would seriously deny. So, the persistence of the increase in real interest rates over more than a decade could not be seriously ascribed to monetary authorities. Without trying to deny the long run neutrality of money, I shall however return to this point later.

At the end, only the first two explanations receive support in the empirical literature. Although Blanchard and Summers had concluded that an increase in business profitability was at the heart of the problem, at the expense of the reduction in savings hypothesis, the following literature is almost equally divided between these two theses.

Empirical studies on the topic deeply differ in their methodology. A first strand of literature doesn't use formal testing procedures, but only compares a range of empirical facts with the predictions of the theory. Blanchard and Summers paper for instance belongs to this category. Their conclusion about the predominance of the increased business profitability is based on the observation that stock prices have increased along with real interest rates: in the absence of any increase in business profitability, arbitrage between stocks and bonds should have depressed stock prices. Other early papers on the topic (Knight and Masson (1986) or Mc Kibbin and Sachs (1986) e.g.) follow a similar route, using macroeconomic models to emphasize the role of fiscal deficits in the rise in real interest rates.

This kind of work can provide useful insights. However this approach has two main drawbacks: testing independently various possible explanations can leave aside important factors whose influence can be hidden by an *a priori* more powerful one; and the proofs of the validity of the given explanation are at best indirect. So I concentrate now on more direct approaches. Most empirical papers estimate equations for one country (generally for the United States or, less frequently, the United Kingdom), or for a whole set of countries one by one. Results are generally mixed as regards the effect of public deficits or public debt on interest rates: Evans (1987a, 1987b), Plosser (1982, 1987) finds no effect, while Tanzi (1985), Coorey (1991), Howe and Pigott (1991), Correia-Nunes and Stemitsiotis (1995) find more favourable results. Fewer papers look at the effect of investment determinants; the papers which do so however generally find positive effects of the rate of return on capital (Howe and Pigott (1991)) or productivity (Coorey (1991)).

Some papers take into consideration the linkage of interest rates between countries: typically, small countries interest rates are found to be strongly related to the one of a neighbouring country (Germany for the Netherlands, France, Belgium..., The

United States for Canada,...) and interest rates of the G3 countries are found to be interrelated. This is the approach followed for instance by Orr and alii (1995). Their results confirm the interdependence between countries, since they find that every country is marked by the influence of at least one other country (which they have imposed to be only temporary). They confirm also the importance of the return on capital and the much weaker influence of public deficits on real interest rates.

The best approach is however certainly to look directly at the determination of "the" world real interest rate. Indeed, in a world with fully integrated capital markets, the no arbitrage condition implies that real rates of return must be equal between countries. Yet, the integration of capital markets have been questioned by Feldstein and Horioka (1980) and their followers. However, recent research (cf Taylor(1994)) has proved less unfavourable to this thesis. Anyway, even if capital markets are only partially integrated, every variable which can be thought to influence real interest rates (budget deficits, money growth...) has also a potential effect on exchange rates expectations: when estimating the effect on interest rates of this variable, one cannot be sure that it doesn't transiate through its influence on the exchange rate. As a matter of proof, one can look at the behaviour of indexed gilts when the United Kingdom leaved the ERM in september 1992: "real" interest rates as they were measured by these gilts, lost around 100 basis points as the overvaluation of the english pound vanished, decreasing the risk of a future depreciation of the pound. So, even if capital markets are only partially integrated, the risk of misspecification seems to be smaller when looking at an aggregated level than at a country level. Another factor goes in the same direction: over the two or three last decades, real interest rates in OECD countries have moved broadly together, which seems to indicate that they have been hit by the same shocks; looking at the *common trend* in OECD real interest rates is then a way to exhibit these common factors without capturing idiosyncratic shocks which may affect one country or another.

Consequently, many recent papers follow the route pioneered by Barro and Sala-i-Martin (1990). In their paper, Barro and Sala-i-martin (BSM in the remainder of the text) build a "world" nominal interest rate by aggregating short term interest rates of nine countries. The real interest rate is then constructed by subtracting inflation forecasts derived from an ARMA(1,1) to this "world" nominal interest rate. Real interest rates at the world level is then determined by equating saving to investment. Investment demand is supposed to depend on Tobin's Q, whose growth is proxied here by the world rate of return on the stock market. Saving is assumed to depend on real interest rates, on public deficits and on the deviation of current income from permanent income. Again, this last variable is proxied by the relative price of oil. Their results confirm broadly Blanchard and Summers conclusion that the rise in real interest rates is weakly related to a rise in public deficits, but owe mostly to a surge in business profitability as magnified by stock prices.

There are now several papers following BSM methodology. Some authors simply replicate their methodology, beginning with Barro (1992), who have extended his previous results by examining the behaviour of individual countries. Correia-Nunes and Stemitsiotis (1995) have also estimated, besides country regressions, an equation for the long run real interest rate at the world level, ignoring however the investment side, but introducing short term real interest rates. They found a strong effect of budget deficits (which can be due to the omission of investment determinants) and of real short term interest rates. Knot (1995) applies BSM methodology to the European Community, considered as a closed economy, departing so from BSM main hypothesis of a unique

"world" real interest rates. Surprisingly enough, they found that Europe can indeed be considered as a closed economy: neither the US real interest rate nor the European current account (as a percentage of GDP) enters significantly the regression. His analysis however suffers an omission bias, as the same variables measured at the European level and which enter the equation must also be introduced for the US because of their potential influence on agents' expectations. Other results confirm previous studies: stock returns, money growth and lagged investment are driving factors for interest rates, and this is not the case for public debt.

Helbling and Wescott (1995) study differs on several points from BSM. First, they address the question of the weighting scheme: in addition to the one chosen by BSM, based on GDP weights based on purchasing power parity exchange rates, they review other proposed procedures, such as the definition of the world real interest rate by the first principal component of a set of national interest rates (Ford and Laxton (1995)), or the common stochastic trend derived from a cointegration analysis of national interest rates (Brunner and Kaminsky (1994)). The first conclusion they draw is that the weighting scheme doesn't make much difference as concerns the main evolution of real interest rates. The second one, based on a cointegration analysis, is that real interest rates are driven in the long run both by the stock return and the public debt, and in the short run by world growth.

2. The methodology of this paper.

The discussion in section 1 has shown that it is important when trying to explain empirically interest rates to take into consideration the great capital mobility which prevails in the OECD. So I construct as others a "world" interest rate by aggregating G7 **long** term interest rates: the long term interest rate is *a priori* the price that equates saving and investment rather than the short term interest rate; and even if these two prices are in fact equivalent, there should be no loss working with long term interest rates.

There is however one major drawback with this choice: it is much more difficult to find a good proxy of agents' expectations than with short term interest rates, for which mechanical methods work well. To overcome partly this problem, this paper uses a combination of OECD inflation forecasts, past inflation and mechanical methods. OECD forecasts have indeed the great advantage to be a true measure of agents' expectations, even if these agents are rather peculiar. And even if they cover only 3 semesters, these 3 semesters certainly convey a great deal of information about the whole range to be covered: beyond these 3 semesters, agents' inflation expectations can be expected to be rather flat.

This choice constrains us in two different directions: first, OECD inflation forecasts do not cover the years before 1973; second, at the beginning of the period, inflation forecasts were made only for the G7 countries. So, "world" interest will here be constructed from G7 data only and will date back to 1973 only: since much of the variability of interest rates and inflation is concentrated on the seventies and the eighties, the loss of information will be small and since G7 countries take a great part in world output, G7 will presumably be a good proxy of the world.

The model estimated thereafter is in the tradition of the loanable funds models. It assumes that interest rates are determined by equating world demand and supply of funds.

As regards the formulation of investment demand, I adopt a somehow eclectic approach, in order to capture all the effects which can be relevant in practice. Following BSM, one can adopt a Tobin's q approach and assume the following formulation:

$$(1) \quad I/Y = \alpha + \beta q$$

where : I is investment,
Y is output,
q is Tobin's q.

Since Tobin's marginal q, which is the one which is theoretically relevant, is very difficult to measure precisely, BSM choose to differentiate this relation and to proxy the first difference of Tobin's q with the growth rate of real share price (\dot{p}_w). Since this variable measures in fact the first difference of average q, it is then necessary to correct the difference between marginal and average q. The correction used in this paper is twofold. First, as Barro (1992), I introduce the variation in the ratio of consumption on crude oil to GDP (pet), which $\Delta(\text{pet})$. Second, I use the capacity utilization rate, as a measure of the difference between average and marginal productivity of the capital stock. Equation (1) is then extended the following manner:

$$(2) \quad I/Y = I(-1)/Y(-1) + \beta_1 \dot{p}_w - \beta_2 \Delta(\text{pet}) + \beta_3 \text{cu} + \beta_4$$

The capacity utilization rate term can also be justified in a framework where the accelerator plays a prominent role: in that case, the capacity utilization rate is related to the discrepancy between effective and desired capital stock and in an investment equation can play the role of an *error correction term*. The corresponding investment function in an accelerator framework should so take the following form:

$$(3) \quad I/Y = \lambda I(-1)/Y(-1) + \beta_1 (\dot{y} + \Delta(\text{cu})) + \beta_2 \text{cu}(-1) + \beta_3$$

Finally, the postulated investment equation is a mixture of the two functions (2) and (3) :

$$(4) \quad I/Y = \beta_0 I(-1)/Y(-1) + \beta_1 \dot{y} + \beta_2 \Delta(\text{cu}) + \beta_3 \text{cu}(-1) + \beta_4 \dot{p}_w - \beta_5 \Delta(\text{pet}) + \beta_6$$

The saving function that I use is BSM one, extended in two directions. BSM framework is indeed a Permanent Income framework, where households consumption is a fraction of their permanent income, fraction which depends only on real interest rate ($R - \Pi_e$, where R is the nominal interest rate and Π_e are households inflation expectations). Households savings is so assumed to depend only on their transitory income: BSM assume that this transitory income can be proxied by real money growth (\dot{g}_m) by the ratio of consumption on crude oil to GDP and by the ratio of public deficit to GDP (d). BSM allow the ratio of public deficit to GDP (d) not to enter one for one in households saving equation: when

public saving rate is added to households saving rate, total saving rate then depends negatively on the ratio of public deficit to GDP. Ricardian equivalence which is a natural by-product of the PIH hypothesis is so here not assumed to hold.

The first extension that I introduce is to allow a positive influence of income growth on the saving rate: this is one of the main predictions of the Life Cycle theory and this prediction seems to hold very broadly on macroeconomic time-series (see Davidson and alii (1978) for an influential contribution in that vein) as well as on a cross-section basis (see Modigliani (1990) for instance and Deaton (1992) for a discussion on the puzzles that these results lead to when confronted in detail to the Life-Cycle theory). The second extension is to allow the influence on households saving rate of the ratio of wealth to GDP (w), as in the basic Life Cycle and as appears in some empirical modelisations of consumption behaviour in the United States and the United Kingdom.

The assumed desired saving rate is then given as:

$$(5) \quad S/Y = \gamma_0 S(-1)/Y(-1) + \gamma_1 R - \gamma_2 \Pi_e + \gamma_3 \text{pet} - \gamma_4 \dot{m} + \gamma_5 \dot{y} + \gamma_6 w + \gamma_7 \dot{d} + \gamma_8$$

The assumption that the real interest rate is the price that equates ex ante saving rate (5) and investment demand to GDP (4) leads to the following expression for the interest rate:

$$(6) \quad R = \delta_0 I(-1)/Y(-1) + \delta_1 \Pi_e + \delta_2 \text{pet} + \delta_3 \Delta(\text{pet}) + \delta_4 \dot{m} + \delta_5 \dot{y} + \delta_6 w + \delta_7 \dot{w} + \delta_8 \dot{d} + \delta_9 \Delta(\text{cu}) + \delta_{10} \text{cu}(-1) + \delta_{11}$$

with: $\delta_0 \geq 0$, $1 \geq \delta_1 \geq 0$, $\delta_2 \geq 0$, $\delta_3 \geq 0$, $\delta_4 \geq 0$, $\delta_5 \geq 0$, $\delta_6 \geq 0$, $\delta_7 \geq 0$, $\delta_8 \geq 0$, $\delta_9 \geq 0$, $\delta_{10} \geq 0$
(all signs are derived without ambiguity from the signs of the saving and investment equations, expect for the term related to GDP growth, since GDP growth is expected to increase both investment demand and savings; notice also that, in this framework, one expects δ_1 to be equal to one, but that, if there is some kind of nominal illusion, δ_1 could be inferior to one)

I shall introduce one last variable which cannot directly be derived from the loanable funds framework, namely the short term real interest rate ($r - \Pi$):

$$(7) \quad R = \delta_0 I(-1)/Y(-1) + \delta_1 \Pi_e + \delta_2 \text{pet} + \delta_3 \Delta(\text{pet}) + \delta_4 \dot{m} + \delta_5 \dot{y} + \delta_6 w + \delta_7 \dot{w} + \delta_8 \dot{d} + \delta_9 \Delta(\text{cu}) + \delta_{10} \text{cu}(-1) + \delta_{11} + \delta_{12}(L) (r - \Pi)$$

L being the lag operator.

There are two conventional ways to justify the introduction of this variable. The first one, chosen implicitly by every author who works with short term interest rates, is to assume that short term and long term interest rates are perfect substitutes. In that case, equation (2) applies equally to short term interest rates (r). If this way of reasoning is correct, then residuals of equations (2) and (4) will almost certainly be correlated, and this correlation will result in a positive coefficient of r at the estimation of an equation like (3). In that case however a simultaneity bias should appear, since the residuals from the equation should be correlated to a variable (the short term real interest rate) which appears in the right hand side of the regression.

The introduction of the short term interest rate can also be justified by reference to theory of the term structure of interest rates. This theory predicts indeed a positive relation between short term *nominal* interest rates and *nominal* long term interest rates, this correlation being greater, the greater the persistence of short term interest rates. It is not clear however how this correlation between *nominal* interest rates translate to *real* interest rates: over the maturity of long term bonds, monetary policy can be expected to be approximatively neutral, and so current short term real interest rates should not convey much information about ex-ante long term real interest rates (I will come back to this point more formally in the next section).

So, to give a more important role to short term interest rates in the determination of long term interest rates, section 3 examines a more promising avenue, which relies on the role of credibility.

3. Reevaluating the importance of monetary policy: the role of credibility.

Anecdotal evidence points to the incompleteness of the credibility of monetary authorities: the numerous exchange rate crises which has affected the ERM since 1992 or the surge in long term interest rates which has followed the surprise increase in the Fed Fund rates target by the Fed at the beginning of 1994 are examples of such evidence. Financial markets seemed at these occasions to suspect that, like in the litterature built on Kydland and Prescott (1977) seminal paper, monetary authorities are not immune to the tentation of cheating and creating surprise inflation, once they have convinced private agents of their commitment to secure zero inflation.

This lack of credibility can seem at first sight surprising, after more than ten years of severe fight against inflation and while several countries (France, New-Zealand e.g.) have delegated the conduct of monetary policy to independent central banks with the sole objective of securing price stability. Some reasons can be put forward to explain such a lack of credibility. First, the observation that even a central bank whose independence cannot be questionned and whose explicit objective is to secure price stability, as Germany Bundesbank, has not totally succeeded in resisting inflationary pressures stemming from the two oil shocks, shows that there can be implicit constraints which prevent central bankers to fulfil their explicit goal.

Second, in most countries, central bankers are appointed by the government, even in countries with independent central banks (it is the case in Germany as in the United States). So private agents may fear that strong policymakers can be replaced in the future by weaker policy makers. Moreover, even independent central bankers have no absolute control on monetary policy: in most cases, the government, and not the central bank, is in charge of the exchange rate policy. Again, Germany provides us with an useful example: both the participation of Germany to the EMS and the conversion rate between the Ostmark and the Deutschemark were decided by the government, even if the Bundesbank disagreed with this choices and even if they were to complicate the conduct of monetary policy.

Third, as emphasized by the recent litterature on credibility (see e.g. al-Nowaihi and Levine (1996)), the delegation to an independent central banker is itself subject to a commitment problem: it assumes that commitment to a central banker is possible whereas it is not possible to monetary policy.

For all these reasons, it does not seem unlikely that there are some non-linearities in the kind of rule that a central bank can adopt: faced with a very adverse shock, it will be more difficult to adopt the same rule as when shocks are relatively small. Accomodation of very adverse supply shocks is so a possibility than one cannot a priori eliminate, even if safeguards have been put in place. In that respect, the much celebrated new Constitution of the New Zealand Central Bank has yet to be tested in such circonstances and there is no unique possible outcome (see Walsh (1995) for instance).

So, I will take for granted in the rest of this section that, even when monetary authorities are independent and follow an announced rule, which in theory can remove the inconsistency and the non-optimality of plans which arise under discretion, private agents have a subjective probability that this rule could change in the future. I will examine the consequences on interest rates, output and prices of these hypotheses.

The model is the following one:

$$(5) \quad \text{del}(lp) = \alpha \text{del}(lp(-1)) + (1-\alpha) \text{del}(lp(+1)) + \beta (ly - ly^*)$$

$$(6) \quad lm = ly + lp - \gamma lr$$

$$(7) \quad ly - ly^* = -\delta (lr - (lp - lp(-1)))$$

$$(8) \quad LR = \sum_{i=0}^9 lr(+i)$$

The formulation adopted for the determination of prices (equation (5)) is a Phillips curve, as the one adopted in the Multimod model (see Masson and alii (1990)). Due to the existence of overlapping contracts, wages are assumed to be sticky. So prices (noted, in logarithm, lp) are only partially forward-looking and partially backward-looking. As prices do not automatically equilibrate demand and supply, output (noted, again in logarithm, ly) is not at potential (in log, ly^*) and prices are positively related to the output gap. Equation (6) is a traditional money demand equation (with the logarithm of money denoted lm and the logarithm of one plus the short term interest rate denoted lr). The third equation (equation (7)) describes goods demand as a function of interest rates¹. The fourth equation (8) is the term structure of interest rates (with the logarithm of one plus the long term interest rate denoted LR): I have considered a ten years maturity bond (which is today the benchmark for most countries) and neglected risk premia for the sake of simplicity. $\alpha, \beta, \gamma, \delta$ are positive parameters.

In the rest of this section β, γ, δ : take the following values: 0.15, 0.5 and 0.5. The first two values are taken from the Multimod model. The third one is taken for convenience: it represents a moderate value for the interest rate elasticity of demand. Note that only the value of the product $\beta \cdot \gamma$ is important in the model. The value α will be allowed to vary with the experiments I will conduct to provide a plausible path for

¹ Notice that the interest rate we use is the short term real interest rate instead of the theoretically more justified long term real interest rate. This choice have been made for pratical reasons. Using the long term real interest rate should indeed have introduced too much dynamic in the system for it to remain tractable. Since our purpose was only to examine the connection between short and long term interest rates when monetary policy matters, this simplification is not detrimental to our results, although it should be treated correctly in practice.

output. Unimportant constants have been omitted (for instance, in the long run, the golden rule should apply, so that δ^*g_q should be added to the equation (7)). In the rest of the section, I make the unimportant hypothesis that potential output growth is zero: if potential output growth is more realistically assumed to be positive, then all the results which will follow would be unchanged by adding potential output growth to the chosen money growth hypothesis.

I will examine the consequences of a disinflationary policy. In the rest of the section, money growth will be assumed to be equal to 10% in the first period. The system of the four equations (5) to (8) will be assumed to be at its long run equilibrium: $ly-ly^*=0$, $lr=0.1$, $lR=0.1$, $lp=lm+\ln(1.1)^*\gamma$. In every case will shall study, monetary authorities announce at the beginning of the second period that money growth will decline to 8% in that period, 6% in the following period, 4% in the fourth period, 2% in the fifth and 0% thereafter. The so assumed pattern can be considered as a parable of the disinflationary policies lead by the various monetary authorities over the G7 during the eighties.

Let us first assume that monetary authorities are fully credible. Then, the whole system converges to the new long run solution: $ly-ly^*=0$, $lr=0$, $lR=0$, $lp=lm$. As in Ball (1994) model, the behaviour of output depends on the degree of forward indexation of prices: if $\alpha=0.3$, that is if prices are fixed for a short period of time, then the credible disinflationary policy lead by the monetary authorities creates a boom, the reason being that prices are set partly in advance with reference to the planned money growth and so decline faster than actual money growth; if $\alpha=0.7$, then a recession occurs².

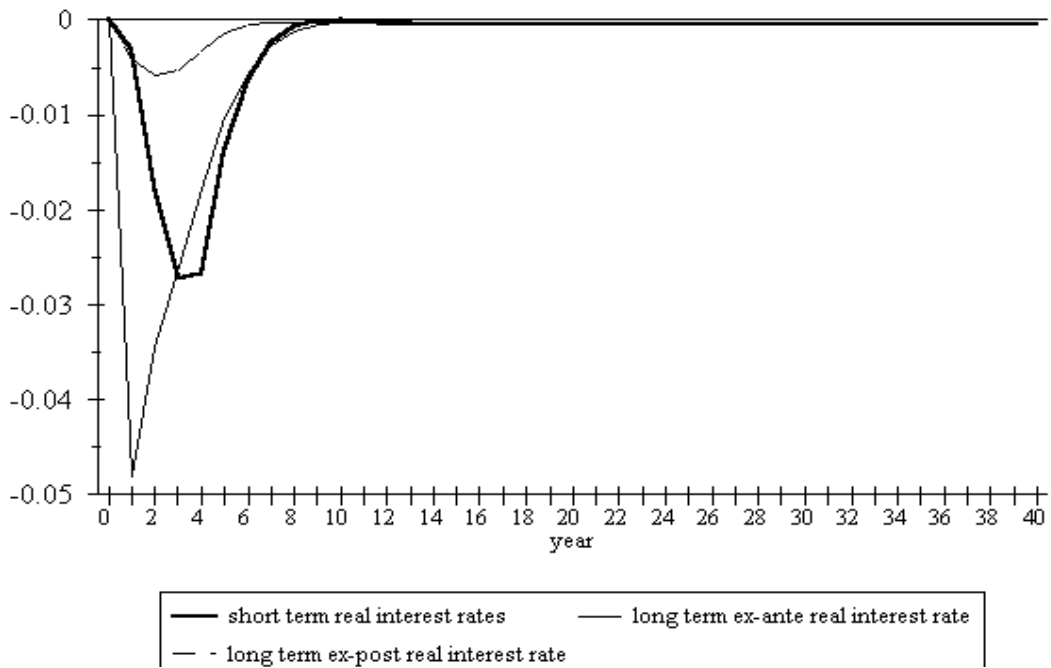
The behaviour of interests rates is summarized on graphs 1 and 2. If $\alpha=0.3$ (see graph 1), then short term interest rates start declining as a corollary of the output boom that occurs. Long term *ex-ante* real interest rates (that is long term nominal interest rates deflated by the current inflation rate) magnify this pattern: since short term *nominal* interest rates decline until they reach their new equilibrium value, and since agents correctly expect this decline to happen, then long term *nominal* interest rates, which are an average of short term expected interest rates, decline more than short term *nominal* interest rates. As regards however long term *ex-post* real interest rates (that is long term nominal interest rates deflated by the average inflation rate observed over the maturity of the bond), the decline is only moderate, since the inflation pattern closely follows that of the short term interest rates.

These results are clearly at odds with macroeconomic experience of the eighties. So, let us now turn to the more realistic experiment where $\alpha=0.7$ (graph 2). Short term interest rates rise as expected: since prices are more rigid, then only a small part of prices adjust to the new -current and expected- monetary conditions; inflation decrease lags behind that of money growth and short term interest rates then rise. This is not the case however for long term *ex-ante* interest rates: agents expect correctly that short term nominal interest rates will eventually decline in the following years (in this experiment, this happens in year 6); so, long term nominal interest rates, which are an average of short term expected interest rates, decline a little. Since prices do not decline much, long term *ex-ante* real interest rates are almost flat. This is not obviously the case for *ex-post* long term interest rates, which are an average of short term real interest rates, and so

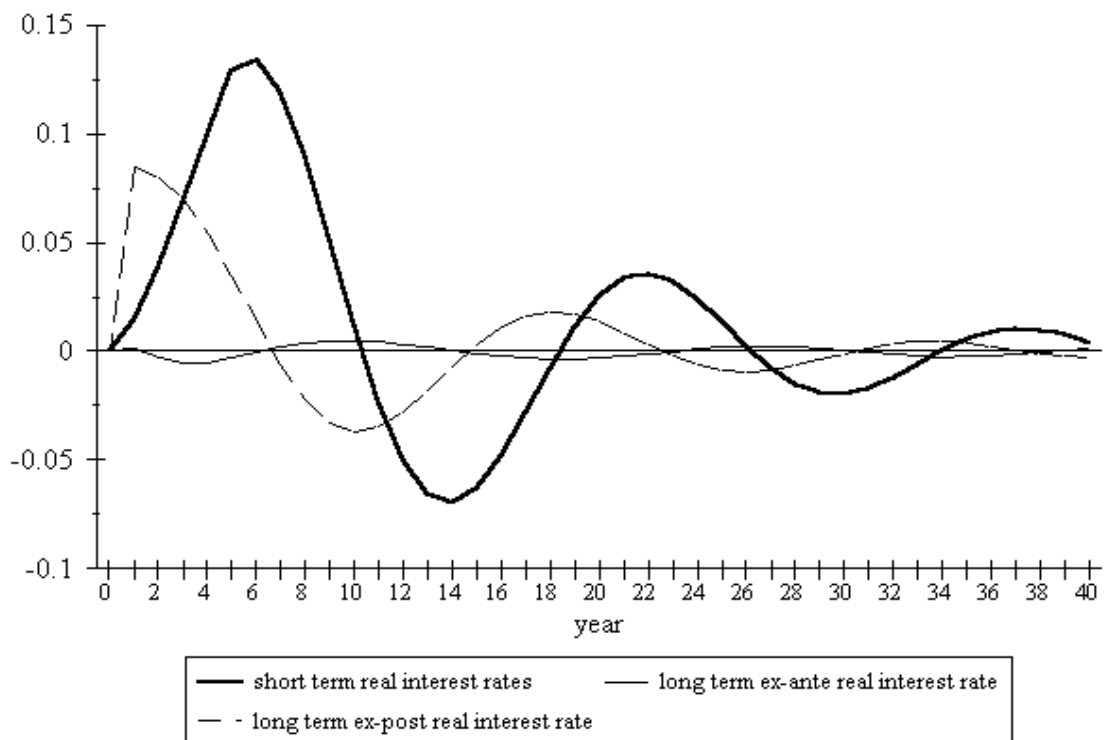
² All the following simulations have been made with the Fair-Taylor forward-looking simulator available in the Troll package.

reproduce their behaviour and rise at first. After a few years, short term interest rates begin to cycle unimportantly as a consequence of the chosen numerical values, but long term, *ex-ante* as *ex-post*, real interest rates remain flat. So, price rigidity alone can explain the long term interest rates rise that initially occurs as a consequence of a monetary disinflationary policy, but not their persistence at high levels after the disinflation has succeeded.

Graph 1
 $\alpha = 0.3$, total credibility



Graph 2
 $\alpha = 0.7$, total credibility

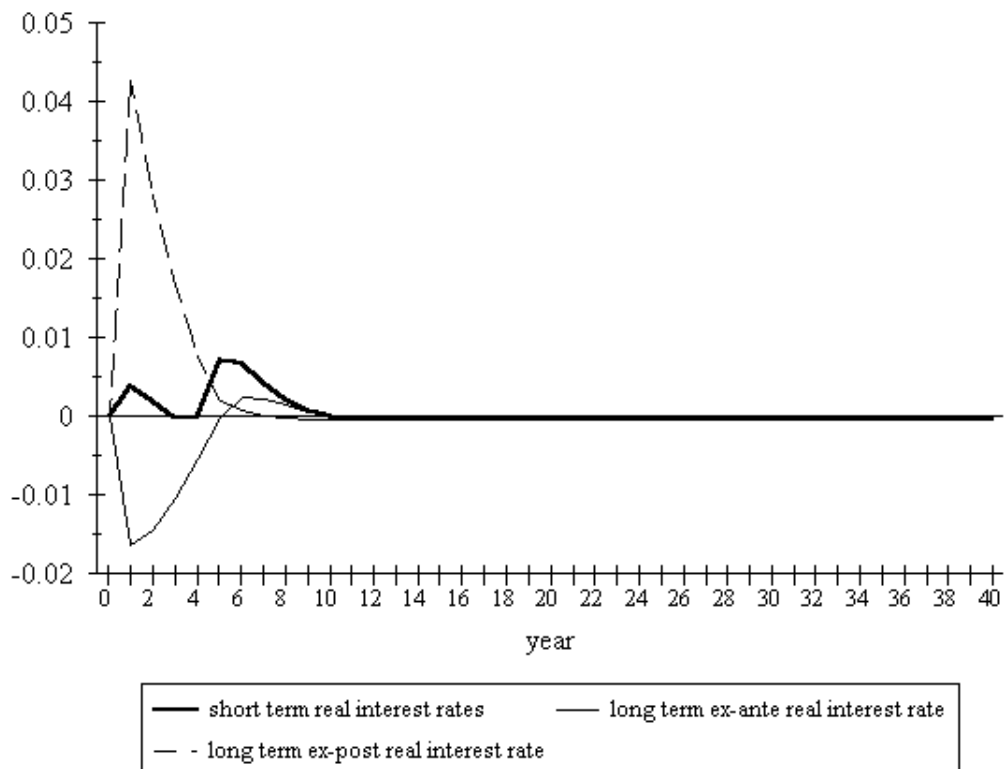


So, let us turn to cases when monetary policy is not perfectly credible. The first case I examine is the one studied by Ball (1994): let us assume that, during the disinflation process, agents believe that, with a probability p , monetary authorities will stabilise money growth forever at its previous value, instead of pursuing the announced path. So, in the second period, there is a probability p that money growth stabilise at 8%, instead of declining to 6%. In the third period, if monetary authorities have reneged, then money growth stays at 8%. If they have not reneged, there is again a probability p that they renege, and that money growth stabilise at 6%, instead of declining to 4%, and so on...

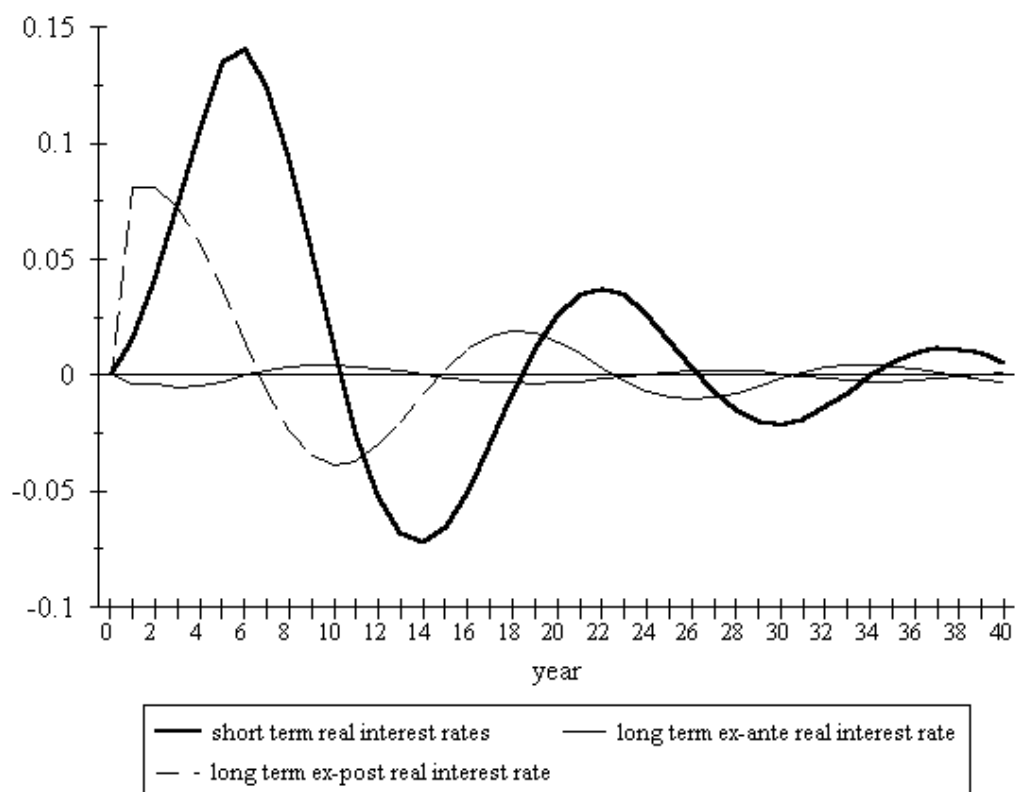
The results of the corresponding simulations³, with a p value of 0.3, are summarised in graphs 3 and 4. There are two major differences which appear with the previous results. The first one is that, if $\alpha=0.7$, then the recessionary impact of monetary policy is magnified and so is the behaviour of real interest rates: short term real interest rates rise even more as in the base simulation and long term real interest rates now rise significantly in the first years. The second difference is that now a recession occurs in the case when prices are more flexible ($\alpha=0.3$) and so short term real interest rates now rise instead of declining: this result is a transposition to the behaviour of interest rates of Ball results on output. The main conclusion of preceding results however remains: even if the behaviour of interest rates is more protracted, long term real interest rates show no persistence. This comes naturally from the fact that, once money growth has reached its new long run value (0% here), the effects of credibility are incorporated in past macroeconomic evolutions, but do not affect expectations. So, the system converges to the same long run equilibrium and, via the role of expectations, this convergence is rather quick.

³ notice that realisations are not, until period 5, equal to ex-ante average expectations of agents: since agents expectations incorporate a non zero probability that monetary authorities renege, money growth expectations are above ex-post money growth; technically, this obliges us to run a new simulation at every first 5 periods, taking into account past realisations from the previous simulation and average expectations as regards the subsequents periods.

Graph 3
 $\alpha = 0.3$, ex-post credibility



Graph 4
 $\alpha = 0.7$, ex-post credibility



To exhibit long run interest rate persistence, it is then necessary to assume that credibility is imperfect even when money growth has reached its new level: for the reasons advocated at the beginning of this section, let us assume that credibility takes the same form as before over the period of declining money growth and that, in every subsequent period, money growth can stay constant or grow at a 2% rate with the same probability p^4 than before. The simulations (see graphs 5 and 6) then show that, for all values of α , there is now a persistence of both short term real interest rates and long term real interest rates (ex-ante as ex-post): because agents expect a monetary relaxation, their inflation expectations are necessarily above current inflation; so, prices are set above the level consistent with current money growth; to equilibrate both money and goods markets, short term interest rates must be positive and output negative.

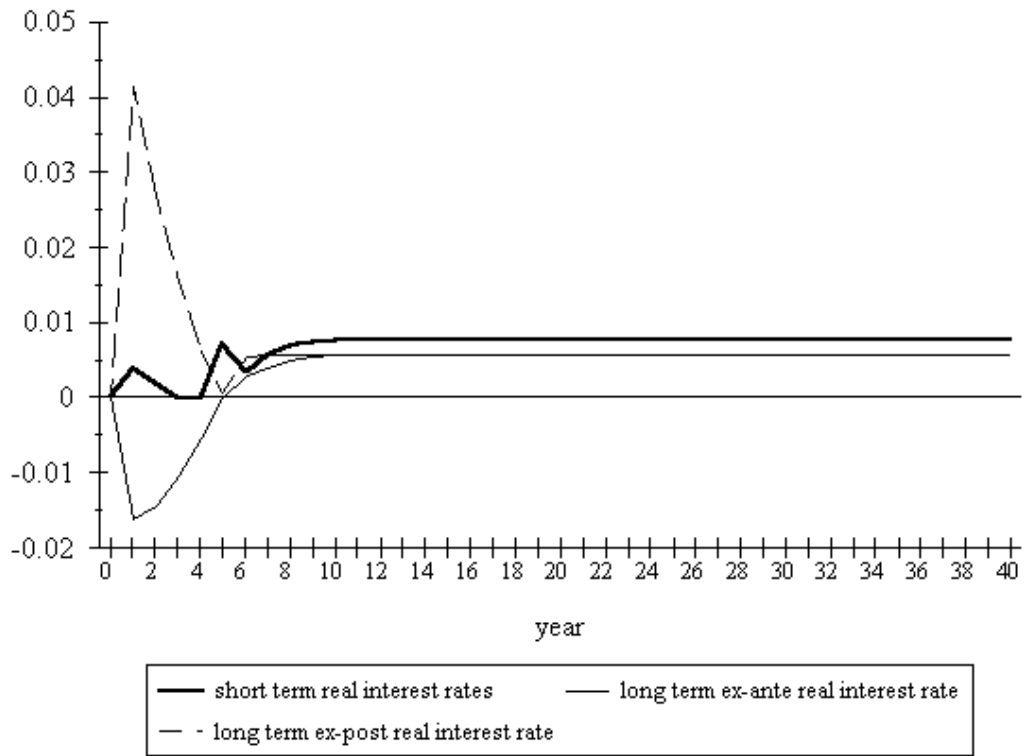
The main conclusions of this analysis can be summarised as follows. First a model where prices are sticky and where credibility of monetary authorities was not perfect and remained imperfect can provide a good representation of what happened since the beginning of the eighties. Second, in that case, a positive correlation between short term and long term real interest rates may arise as a result of the difference between the stabilised growth of money and the one which is expected by agents, but doesn't materialize: this is a variant of the *peso* problem. This correlation would disappear if true expectations of agents were measured. This is however not the case, since even expectations survey (and official forecasts like the one provided by the OECD or the IMF, too) convey mostly information about what agents expect to be the more likely outcome and not about average expectations; if agents have subjective probability of a regime shift, expectations drawn from surveys will so be a biased estimator of average expectations.

Note that strictly speaking, there will be no causality from the short term real interest rates to the long term real interest rates, but simultaneity; since however most central banks control the short run interest rates rather than the money growth, the causality can in practice be expected to go from the short term real interest rates to the long term real interest rates. This contention is the basis of the empirical analysis which follows.

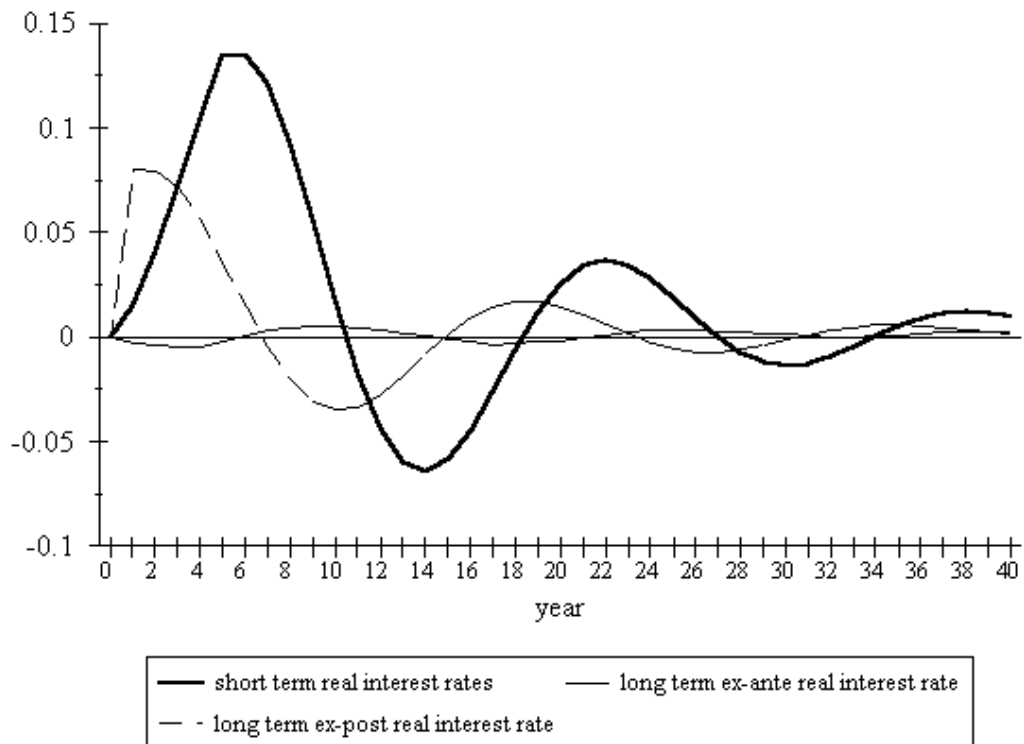
Notice at last that money is in the above model neutral over the very long run, if monetary authorities really renege at the end, but that money will not seem neutral until monetary authorities have reneged.

⁴ to be realistic, more complex hypotheses about agents expectations should be made; the one we have made allows us to make numerical simulations, while keeping the main features we want to address.

Graph 5
 $\alpha = 0.3$, partial credibility



Graph 6
 $\alpha = 0.7$, partial credibility



4. Data.

Data are taken from the following sources: IMF International Financial Statistics (IFS), OECD Main Economic Indicators (MEI) and OECD Economic Outlook 59 (EO).

All series are weighted using PPP adjusted output: PPP exchange rates are taken from Summers and Heston base, extended by OECD PPP.

The following series have been aggregated this way at the G7 level (the name I use from now on to describe the series is given between brackets):

- MEI short term interest rate, except for Japan (before may 1979) and Italy (before october 1978) where the MEI series are not available and are replaced by the IFS call money rate series, augmented by an average term premium [r] and IFS Treasury Bill rate (USA, United-Kingdom);
- MEI long term interest rates [R];
- MEI capacity utilization rate [cu]⁵;
- EO inflation forecasts for the first three semesters, starting from the current semester [OECD₀, OECD₁, OECD₂]; note that, at the time when OECD forecasts are made (june and december generally), all the information concerning the current semester is not available, which means that OECD₀ is partly a forecast; note also that, to have series starting from 1973, I am obliged to use only these three semesters, although more semesters are now forecasted by the OECD;
- EO net public debt series, as a percentage of GDP [pdr];
- EO output growth [];
- EO consumer prices growth over the semester [gspc] and over the year [gapc];
- EO total investment supplemented by the variation of inventories, as a percentage of GDP [ir];
- end of semester growth of IFS industrial share prices [gsp];
- end of semester growth of MEI M1 [gm1];
- ratio of energy importations, supplemented by the value of national production of crude energy, on GDP, taken from the ATLAS database [pet]⁶.

Besides OECD inflation forecast, other proxies of agents inflation expectations, already used in the litterature, have been built using quartely inflation data and then aggregated to provide semestrial data at annual rate: first, ARIMA one semester [gpc_{ARIMA1S}] and ten year [gpc_{ARIMA10Y}] forecasts⁷; second, the Hodrick-Prescott low frequency component of inflation (estimated with parameter λ fixed at its standard value 1600)[gpc_{HP}]; and the inflation rate measured over the past ten years [gpc_{10Y}].

⁵ For Japan and the United Kingdom, there is no such series, but instead series of judgment on capacity utilization and of percentage of firms operating at full capacity respectively; these series have been rescaled using the approach described in Dubois (1992) to give a proxy of the true capacity utilization rate.

⁶ This variable looks very like the one adopted by Barro(1992)

⁷ Unlike Barro and Sala-i-Martin (1990), who use systemetically ARMA(1,1) model to adjust the inflation rate, we have choosen for each country among the ARMA(1,1), AR(2), AR(3), ARIMA(0,1,1) the one which fitted at best the data.

5. Econometric results.

5.1 Explaining world long term interest rates.

Table 1 presents the main results for the world real interest rate⁸. Estimation period goes from the first semester of 1973 to the second semester of 1993. The first column describes my preferred equation. Real long term interest rate is here calculated as the difference between nominal interest rate (R) and OECD inflation forecasts at a three semesters horizon (OECD₂). Public debt, as a percentage of GDP, has been introduced in first difference: this is almost equivalent to public deficit. Because of the lack of degrees of freedom, constraints have been imposed when they were accepted by the data. Real "world" long term interest rates are found to depend on some investment determinants (variation of capacity utilization, growth of real industrial share prices), saving determinants (public deficits -with the good sign, but with very weak statistical significance-, money growth, and, again, if one think at wealth effects, growth of real industrial share prices), on an unimportant autoregressive term and on short term real interest rates (current and lagged).

The other columns show the validity of some important restrictions which have been imposed. First, in the second column, I have added the various proxies of inflation expectations proposed in the preceding section: OECD forecasts at the third horizons (OECD₀, OECD₁, OECD₂), inflation one semester and ten year expectations build from ARIMA models ($gpc_{arima1S}$ and $gpc_{arima10Y}$), from the HP filter (pc_{HP}) and mean inflation measured over the past ten years (pc_{10Y}). None of these variables are statistically significant. First, this means that, among all these proxies of inflation expectations, other measures than OECD forecasts convey no additional information: this proves the very usefulness of this proxy of inflation expectations, which had been until now ignored. Second, since in column 1 the long run effect of inflation on real long term interest rate is imposed to be null, this means that private agents are not victim of nominal illusion.

The third column shows that neither lagged budget deficit (Δpdr_{-1}), nor current public debt (pdr) is statistically significant; as in many other studies, I find no effect of public debt on world real interest rates (which means that repudiation and monetization risks are ignored by investors) and that the effect of public deficits are at best small, an 1% increase of public deficit causing a 0.11% increase of world real interest rates. Other results, not reported here, show that neither the lagged investment ratio (ir), nor the growth rate of GDP (gQ) nor the ratio of expenditures on energy consumption (pet) are significant, as they were in Barro (1992) paper (and, as regards this last variable, it is also the case in my own regression, when the short term interest rate is used instead of the long term one, see below). As regards the growth rate of GDP, the result is not so much surprising, since it may reflect the cancelation of two effects with opposite sign, one positive stemming from investment demand, the other one negative coming from ex-ante saving rate. More surprising is the absence of significant effect of the lagged investment ratio: the model derived in section 2 showed that this variable should have a positive effect. Recall however that the positive sign of this variable comes is expected

⁸ Standard unit root tests show that real short term and long term interest rates are unambiguously non stationary while other variables are stationary; cointegration tests -ADF test with a -3.26 T statistic and Philips-Perron test with a -2.93 T statistic- show that the null hypothesis of no cointegration would be rejected at best at a 7.5% level; although not totally in favour of the cointegration hypothesis, we choose to interpret loosely these tests, given their notoriously low power; with this interpretation of our cointegration tests in mind, the results of table 1 are valid, even though Student statistics of the level of the interest rate variables cannot be interpreted.

mainly from Tobin's q model of investment, which can be dominated here (as it is empirically generally the case) by the accelerator effect that the capacity utilization rate represents. In that case, the positive effect of the growth of real share prices must also be interpreted as coming from the saving side.

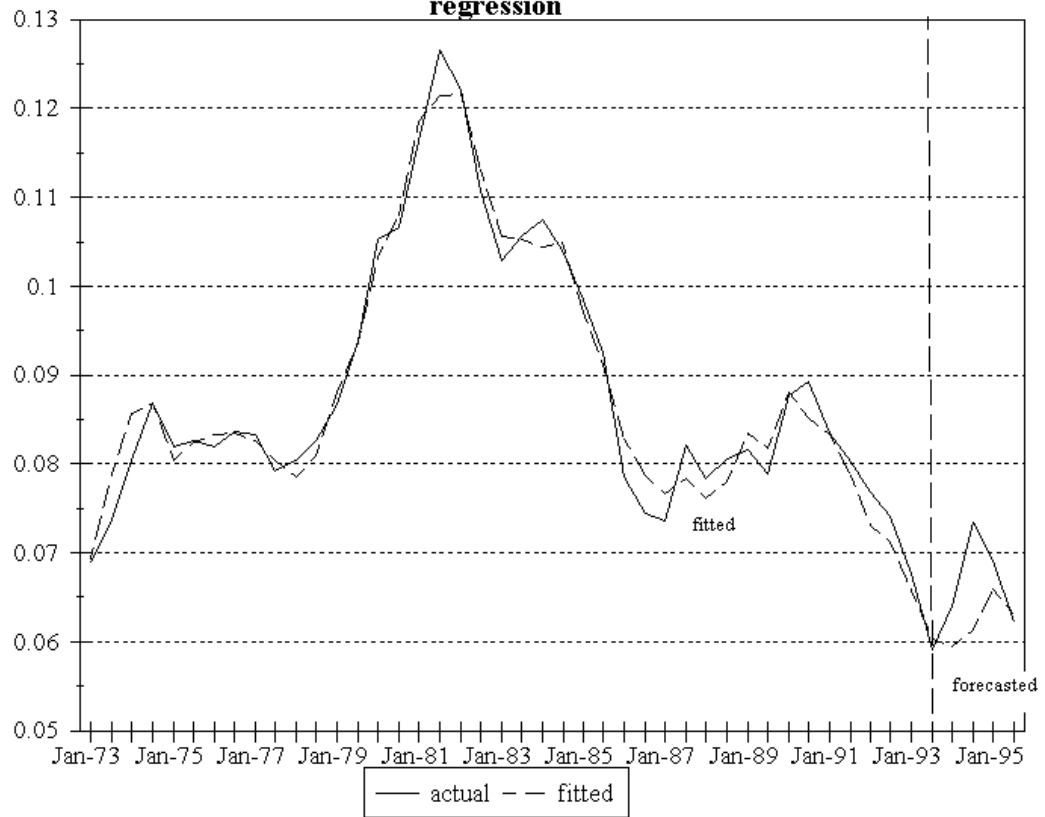
Third, in the fourth column, I have dropped the contemporaneous effect of short term real interest rates, since this variable can be presumed not to be exogenous for long term interest rates (cf part 5.2 for an analysis of this point); some variables loose their significance (budget deficit and the growth of real industrial share prices), but lagged short term real interest rates remain significant, which proves that there is some robust causality stemming from the short term real interest rates to the long term real interest rates.

Lastly all specification tests, except for the predictive failure test, are passed at the 5% conventional significance level: the Lagrange Multiplier test ($F(4,30)=2.27$), the White hetroskedasticity test ($\chi^2(35)=37.1$), the Bera-Jarque normality test ($\chi^2(2)=2.14$) and the ARCH test ($F(4,26)=0.27$). The predictive failure test ($\chi^2(4)=17.47$) is rejected and data show that it is so because of the very large increase in long term interest rates which occurred at the end of 1994 and which the equation -as many observers!- could not explain (see chart 7). Long term interest rates have since then come back to a more normal level and this fact could indicate that the big discrepancy between observed and simulated interest rates during the second semester of 1994 is only an accident.

Table 1 : regression results

variable	R-OECD ₂	R-OECD ₂	R-OECD ₂	R-OECD ₂
$R(-1) - OECD_2$	0,55 (10,11)	0,57 (5,67)	0,54 (9,12)	0,80 (16,01)
$r - OECD_1$	0,28 (6,01)	0,27 (3,96)	0,28 (5,73)	
$\Delta(r(-1)-gpc(-1))+r(-5)-gpc(-5)$	0,08 (2,71)	0,04 (0,99)	0,07 (2,03)	0,11 (2,58)
$\Delta(r(-2)-gpc(-2))$	0,14 (2,77)	0,14 (2,40)	0,13 (2,64)	0,16 (2,32)
$gm1(-1) - gpc(-1)$	-0,061 (-2,02)	-0,016 (-0,38)	-0,062 (-2,00)	-0,11 (-2,63)
$(gsp(-3)-gspc(-3))+gsp(-4)-gspc(-4)$	0,0057 (2,01)	0,0075 (1,75)	0,0053 (2,26)	0,0047 (1,43)
Δcu	0,13 (3,62)	0,23 (4,01)	0,14 (3,61)	0,12 (2,30)
Δpdr	0,11 (1,37)	0,08 (0,85)	0,14 (1,46)	-0,11 (-1,04)
constant	0,0065 (8,22)	0,0012 (0,18)	0,0049 (1,98)	0,0060 (5,36)
$OECD_0$		-0,00 (-0,02)		
$OECD_1$		0,14 (0,16)		
$OECD_2$		-0,16 (-0,72)		
gpc^{HP}		-0,09 (-0,95)		
gpc^{10}		-0,01 (-0,17)		
$gpc^{ARIMA1S}$		0,18 (1,44)		
$gpc^{ARIMA10Y}$		0,03 (0,27)		
$\Delta pdr(-1)$			-0,05 (-0,57)	
pdr			0,0080 (0,70)	
$\hat{\sigma}$	0,0028	0,0028	0,0029	0,0040
SSR	0,0026	0,00020	0,00025	0,000544
DW	2,07	2,07	2,07	1,86

Graph7: Goodness of fit of the regression



5.2 Testing weak exogeneity of short term real interest rates.

The influence I have found of real short term interest rates on long term real interest rates can merely result from the simultaneity of adjustments of these two types of interest rates to ex-ante disequilibrium between saving and investment: in that case nevertheless there will be a simultaneity bias in the regression. If however credibility is at the heart of this result, and since short term real interest rates are firmly controlled by central banks, then one expects short term interest rates to be predetermined. In econometric terms, this means that the real long term real interest rate can be conditioned upon short term interest rates and give rise to a well specified econometric model: in Engle and Hendry terminology (see e.g. Engle and Hendry (1990)), this means that short term interest rates must be *weakly exogenous* and that the estimated parameters must be *invariant* to modifications in the econometric explanation of short term interest rates. The tests of these two notions are performed in this section. The first step is to estimate an equation for the short term real interest rate and to perform an Hausman test for the long term real interest rate equation. The estimation leads to the following equation:

$$(9) \quad r - \text{gapc}_{\text{ARIMAIS}} = \underset{(6,57)}{0,58} (r(-1) - \text{gpc}(-1)) + \underset{(2,42)}{0,21} (r(-2) - \text{gpc}(-2)) + \underset{(2,62)}{0,21} (\text{gapc} - \text{gpc}_{\text{ARIMAIS}}) + \underset{(6,08)}{0,38} \text{pet} \\ + \underset{(6,27)}{0,33} \text{cu} - \underset{(-6,27)}{0,27}$$

SER = 0.0059 DW=1,36

Neither the lagged investment ratio, nor the lagged monetary growth, nor the lagged real share prices growth have been found significant. This relation exhibits some instability around the first semester 1980: this is exactly the time when the Fed decided to tighten its monetary to fight against the inflation pressures caused by the second oil shock. So I have estimated the following equation, which doesn't exhibit residual instability (with $p_{80S1}=1$ from the first semester of 1980, 0 before and $p_{82S2}=1$ from the second semester of 1982, 0 before):

$$(10) \quad r - gpc = \underset{(6.85)}{0.55}(r - gpc(-1)) + 0.014 + \underset{(5.43)}{0.36} p_{80S1} pet + \underset{(4.23)}{0.56} p_{82S2} (gpc_{ARIMA1S} - gpc) + \underset{(5.39)}{0.24} p_{82S2} cu \\ - \underset{(-5.56)}{0.21} p_{82S2}$$

SER = 0.0048 DW=2.52

Note that this equation can be interpreted as the monetary authorities reaction function, with major breakdowns when the Fed decided to change its operating procedures and to give more weight to the fight against inflation.

I have then injected successively the residuals obtained from these regression in my preferred equation of long term interest rates and found Student Ts of respectively -1,22 and -1.44, (see table 2) confirming both the weak exogeneity of short term interest rates and the invariance of the effect of short term real interest rates on long term ones to events affecting the determination of short term interest rates.

Moreover, Engle and Hendry have shown that, if a variable is weakly exogenous for another one, then the converse could not be true. This is exactly what happens here. Indeed, although the contemporaneous term (but not the lagged ones) of the real long term interest rate is significant in regression (9), residuals of the first equation in table 1, when incorporated in equation (9) in addition to long term term real interest rates, are also significant ($T=-2.85$): *real long term interest rates cannot be considered as exogenous for short term real interest rates.*

The results reported in this section are then unambiguously in favour of the hypothesis that there is a causality stemming from short term real interest rates towards long run real interest rates, exactly the result which was expected from the analysis conducted in section 3.

Table 2: testing weak exogeneity of short run interest rates for long run interest rates

variable	R-OECD ₂	R-OECD ₂
$R(-1) - \text{OECD}_2$	0,51 (8,05)	0,51 (8,51)
$r - \text{OECD}_1$	0,32 (5,61)	0,31 (6,10)
$\Delta(r(-1)-\text{gpc}(-1))+r(-5)-\text{gpc}(-5))$	0,09 (2,89)	0,09 (2,97)
$\Delta(r(-2)-\text{gpc}(-2))$	0,15 (2,99)	0,15 (3,00)
$\text{gm1}(-1) - \text{gpc}(-1)$	-0,066 (-2,20)	-0,059 (-2,01)
$(\text{gsp}(-3)-\text{gpc}(-3))+(\text{gsp}(-4)-\text{gpc}(-4))$	0,0048 (2,05)	0,0048 (2,10)
Δcu	0,14 (3,70)	0,14 (3,91)
Δpdr	0,14 (1,68)	0,15 (1,78)
constante	0,0067 (8,37)	0,0067 (8,48)
residuals from equation (9)	-0,13 (-1,22)	
residuals from equation (10)		-0,19 (-1,44)
$\hat{\sigma}$	0,0028	0,0028
SSR	0,00248	0,00244

6. Conclusion.

This paper has followed the route pioneered by BSM (1990) and analysed the determinants of interest rates at a world level. The use of long term real interest rates, instead of short ones, has nevertheless confirmed their analysis that budget deficits are not an important factor behind the evolution of real interest rates over the past 20 years, but that investment determinants are a much more important factor.

This paper presents however new results. First, capacity utilization rates proved to be highly significant and so should not be forgotten in such an analysis as one of the important determinants of investment demand. Second, and more importantly, OECD inflation forecasts proved to be very useful as a proxy of agents expectations. Admittedly, more is still to be done to obtain true expectations at long horizons, but this is an important step in that direction.

Lastly, credibility should not be ignored as an important determinant of long term real interest rates. The results obtained are nevertheless very fragile and more progress needs to be done in that direction to understand the mechanisms at work. Particularly, they have to be confirmed by a close examination of country specific experiences: this is left to further research. If the results presented in this paper have some relevance, then one of their implication however should be that world real interest rates are somehow bound to remain high, unless monetary authorities around the world manage to convince private agents that they are able and willing to fight inflation *in every circumstances and whatever the price can be.*

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