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THE DYNAMICS OF CAPITAL LIBERALIZATION: A MACRO-ECONOMETRIC ANALYSIS

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Abstract

In this paper we aim to show that the use of a continuous time econometric model is essential for a correct analysis of the liberalization of international capital flows in the Italian economy. These are, in fact, modelled as flows deriving from the adjustment of the actual to the desired stock of net foreign assets. Hence one needs in the first place a rigorous estimation of the associated speed of adjustment independently of the sampling interval. Capital liberalization takes the form of an increase in this adjustment speed. We examine this issue using the Mark V version of our Italian continuous time model. Here we bring together our previous work showing the results of several simulations of the model, and also present new results. The model is capable of explaining what has been happening in the Italian economy after capital liberalization (apparent stability for a couple of years after the liberalization, then huge capital outflows culminating in the devaluation of the lira-realignment on 14 September 1992 and subsequent events).

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1. Introduction

This paper examines the dynamics of the liberalization of international capital flows in the Italian economy. The analysis is carried out using the fifth version of the Italian continuous time model (Gandolfo and Padoan, 1990).

The use of a continuous time econometric model turns out to be very important for the analysis of the problem at hand. In fact, international capital movements are modelled according to the portfolio adjustment view. Hence they are considered as the flow deriving from the adjustment of the actual to the desired stock of net foreign assets. Thus, one needs in the first place a rigorous estimation of the associated speed of adjustment independently of the sampling interval. This estimation can be obtained only through the continuous time approach to econometric modelling. In this context, capital liberalization takes the form of an increase in the adjustment speed of net foreign assets to their (partial) equilibrium value. The analysis of the consequences of this increase is carried out at two levels. First, stability and sensitivity analysis about the steady state of the model identify a source of instability in the increase in question. Possible stabilizing factors are also considered. In the second place, the systemic consequences of capital liberalization are considered by carrying out several simulations with different degrees of capital liberalization (including the case of perfect capital mobility). This paper brings together previous work of ours (Gandolfo and Padoan, 1992a,b,c), and gives new results.

The plan of the paper is as follows. In sect. 2 we give an overview of problem of modelling capital liberalization, and present our solution, which is then followed by a brief description of the relevant parts of our model (sect. 3). Section 4 examines the stability of the model around the steady state and gives the results of sensitivity analysis[1]. The following sections deal with our simulation exercises. The basic case, i.e. when we simply change the adjustment speed of capital flows, is treated in sect. 5. Section 6 shows the importance of exchange rate expectations . Here much attention has been devoted to the role and relative weight of different agents in the foreign exchange market (*chartists* and *fundamentalists*), which is crucial for the onset of possible destabilizing speculative capital flows. The effect of the introduction of a "Tobin tax" (i.e., a tax on all foreign exchange transactions) is examined in section 7. Section 8 deals with the issue of trade liberalization in relation to capital flow liberalization. Section 9 concludes the paper.

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[1]By sensitivity analysis we mean the study of the partial derivatives of the characteristic roots of the model with respect to the estimated parameters. For details see Gandolfo, 1992b.

2. Perfect capital mobility: an overview

The starting point is the Mundellian analysis (Mundell, 1963), which -given the assumption of perfect capital mobility- shows the totally different effectiveness of monetary and fiscal policy under fixed and flexible exchange rates. Under fixed exchange rates, perfect capital mobility implies the ineffectiveness of monetary policy and the full effectiveness of fiscal policy. Exactly the opposite is true under flexible exchange rates: monetary policy is fully effective while fiscal policy becomes ineffective. These propositions are 30 years old, but subsequent studies do not seem to have added much to them (refinements include the distinction between perfect capital mobility and perfect asset substitutability, the reintroduction of some effectiveness of fiscal policy through changes in the real money supply due to exchange-rate changes, etc.: see Gandolfo, 1987, § 16.6).

The recent literature on the relationships between capital controls and crises of the foreign exchange markets points out that, in a regime of fixed but adjustable parities, the removal of capital controls may give rise to speculative attacks capable of exhausting official reserves thus forcing parity realignments. Besides, in the presence of perfect capital mobility, accomodating realignments, i.e. realignments that completely offset the cumulated loss of competitiveness, may give rise to undesirable oscillations in the exchange rate and to vicious circle phenomena (see Wyplosz, 1986, Driffill, 1988 and Obstfeld, 1988). This would increase the frequency of realignments hence undermine the credibility of the exchange-rate arrangements. The conclusion is that one cannot rely solely on realignments of exchange rates to eliminate external disequilibria. But, again, nothing new under the sun: these problems and propositions are, in fact, well known to every student of the Bretton Woods system.

Let us now come to our main point, which is how to model capital controls and liberalization. In some cases (Wyplosz, 1986) capital controls are modelled so as to lead to zero capital outflows from residents as only non-residents' capital movements are allowed. While this way of modelling capital controls partly reflects -among others- the Italian past experience of asymmetric capital controls (where only capital inflows were freely allowed) - see, e.g. Papadia and Vona, 1988, Papadia and Rossi, 1990 - it seems much too extreme especially if the case of developed countries is considered. More accurately, in our view, Khan and Zahler (1983, 1985) assume that, given an equation for capital movements where flows react to covered interest rate differentials, controls are modelled through the introduction of a coefficient which takes on the value of zero (less than one) in case of total (partial) controls. A more rigorous specification is the one followed by Gros (1987) who assumes that capital controls are equivalent to a (positive but not prohibitive) adjustment cost that

markets have to bear in order to adjust their financial assets to the desired value whose amount does not depend on controls. Such a specification allows to take into account two features of a world with capital controls: one is that capital controls seldom, if at all, lead to a complete elimination of capital movements; the second is that capital liberalization can be clearly understood as an intrinsically dynamic process. In this respect it is not fully convincing the view (Palmisani and Rossi, 1988) that capital controls, and any other kind of currency restriction, can be thought of as a tax on interest income. In fact, a tax on interest income changes the desired stock of net foreign assets since it alters the interest differential, but has no effect on the speed at which agents adjust the actual to the desired stock. Thus we believe that the question of the speed of adjustment and the tax on interest income are two aspects that can coexist but should be kept distinct.

This brief review of the literature suggests that the study of the effects of the liberalization of capital movements in an advanced open economy should be carried out according to the following lines: a) it should consider the dynamic nature of the process of adjustment towards a liberalized regime. Technically --as recalled above-- this means that we should use dynamics and not comparative statics; b) it should take account of the role of economic policy and in particular of the behaviour of the monetary authorities as regards international reserves, exchange rates, etc.; c) it should consider the effects of the liberalization on the whole economic system. This last point has a twofold nature. On the one hand, it would be insufficient to consider only the effects on the foreign exchange market. On the other, even if one were interested in examining solely the effects on the exchange rate, it should be noted that liberalization influences the foreign exchange market not only directly but also indirectly through the changes in the macroeconomic variables induced by the liberalization. In short, the study should be carried out in the context of economy-wide dynamic macroeconometric models. The existing models are generally not suited to this purpose, at least as regards Italy, partly because they do not contain an adequate modelling of capital movements and lack the technical possibility of embodying perfect capital mobility in a rigorous way.

According to the portfolio view, capital movements are not pure flows but represent the adjustment of the desired to the actual stock of net foreign assets. Now, the parameter representing the adjustment speed depends not only on the behaviour of economic agents but also on the presence of capital controls hence on an institutional arrangement -- in the sense that a low adjustment speed is due to the fact that agents are not free to immediately adjust the actual to the desired stock of net foreign assets. To put the same concept in other words, the desired stock of NFA (net foreign assets) depends on fundamentals, the adjustment speed reflects institutional features such as capital controls.

More precisely, the dynamic version of the portfolio approach to capital movements starts from an equation of the following type:

$$DNFA = \alpha(\hat{NFA} - NFA), \qquad (1)$$

where D denotes the differential operator d/dt, α the adjustment speed, and NFA the stock of net foreign assets. $\hat{NFA} = \varphi(...)$ is the *desired* stock, which depends on fundamentals (the arguments of the function φ, such as the interest rate differential, etc. These will be specified later on). In equation (1), a low value of α reflects capital controls. In the presence of capital controls, in fact, economic agents are not free to immediately adjust the actual to the desired stock of net foreign assets. While the desired stock of net foreign assets depends on fundamentals, the adjustment speed reflects institutional features such as capital controls.

In this context, the transition to a regime with higher capital mobility is equivalent to an increase in α or, which is the same thing, a decrease in the mean time lag of adjustment. In continuous time, the mean time lag is given by the reciprocal of α, and measures the time required for about 63% of the discrepancy between desired and actual values to be eliminated by the adjustment process.

3. The Italian continuous time model and capital flows

Our model (see Tables A.1 and A.2 in the Appendix for a summary view; for a full description see Gandolfo and Padoan, 1987, 1990) is a medium term disequilibrium model specified and estimated in continuous time as a set of stochastic differential equations which stresses real and financial accumulation in an open and highly integrated economy. The Mark V version includes a detailed specification of the financial sector as well as the endogenous determination of the exchange rate.
It considers stock-flow behaviour in an open economy in which both price and quantity adjustments take place. Stocks are introduced with reference to the real sector (where adjustments of fixed capital and inventories to their respective desired levels are present) and to the financial sector which includes the stock of money, the stock of commercial credit, the stock of net foreign assets and the stock of international reserves. The exchange rate is endogenously determined in the exchange market which clears instantaneously. Since we do not privilege any one of the competing theories but believe in an eclectic approach, exchange rate determination in thus related to all the variables present in the model including policy variables. Policy reaction functions cover fiscal variables (government expenditure and taxes) and financial variables such as the interest rate, money supply and international reserves.

Let us take a closer look at the equation which most interest us in the present context, namely the capital movements equation, which is specified as follows:

$$DlogNFA = \alpha_{24}\log(\hat{NFA}/NFA) + \alpha_{25}\log(PMGS_f \cdot E \cdot MGS/PXGS \cdot XGS),\ \alpha_{25}<0 \qquad (2)$$

where:

$$\hat{NFA} = \gamma_{11} e^{\beta_{19}[i_f + \log(FR/E) - i_{TIT}]} (PY)^{\beta_{20}} (PF_f \cdot E \cdot YF)^{-\beta_{21}}.$$

This equation has a twofold nature. First of all, the stock of net foreign assets (NFA) adjusts to its desired value $\hat{NFA}$. The latter reflects the portfolio view, in which the scale variables are proxied by the domestic (PY) and foreign ($PF_f \cdot E \cdot YF$) money incomes. Given the scale variables the level of $\hat{NFA}$ is determined by the interest differential term corrected for exchange rate expectations; these are proxied by the ratio of the forward to the spot exchange rate (FR/E)
The second element in the equation refers to capital movements which are not strictly related to portfolio considerations, but rather to trade flows. The ratio of the value of imports to the value of exports is meant to capture the effect of commercial credits on the capital account. A trade deficit -- i.e. $(PMGS_f \cdot E \cdot MGS/PXGS \cdot XGS)>1$; hence log( )>0 -- is partly financed through commercial credits from abroad, hence an increase in foreign liabilities (DlogNFA<0).

The interest differential term is also included in the interest rate equation. This is consistent with the idea that the domestic interest rate moves to close the discrepancy between its current value and the covered interest parity value. In fact, under perfect mobility and infinite elasticity of arbitrage funds the relation

$$i_{TIT} = i_f + (FR-E)/E \qquad (3)$$

should hold. Considerations of imperfect capital mobility can however explain the presence of a gap between the two members. This, in turn, gives rise to a (policy managed) movement of i_{TIT} aimed at the reduction of the gap.

Given the relevance of the topic some further considerations on the modelling of exchange rate expectations seem appropriate. In an open economy with perfect capital mobility, perfect asset substitutability[2], and risk neutral agents, *uncovered interest parity* holds, i. e.

$$i_{TIT} = i_f + D\dot{E}/E, \qquad (4)$$

where $D\dot{E} = \dot{E} - E$ is the expected variation in the exchange rate. If we assume --according to the portfolio approach-- imperfect substitutability between domestic

[2]Perfect capital mobility is often taken to imply perfect asset substitutability, but the two concepts are best kept apart. See Gandolfo, 1987, p. II.398.

and foreign assets, the interest-parity relation becomes

$$i_{TIT} = i_f + D\dot{E}/E + \omega \qquad (5)$$

where ω is a risk premium (see, for example, Gandolfo, 1987, p. II.413).

However, if we take account of imperfect capital mobility, neither relation (4) nor relation (5) will hold. A discrepancy between i_{TIT} and the right-hand-side of either eq. (4) or eq. (5) will not, in fact, cause an instantaneous and huge amount of capital flow. What will take place is a limited amount of capital flow, as described by the first term on the r.h.s. of eq. (2). This flow will also cause a tendency of i_{TIT} to move to close the discrepancy (see eq. (12) in table A.1); the speed of this adjustment depends, inter alia, on the degree of the authorities' control on capital movements. It should be noted that, given the volatility of the risk premium and the difficulty of modelling it precisely, we have not included it explicitly. This does *not* imply the assumption of perfect asset substitutability because we are not considering an equilibrium relation like (4) or (3), but a disequilibrium adjustment equation. The observed discrepancy between i_{TIT} and $(i_f + D\dot{E}/E)$, therefore, reflects both imperfect capital mobility and imperfect asset substitutability. This enables us to keep this discrepancy even under perfect capital mobility.

The problem of exchange rate expectations -as we have mentioned- has been solved by using the forward exchange rate. From the formal point of view, log (FR/E) $\cong$ (FR-E)/E if we expand in Taylor's series and neglect all higher order terms. From the substantial point of view, in an efficient foreign exchange market with rational expectations, the forward exchange rate is an unbiased predictor of the future spot exchange rate. Hence the expected spot rate can be represented by the forward rate. But what if the foreign exchange market is not efficient and expectations are not rational, as recent empirical evidence seems to suggest? (see, for example, Ito, 1990, and Takagi, 1991). Let us introduce the concept of "plausible" expectations, i.e. expectations which use easy and plausible information in a simple way, as opposed to rational expectations which use all the existing information efficiently. Now, in the context of plausible expectations a reasonable candidate for representing the expected spot exchange rate remains the forward exchange rate, irrespective of the efficiency of the market. First of all, we observe that in some cases the forward exchange rate outperforms all other forecasts based on econometric analyses (random walk, ARIMA, PPP, uncovered interest parity, various versions of the monetary model: see Hogan, 1986). Secondly, even admitting that the forward exchange rate is generally not the best unbiased predictor of future spot rates, the problem remains of how agents involved in international transactions form their expectations. The proliferation of

exchange-rate forecasting services may suggest that agents rely on these forecasts, but are these better than the forward exchange rate? The findings of Goodman (1979), Levich (1980), Blake, Beenstock, and Brasse (1986), indicate that the forward exchange rate is a predictor of future spot rates which is not worse (and sometimes better) than the predictions of the exchange-rate forecasting services. In addition, the forward exchange rate has no cost. Thus it seems reasonable to assume that a rational agent (not necessarily in the sense of an agent holding rational expectations, but in the general sense of *homo economicus*) uses the forward rate. It should also be noted that the forward exchange rate, which is considered an exogenous variable for estimation purposes, becomes an endogenous variable in the long run (see Gandolfo and Padoan, 1990).

This as regards the estimated version of the model. When one passes from a situation of capital controls to perfect capital mobility, it is plausible to think that exchange rate expectations undergo a modification as well. Hence the necessity arises of considering different hypotheses about the formation of these expectations. These will be considered in more detail below.

4. A first look at the consequences of capital liberalization. Stability and sensitivity

The (local) stability of the model has been examined by using the linear approximation about the steady state. The model has two exchange rate regimes (fixed and floating exchange rates), as the sample period covers 1960.IV-1984.IV. This requires the computation of two steady-states (one for each regime) and, consequently, of two linear approximations. The model is practically stable under both regimes, which show no appreciable difference as regards stability (Tables A.3, A.4). In fact, all the complex roots have negative real parts and all but one real characteristic root are negative. However, the positive root is not significantly different from zero at the 5% level. We therefore conclude that the hypothesis of stability cannot be rejected.

There is, however, a possible interpretation of this positive root suggested by sensitivity analysis. By sensitivity analysis we here mean the analysis of the effects of changes in the parameters on the characteristic roots of the model. This can be performed in a general way by computing the partial derivatives of these roots with respect to the parameters. If we call A the matrix of the linear approximation of the original non-linear system, we can compute $\partial\mu_i/\partial A$, where μ_i denotes the i-th characteristic root of A. Now, the partial derivative of one real root with respect to α_{24} is positive and very large in relative terms, which implies that the model becomes unstable for sufficiently high capital mobility. This is a worrying result, but sensitivity analysis indicates some possible stabilizing effects. Table A.5 gives the main results of sensitivity analysis under flexible exchange rates; in this table we present only the

results concerning the parameters that crucially affect stability. This table shows a large and positive partial derivative of the possibly positive root with respect to α_{24} (the adjustment speed of net foreign assets). Such a result implies that an increase in α_{24} would cause an increase in this root, hence instability for sufficiently high values of α_{24}. This result holds also under fixed exchange rates. Under flexible exchange rates it is possible to suggest an explanation for this phenomenon. Let us first note that our use of the forward exchange rate as a proxy for the expected spot rate may also be seen as representing rational expectations. Then, if we couple a very high adjustment speed ($\alpha_{24} \to \infty$) with rational expectations we are in a well-known context. Efficient asset markets with rational expectations imply that the equilibrium state has the saddle-point property, hence at least one positive root. The presence of only one positive root is related to our choice of using also other types of expectations in addition to rational expectations. This is a deliberate choice due to our eclectic approach (discussed in detail in Gandolfo and Padoan, 1990, and confirmed by the estimates).

There is, however, more to it than that. With $\alpha_{24} \to \infty$ we have perfect capital mobility which, as shown above, implies instability unless we can rely on rational expectations causing the model to jump on a stable path. Since we do not have generalized rational expectations (see above), full capital liberalization may have a destabilizing impact on the model ceteris paribus. We wish to stress the ceteris paribus clause, because by (directly or indirectly) acting on other parameters one might counteract this destabilising effect. Sensitivity analysis indicates some possible stabilising effects. Both an increase in α_5 (the adjustment speed of imports) and an increase in α_8 (the adjustment speed of exports) have a stabilizing effect on the same root. The implication seems to be that the destabilizing impact of an increase in capital mobility can be counteracted by an increase in goods mobility: when one frees capital movements one must also have free trade in goods and services. This interesting result confirms some of the insights of the literature on the order of liberalization mentioned in Sect. 2. A stabilizing effect is also displayed by an increase in δ_8, a parameter present in the monetary authorities' reaction function. This parameter can be interpreted as the weight that the monetary authorities give to the discrepancy between the desired and the actual stock of international reserves when they decide the intensity of their intervention in the foreign exchange market.

5. Simulation exercises: the basic case

Further indications on the effects of higher capital mobility may be obtained through simulation analysis. The behaviour of the control solution has been compared with that of versions in which some parameters have been altered to represent capital

liberalization. These exercises have been performed by using the original non linear model. In fact, the parameters being estimated are those of the original non-linear differential model. Hence we can use this non-linear model for simulation rather than the linear approximation. The starting point was the first quarter of 1980 to have, in principle, five years of in-sample behaviour for comparison. The spirit of the exercise is to "rerun history," asking what would have happened had capital movements been liberalised at that point.

In this basic case simulation higher capital mobility has been simulated by imposing an increase in α_{24}, the adjustment speed of net foreign assets to their desired value[3], and eliminating capital controls from the equation of real imports[4]. Let us note that an increase in α_{24} would probably be accompanied by an increase in α_{18} and perhaps in α_{17}. These parameters, however, do not affect stability in an appreciable way (they do not, in fact, appear in Table A.5). Thus we decided not to consider these changes for the sake of brevity.

The value of α_{24} has been set to different values, starting from $\alpha_{24}=0.2$ which is the bifurcation value of the parameter derived from sensitivity analysis discussed above. The highest value considered is $\alpha_{24}=90$, i.e. a mean time lag of one day, an assumption of (almost) perfect capital mobility. The behaviour of the model does not change significantly from a qualitative point of view. By this we mean that the basic features of the reaction mechanism triggered by the increase of α_{24} do not change with the value of the adjustment speed. The only difference lies in the intensity of the movement of the variables. We decided, therefore, to present for each of the first two cases considered (see below) the results obtained with $\alpha_{24}=90$, i.e. the case of full capital liberalization. It should also be stressed, from the purely theoretical point of view, that a very great (let us suppose infinite) speed of adjustment of the net foreign asset position does *not* mean an infinite flow of capital (which, if true, might threaten the non-negativity of the reserves, as pointed out in the discussion). An infinite speed of adjustment, in fact, simply means that economic agents are allowed (and able) to adjust the actual to the desired stock of net foreign assets immediately. The amount of the ensuing capital flow will be equal to the difference between NFA and $\hat{NFA}$, and this difference is finite because $\hat{NFA}$, according to the portfolio view, is a finite amount as determined by eq. (12.1) of the model.

The main result of the simulations is that, after a period of apparently stable

[3]This procedure is similar to that followed (though in a different context) by Jonson, McKibbin and Trevor (1982) in their continuous time model of the Australian economy.

[4]The introduction of capital control variables in the equation for real imports reflected an attempt to account for clandestine capital movements. An earlier study (Gandolfo, 1977) found significant empirical evidence for this phenomenon in the Italian economy on the import side. Clandestine outflows are presumably positively related to controls in international capital movements.

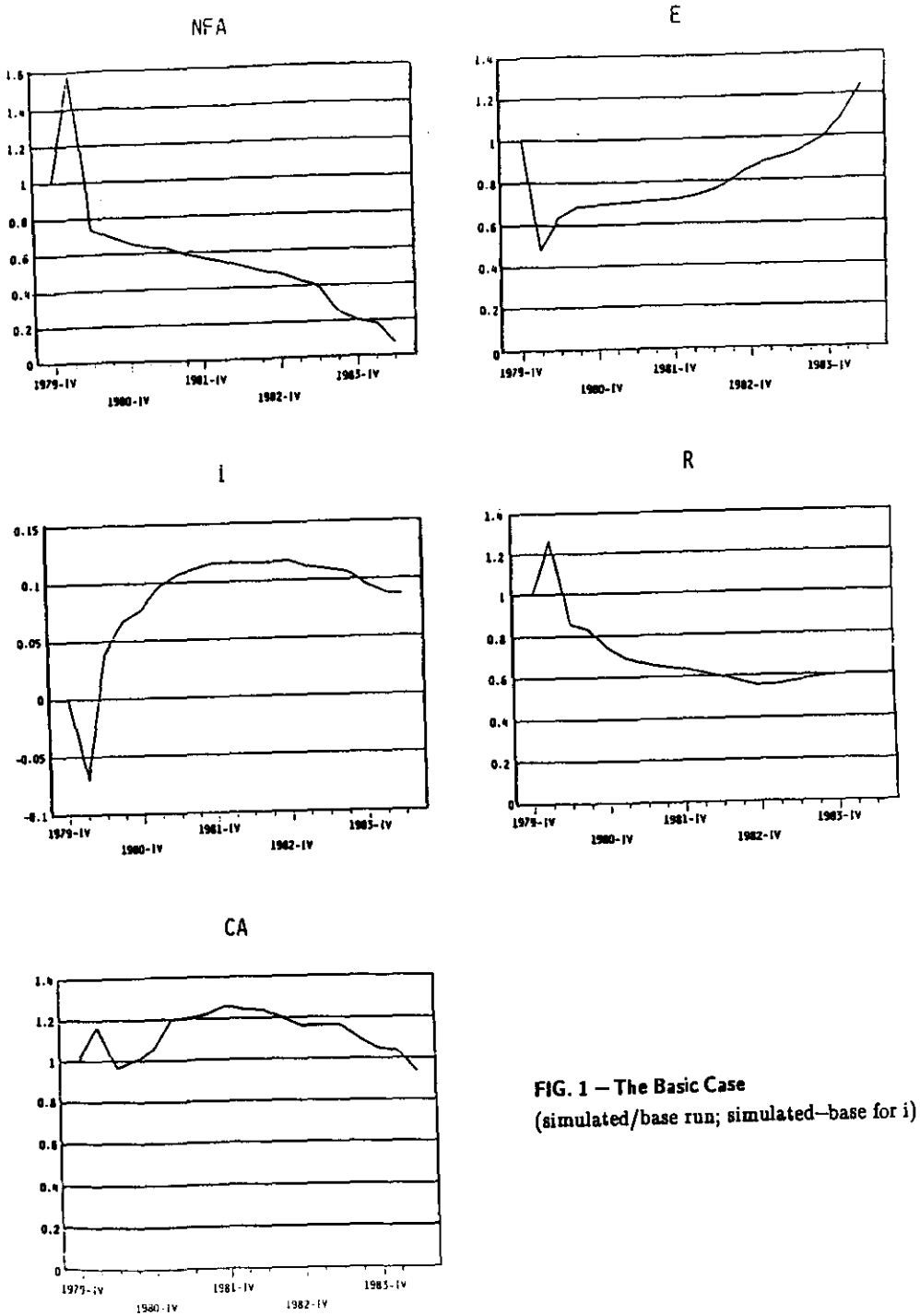

FIG. 1 – The Basic Case
(simulated/base run; simulated–base for i)

behaviour, the dynamic path of some variables, notably the exchange rate, becomes explosive. We may distinguish between an impact effect and an adjustment mechanism (see Fig. 1). The increase in α_{24} leads to an immediate increase in NFA, which causes an appreciation of the exchange rate E (impact effect). This is a well known effect in portfolio models (see Gandolfo, 1987, Sect. 18.8.3.3). The change in E, in turn, leads to a decrease in the interest rate (i_{TIT}) and to an increase in the level of international reserves (R). This is the consequence of the "leaning against the wind" components present in both equations. These components cause the interest rate to increase (decrease) and international reserves to decrease (increase) when the change in the exchange rate (DlogE) is positive (negative). Finally the improvement of the terms of trade associated with the decrease in E produces an improvement in the current account. From this point onwards a reaction mechanism involving mainly the interest rate and the level of international reserves is set into motion.

The level of R is now higher than the target value which depends on the value of imports (now lower because of the appreciation of the exchange rate). As a consequence, the level of reserves tends to decrease. The level of the interest rate, on the contrary, is pushed upwards by two elements. One is the appreciation of the spot exchange rate relative to the forward rate which increases the target value of i_{TIT}. The other is the monetary squeeze caused by the decrease in international reserves through the money supply equation. The increase in i_{TIT} leads to a decrease in the accumulation of net foreign assets.

The decrease in NFA pushes towards the depreciation of the exchange rate. This effect is partially offset by the behaviour of the current account (which is improving). At this stage the economy is apparently following a stable path characterized by a lower exchange rate and a higher interest rate. One important real effect is the relatively lower level of fixed investment produced by the tighter monetary and credit conditions. After about three years, however, the pressure for a higher exchange rate overcomes the opposing forces. The exchange rate starts a depreciating movement which soon becomes explosive. The results confirm the widespread view that a decrease in capital controls leads initially to a higher stock of net foreign assets. They also confirm the similarly widespread opinion that the economy can be kept on a relatively stable path with appropriate interest rate and exchange rate policies. This latter opinion, unfortunately, is true only for a few years, and does not hold in the longer run. What this exercise shows, in fact, is that the new regime leads to the build up of market pressures concentrating on the exchange rate which eventually become unsustainable.

6. Alternative exchange–rate expectations

The role of policy interventions associated with the "leaning against the wind" component was crucial in the basic case. A second group of simulations has been carried out by eliminating this component from the two policy equations (interest rate and international reserves). A second major modification is related to exchange rate expectations which are represented by the ratio of the forward to the spot exchange rate. The forward rate was kept exogenous in the basic case and this fact might have somewhat distorted the result of the exercise.

The role of exchange rate expectations is, in fact, crucial for the onset of possible destabilising speculative capital flows. Thus we also considered different hypotheses about the formation of exchange rate expectations. The relevant literature is enormous, so that we decided to consider, in addition to those included in the estimated version of the model, only the following types of expectations: extrapolative and "normal" or "regressive" as well as a combinations of the two. The former simply mean that, if a change has taken place, a further change in the same direction is expected; as regards the latter, they imply that economic agents have an idea of a normal, long-run value of the variable under consideration so that, whenever the current value is different from the normal one, they expect that the current value will sooner or later move towards (or "regress" to) the normal one. It seems plausible to assume the PPP value as the long-run normal exchange rate, also because the model possesses a steady state path on which the exchange rate is at its PPP value (see Gandolfo and Padoan, 1990). Hence rational agents, who know the model (and the fact that its steady state is stable) have this normal value in mind.

It is fairly obvious that extrapolative expectations are bound to have a destabilizing effect whereas normal expectations will have a stabilizing effect. The reason for considering these two types of expectations is related to the argument recently put forth by Frankel (1988). From surveys of the forecasts of the agents operating in the foreign exchange market, Frankel concludes that those who forecast at shorter horizons display destabilising expectations because they tend to extrapolate recent trends, while those who operate with relatively longer horizons tend to have regressive, or stabilizing, expectations. The reasons for this different behaviour are to be seen, according to Frankel, in the fact that short-term traders in the foreign exchange market have to show to their superiors (typically, bank executives) that they are able to make profits over a much shorter time period than that over which the performance of longer-term traders is evaluated. Independently of the reason, we believe that Frankel's distinction is correct, since it corresponds to the distinction between "occasional" and "permanent" speculators introduced long ago by Cutilli and Gandolfo (1963, 1972, 1973).

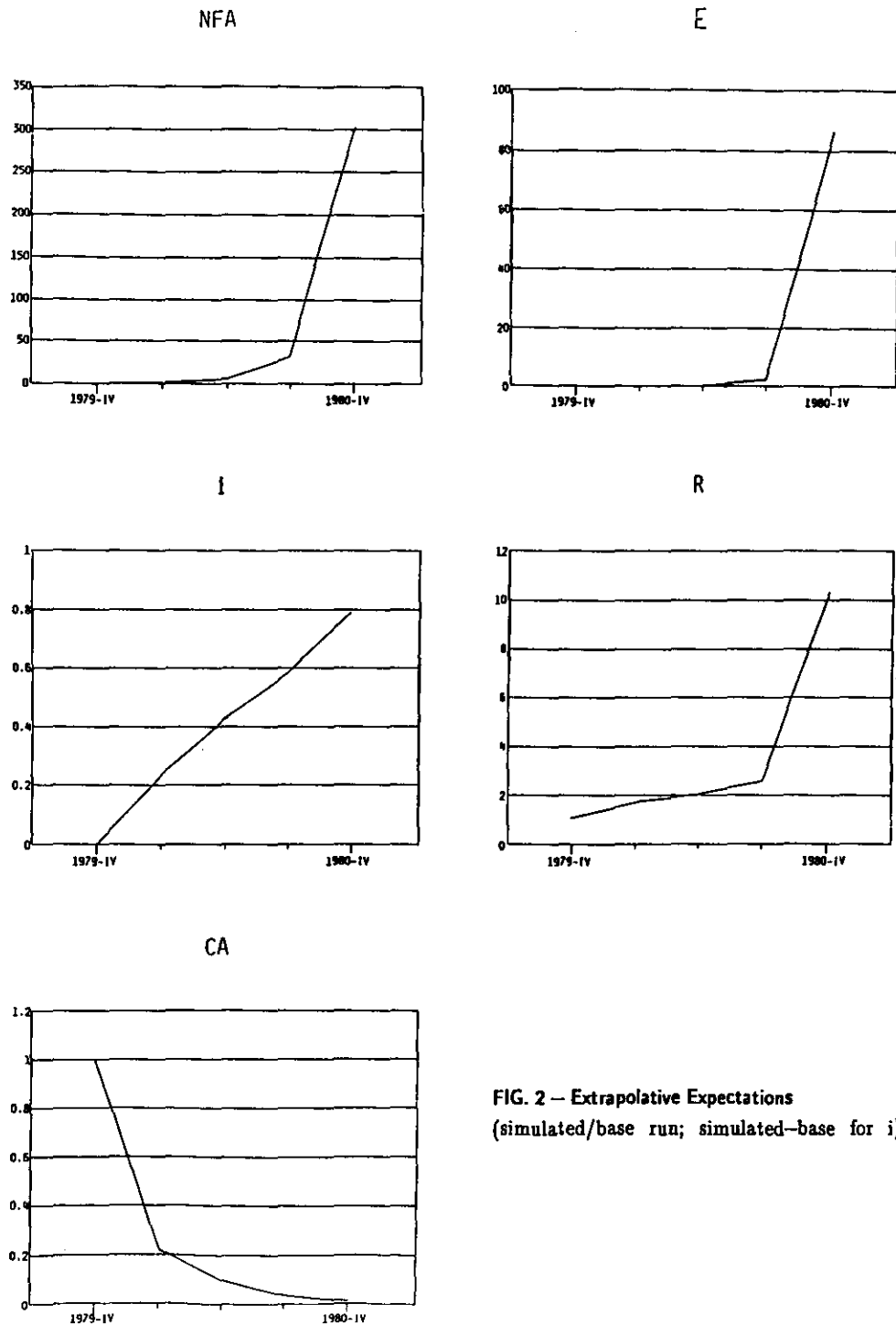

FIG. 2 – Extrapolative Expectations (simulated/base run; simulated–base for i)

In the light of this distinction, one should not only consider the two extreme cases (all agents are of the same type, i.e. with either extrapolative or normal expectations), but also the intermediate ones. These are the cases where there are agents of the two types operating simultaneously in the market; the outcome will depend on the relative intensity of action of the two categories (Cutilli and Gandolfo, op. cit.).

6.1 Extrapolative expectations Expected exchange rate changes were proxied by the rate of change of E, DlogE, which replaced log(FR/E) in both the interest rate and the capital movements equation. In this case too the experiment of capital liberalisation leads to an explosive movement of the exchange rate (see Fig. 2). This movement, however, occurs much earlier (and with a much greater reaction in the variables considered) than in the previous case (see Fig. 2). The increase in α_{24} produces, as before, an increase in NFA and an appreciation of the exchange rate. The absence of leaning-against-the-wind components leaves the interest rate unchanged while international reserves slowly increase. Easier monetary conditions cause the current account to deteriorate. This is due to both higher imports and lower exports (which are inversely related to credit and hence money supply growth). The rather marked deterioration in the current account puts a pressure on the exchange rate which starts a very rapid devaluation course. As a consequence, the economy starts a cumulative process which eventually explodes. The devaluation is generated by the deterioration in the overall balance of payments. This is the result of stock-flow interactions as well as of different adjustment speeds in the balance of payments components. Let us consider, in fact, the relatively low adjustment speeds of real imports and exports. We can then understand that the favourable quantity effect of the devaluation on trade flows will be felt much more slowly than the adverse terms-of-trade effect. This leads to a further devaluation which is accepted by the monetary authorities, since the leaning-against-the-wind components have been suppressed. On the contrary, the central bank accumulates reserves to reach the target value for R. This value, in fact, keeps on increasing due to the increasing value of imports determined by the depreciation of the exchange rate. Higher reserves lead to easier monetary conditions and further current account deterioration.

6.2 Normal Expectations. In this set of simulations the exchange rate expectations were modelled assuming that traders form an idea of the "normal" or "long run" exchange rate based on the "fundamentals" of the system (relative prices). Accordingly, the expected proportional change in the exchange rate was proxied by the log of the ratio of the "normal" to the spot exchange rate, $\log(\hat{E}/E)$, where $\hat{E}=PXGS/PF_f$ is the ratio of domestic export prices to foreign competitors' export prices in foreign currency, i.e.the exchange rate necessary to maintain price competitiveness. This way of modelling expectations also takes into account the fact

that, in the model, monetary authorities adjust international reserves, i.e. intervene in the foreign exchange market, considering price competitiveness in addition to other targets (see Gandolfo and Padoan, 1990). Normal exchange rate expectations were introduced in the form $\delta_E \log(\hat{E}/E)$, where δ_E was given a set of values ranging from 0.1 to 1.0. However in what follows we will present only the case of $\delta_E=1.0$ since the dynamic behaviour of this set of simulations does not change in its main characteristics with a change in the value of δ_E. The following cases also include a change in the value of the parameter δ_8, i.e. the parameter associated with the desired value of international reserves in the monetary authorities' reaction function, whose value was set to 1.0 (while its estimated value was 0.282). This change, as recalled above, is suggested by sensitivity analysis (see Sect. 4) which indicates that an increase in δ_8 has a stabilizing effect on the system. The results of the simulation run are summarised in Fig.3.

As in the basic case we can distinguish between an impact effect and an adjustment mechanism. As in the basic case the increase in α_{24} leads to an immediate increase in NFA which causes an appreciation of the exchange rate and, consequently, a decrease in i_{TIT}, an increase in the level of international reserves, and an improvement of the trade balance due to better terms of trade. From this moment onwards the adjustment mechanism develops quite differently from the basic case. The level of international reserves adjusts to a lower desired value determined by the lower value of imports which results from the decrease in E. The higher value of δ_8 strengthens this effect thus producing a lower level of R with respect to the basic case. The interest rate is initially higher than the control solution but, contrary to the basic case, it begins taking on lower values after nine quarters. This is the consequence of the fact that long term exchange rate expectations indicate an appreciation thanks to the "virtuous" interaction between the decrease in the spot exchange rate and the decline in domestic prices (and hence in export prices); consequently the target value of i_{TIT} decreases. The initial increase in i_{TIT} leads to a decrease in net foreign assets which continues till the end of the simulation, also as a consequence of the behaviour of exchange rate expectations. The current account improves, mainly thanks to the improvement in the terms of trade, for more than twelve quarters.

The forces sustaining this apparently stable path begin to loose strength after three years. While the exchange rate keeps appreciating, a pressure towards depreciation develops both from the decrease in NFA and from the change in the behaviour of the current account, which starts to deteriorate. After nineteen quarters the exchange rate inverts its course, and starts a depreciating movement which becomes explosive.

The main lesson from this exercise is that the formation of expectations is crucial in determining the dynamic behaviour of the system. The assumption of "normal" or

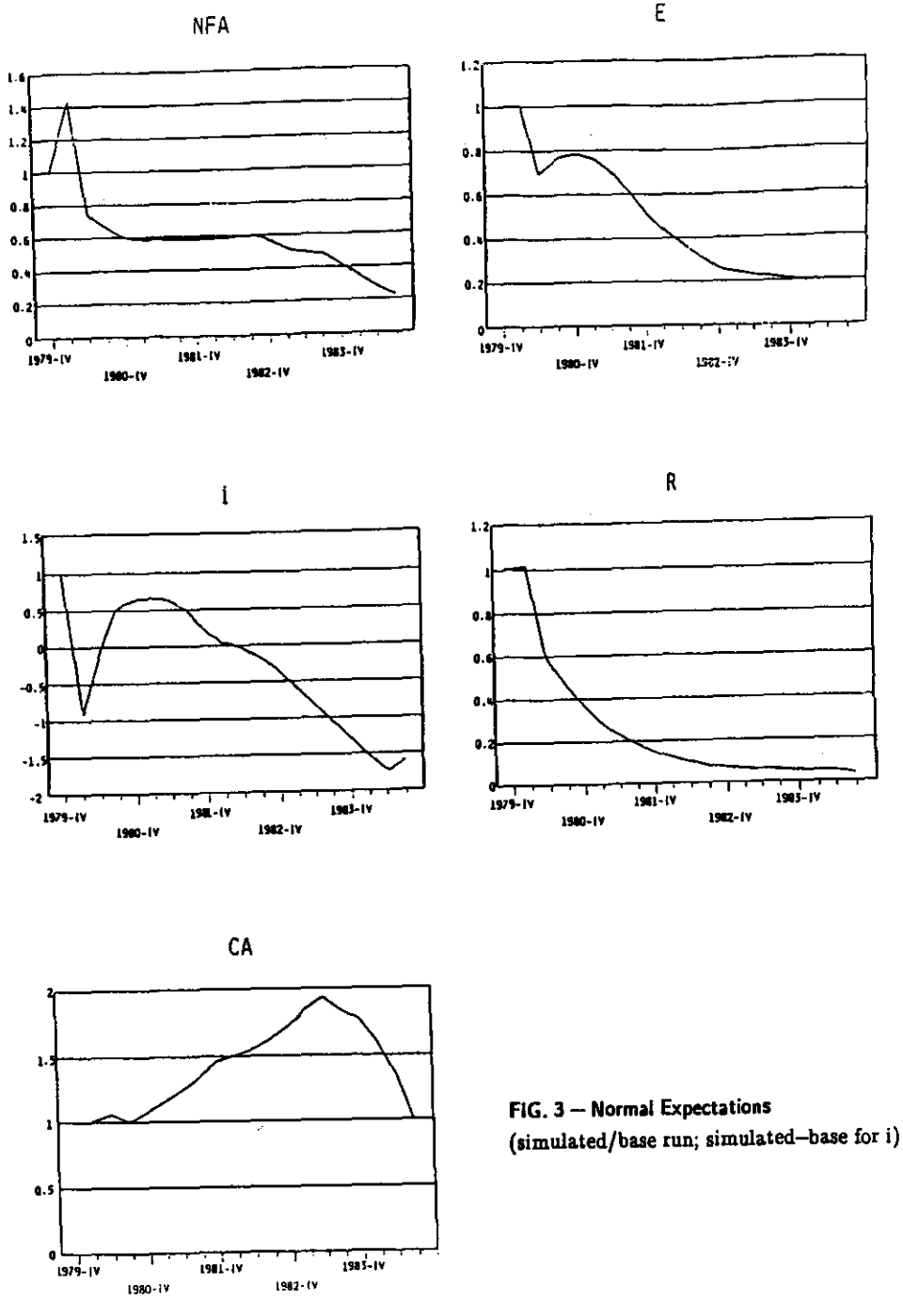

FIG. 3 – Normal Expectations
(simulated/base run; simulated–base for i)

"long run" expectations has dramatically improved the ability of the system to bear the impact of full capital liberalization with respect to the case of extrapolative expectations. However this was not enough to avoid a final collapse. In this respect what this exercise has shown is that while exchange rate expectations based on "fundamentals" (relative prices) do exert a stabilizing effect, they cannot fully offset the destabilizing effects of financial transactions.

6.3 Mixed expectations. The expected change in the exchange rate is given by $\pi_E\delta_E \text{DlogE} + \pi_N\delta_N \log(\hat{E}/E)$, where $\pi_E+\pi_N = 1$ are the relative weights of the two categories of agents, and the other symbols have the same meaning as before. The combined parameters $(\pi_E\delta_E)$ and $(\pi_N\delta_N)$ were given values ranging from 0.1 to 2.0 in 0.1 increments. This allows for a wide number of possible combinations only a few of which will be discussed here. Given the results of the previous simulation exercises one of the points to be checked was the role of normal expectations in offsetting the destabilising effect of extrapolative expectations. In order to do this we proceeded as follows. We started with a value of $\pi_E\delta_E = 1.0$ and a value of $\pi_N\delta_N = 0.1$. The main result was that , as in the case where only extrapolative expectations were considered, the behaviour of the exchange rate became explosive. However, the run came to a stop after eight quarters, i.e. a longer time span with respect to the case where normal expectations were not present. Slight increases in the coefficient associated with normal expectations lengthened the period over which the behaviour of the exchange rate, and of the whole model, remained relatively stable. With a value of $\pi_E\delta_E = 1.0$ and $\pi_N\delta_N = 0.5$ the model completed its run over the five year period. We shall refer to this case, which will be discussed in more detail below, as case 1. The experiment was then continued by increasing the value of $\pi_N\delta_N$ while keeping the other coefficient constant at the value of 1.0. One economic interpretation of such an experiment may be the following. Since one of the variables determining the behaviour of monetary authorities in exchange rate intervention -eq. (16)- is international competitiveness, an increasing weight of normal expectations in determining market behaviour may reflect the fact that the market considers such a policy commitment as increasingly credible. In other words a variable weight of normal expectations reflects a change in the policy regime (as far as exchange rate intervention is concerned) which is credible. As the simulations show this may prove crucial in affecting capital movements, a fact that has been suggested with respect to the Italian experience in the EMS by Giavazzi and Spaventa (1990).

The main result of the increase in the coefficient associated with normal expectations is that the model continues to behave satisfactorily over the five year simulation period and generates different paths of the relevant variables, namely the exchange rate, net foreign assets and the current account. In what follows we will also discuss the case

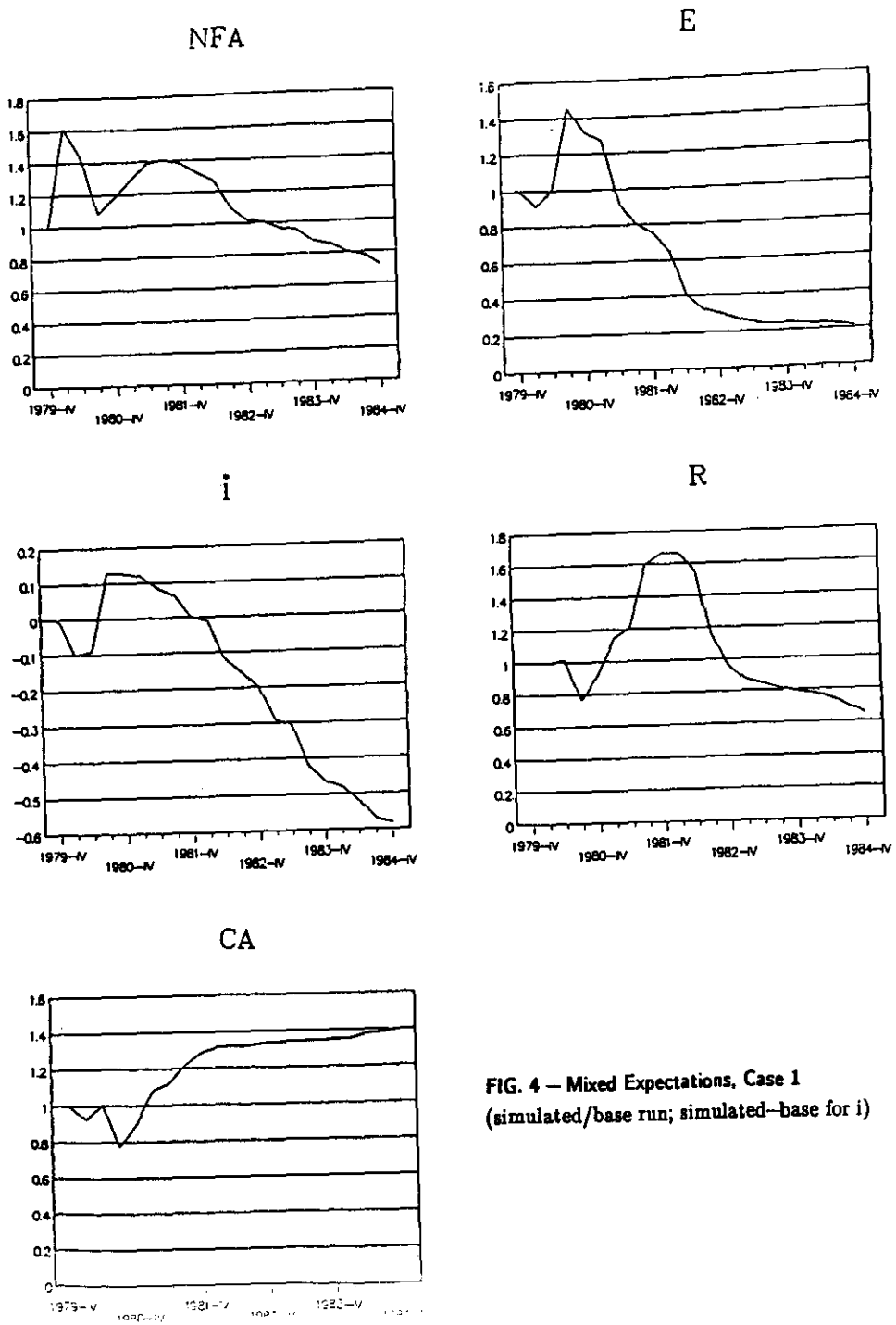

FIG. 4 — Mixed Expectations, Case 1
(simulated/base run; simulated–base for i)

-which we will call case 2- in which $\pi_N \delta_N$ takes on the value of 2.0 and $\pi_E \delta_E$ the value of 1.0

6.3.1 Case 1. As in previous cases the first relevant effect is an increase in NFA (see fig.4) and , after an initial appreciation, a depreciation of the exchange rate which leads to an increase in the interest rate and a deterioration of the current account because of the adverse terms of trade effect. The deterioration of the two components of the balance of payments further leads to a devaluation which strengthens the effect of a rising interest rate. The devaluation , however, eventually leads to an improvement of the current account, while the stock of net foreign assets keeps on a fairly steady path. and then tends to decrease after about ten quarters. The current account keeps on improving although at a rather slow pace. The exchange rate keeps appreciating, thus reinforcing the now positive terms of trade effect. The behaviour of both extrapolative and normal expectations generates a decrease in the level of the interest rate. This, however, is not enough to invert the behaviour of NFA which is more strongly affected by favourable expectations. The economy displays both a lower exchange rate and a lower interest rate with respect to the control solution. The difference with respect to e.g. the basic case discussed above, is that now the role of expectations is more important in determining the behaviour of capital movements.

6.3.2 Case 2. As can be seen from Fig. 5, the behaviour of the variables is opposite to the previous case.

Net foreign assets increase and the exchange rate devalues. The stronger role of normal expectations is felt in the behaviour of capital movements which flow out of the country as a larger depreciation is now expected. This deteriorates the balance of payments in both of its components, inducing a faster devaluation which deteriorates the current account because of the adverse terms of trade effect. Both of these forces push toward a further devaluation and hence feed negatively on expectations. International reserves must grow to face the higher nominal value of imports generated by the devaluation. This leads to an expansion in the money supply which feeds both on the current account, through higher demand, and on the interest rate, which decreases as a reaction to a larger money supply, although it assumes a higher level with respect to the previous case because of the different behaviour of exchange rate expectations.

This last case illustrates the influence of policy behaviour on expectations. If the market believes that the authorities will drive the exchange rate to keep up with international competitiveness, it will react by generating a capital account which may eventually become unsustainable. The case just discussed is an extreme one as the weight assigned to normal expectations has proved to be "excessive" with respect to extrapolative ones. In fact, other cases which have not been discussed here, show that, when normal and extrapolative expectations take on approximately equal weights, the

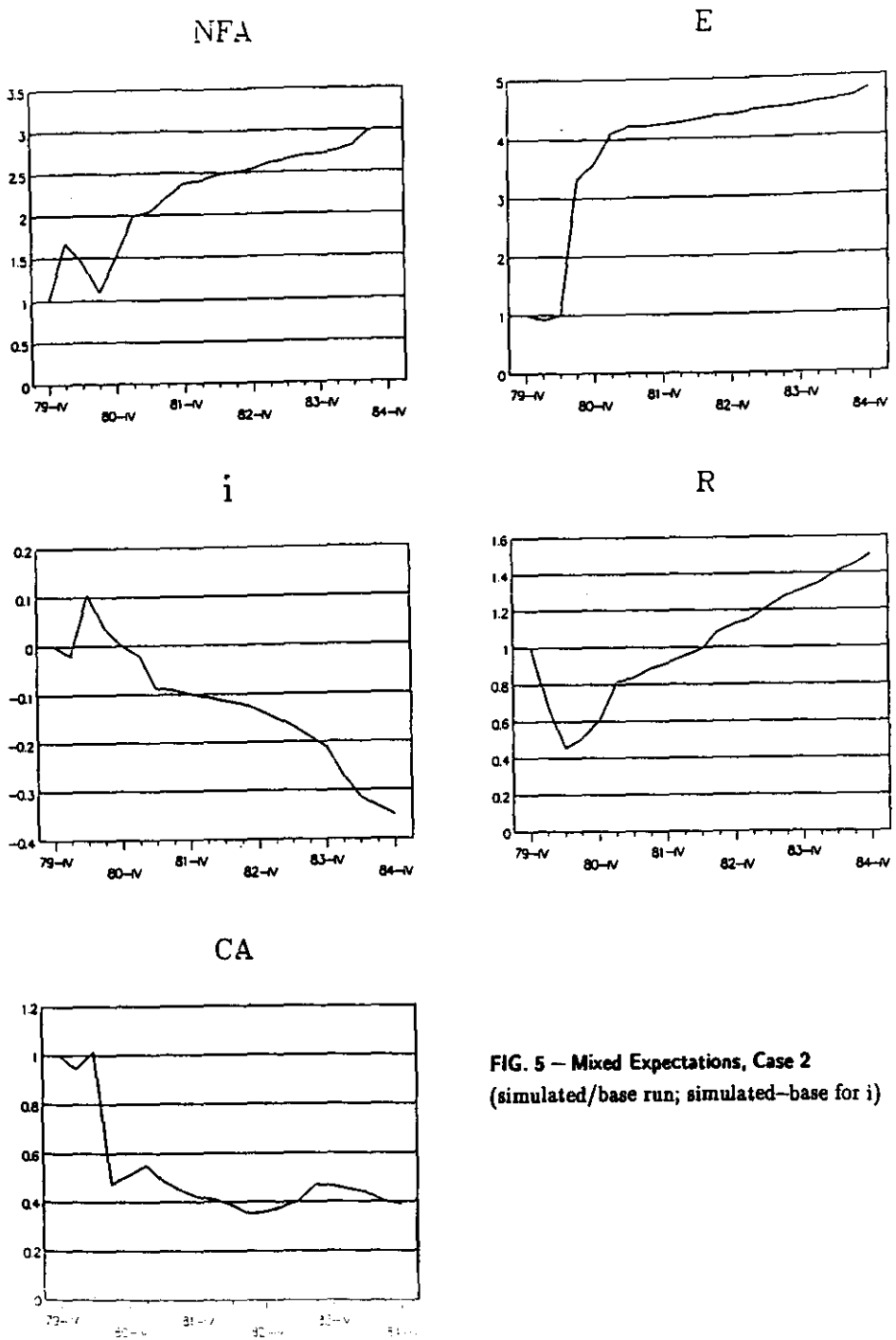

FIG. 5 – Mixed Expectations, Case 2
(simulated/base run; simulated–base for i)

behaviour of the model is more satisfactory, i.e. the variables follow paths which are intermediate between those shown in figures 4 and 5.

7. Will a Tobin tax help?

In the light of the distinction -recalled above- between "occasional" and "permanent" speculators, the argument in favour of a Tobin tax on all capital flows (so as to avoid the practical enforcement problem of trying to distinguish between foreign exchange purchases for "speculative" purposes versus purchases for the purpose of longer-term investments) seems to receive new support. Such a tax, in fact, would not be much of a deterrent to anyone contemplating the purchase of a foreign security for longer-term investing, but it might discourage the spot trader who is now accustomed to buying foreign exchange with the intention of selling it a few hours later. As Frankel notes (1988, p. 184), there has been little if any attempt to appraise the Tobin proposal in the context of an appropriate macroeconomic model. This is particularly true of Italy, where the Tobin tax has been advocated by various authors (see, for example, Basevi and Cavazzuti, 1985) without much empirical support.

The Tobin tax on capital flows is a tax on the relevant foreign exchange transactions, but it can be translated into an equivalent tax on interest income. It is, in fact, equivalent either to a tax on foreign interest income at a rate which is an increasing function of the Tobin tax rate θ, or to a negative tax (i.e., a positive subsidy) on domestic interest income at a rate which is an increasing function of θ. To show this, let us consider the standard method of determining the relative profitability (including the gains due to expected changes in the exchange rate) of placing funds abroad or at home. This amounts to comparing $(1/E)(1+i_f)\bar{E}$ with $(1+i_h)$, where the interest rates and $\bar{E}$ (the expected exchange rate) are referred to the same time interval. Let us now introduce a tax at the unit rate θ (to be paid in domestic currency) on both the amount of domestic currency transferred abroad and the amount that will be repatriated (principal plus interest) at the end of the relevant period. The first term of the comparison then becomes $[(1-\theta)(1+\theta)^{-1}/E](1+i_f)\bar{E}$. By simple manipulations[5] one obtains that the relevant interest differential is

[5] With perfect capital mobility, the relation $[(1-\theta)(1+\theta)^{-1}/E](1+i_f)\bar{E} = (1+i_h)$ should hold. If we multiply both members by $(1+i_f)^{-1}(1+\theta)/(1-\theta)$ and subtract 1, we obtain $[(1+\theta)(1+i_h)-(1-\theta)(1+i_f)]/[(1-\theta)(1+i_f)] = (\bar{E}-E)/E$.
By manipulating the left hand side and neglecting, as is usuallly done, the denominator, we obtain $i_h - [(1-\theta)i_f-2\theta](1+\theta)^{-1} = (\bar{E}-E)/E$ or, equivalently, $[2\theta+(1+\theta)i_h](1-\theta)^{-1} - i_f = (\bar{E}-E)/E$. In

$[(1-\theta)i_f 2\theta](1+\theta)^{-1}$ - i_h or, equivalently, i_f - $[2\theta+(1+\theta)i_h](1-\theta)^{-1}$. It is then easy to simulate the introduction of a Tobin tax in our model, by appropriately modifying the interest differential that appears in the definition of $\dot{NFA}$ (see Sect. 3).

The Tobin tax was tested assuming two different expectation formation mechanisms: extrapolative and normal.

7.1 Extrapolative expectations. The expected proportional change in the exchange rate is given by δ_EDlogE, δ_E>0. This coefficient was given values ranging from 0.1 to 1.0. In all cases the model produced an explosive (devaluationary) behaviour of the exchange rate which developed after very few quarters (no more than four). The other variables followed a behaviour quite similar to that observed in the previous simulation. The introduction of a Tobin tax was modelled by multiplying the foreign interest rate, i_f, by a term $(1-t)$, with t=0.3. This is equivalent to assuming a Tobin tax rate θ approximately equal to 1.6%[6], a large value if one recalls that θ is applied to the principal and on both the outflow and the inflow. This value was chosen after that several runs with alternative values of t had shown that, in order to obtain relevant results, t (and hence θ) had to be large. The introduction of the Tobin tax, however, improved the behaviour of the model only slightly. What happened is that the explosive behaviour of the exchange rate developed from two to three quarters later with respect to the cases without the introduction of the tax.

7.2 Normal expectations In this exercise the Tobin tax takes on the same value as in the case with extrapolative expectations (about 1.6%, corresponding to a tax of 30% on foreign interest income on a yearly basis).

The results are reported in Fig.6.

The most relevant result is that now the system follows a stable path throughout the simulation period. In this case too we can distinguish between an impact effect and an adjustment mechanism. The impact effect is similar to the previous one showing an increase in NFA and an appreciation of the exchange rate. The interest rate, however, decreases steadily over the period. This is due to the fact that the Tobin tax lowers the target value for the domestic interest rate. The total effect of the Tobin tax is such that the interest rate differential is, compared to the previous simulations, in favour of the foreign rate. This determines a relatively higher accumulation of net foreign assets (which is, nonetheless, lower with respect to the control solution). The important

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the absence of the tax, the relation would be $i_h - i_f = (\dot{E}-E)/E$. In both cases, the presence of a risk premium explains why the equality does not hold even with perfect capital mobility.

[6]The relationship between θ and t is given by $[(1-\theta)i_f-2\theta)]/(1+\theta) = (1-t)i_f$. With a value of i_f around 12%–13% per annum in the simulation period, this gives a value of θ around 1.6% for t = 30%.

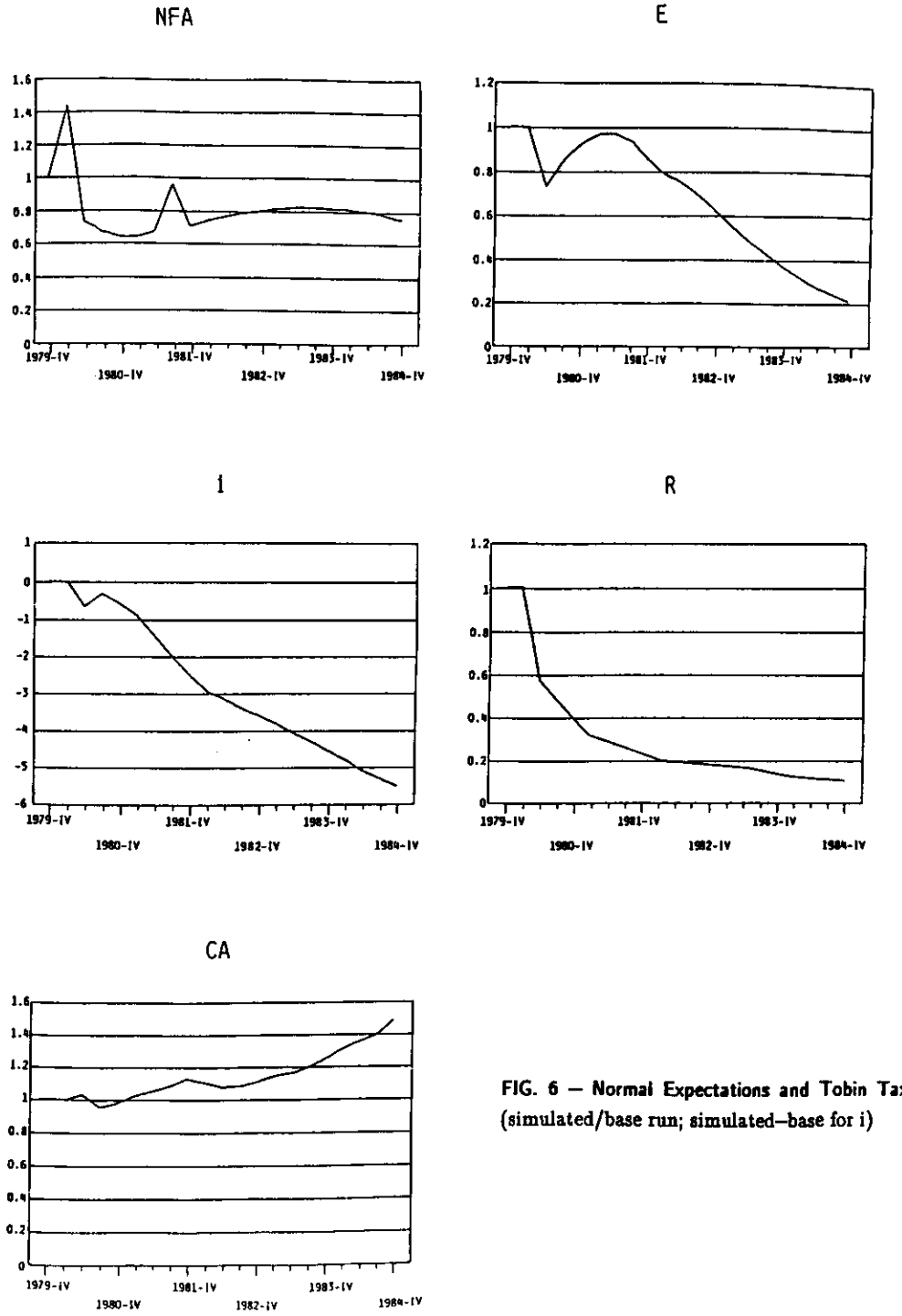

FIG. 6 — Normal Expectations and Tobin Tax (simulated/base run; simulated–base for i)

element, however, is that, contrary to the previous simulations, the level of NFA mildly fluctuates around a stable value rather than decreasing steadily. The exchange rate tends to appreciate under the pressure of an improving current account.

The main message from this exercise is that the introduction of a Tobin tax provides a crucial contribution to the stabilization of the system with full capital liberalization and exchange rate expectations geared to relative prices. However there is more to it than that. A Tobin tax allows the system to operate with a lower level of the domestic interest rate as it makes the constraint represented by the foreign rate less stringent. This obviously gives more room for domestic financial policy in terms of e.g. financing of the domestic public debt, an issue which is of paramount importance for the Italian economy. The counter argument for such a tax is that if not all countries adopted it, then the business would simply go to the financial centres where the tax is not present.

8. Trade and capital liberalization.

Our final exercise includes the joint liberalization of capital movements and trade flows. The basic model is modified as in case 1 with the addition of an increase in the adjustment speed of both imports and exports of goods and services. Accordingly, both α_5 and α_8 are set equal to 15, i.e. a mean time lag of roughly one week. Lower values of α_5 and α_8, i.e. longer mean time lags, did not alter the results significantly. As sensitivity analysis indicates, an increase in α_5 and α_8 exerts a stabilizing effect on the model. The main result of the simulation (see Fig. 7) is that the behaviour of the model is more stable. After four years, nevertheless, the unstable movement of the exchange rate emerges as in the previous cases. The behaviour of the system, however, is different. As in case 1 the increase in α_{24} leads to an immediate increase in NFA, which causes an appreciation of the exchange rate. This, in turn, leads to a decrease in the interest rate and to an increase in the level of reserves. The current account, on the contrary, heavily deteriorates as the increase in the quantity of imports is larger than the increase in the quantity of exports. Following this "impact effect" the model sets itself onto a path characterized by the following properties. The level of reserves stays at the new, higher, level as required by the higher level of imports. This determines a higher money stock which leads to a lower interest rate and hence to lower desired net foreign assets ($\hat{NFA}$). This effect is offset, however, by the lower level (revaluation) of the exchange rate which pushes up NFA. The consequence is a stable behaviour of NFA. Simultaneously, the current account is improving thanks to the catching up of XGS in spite of the negative effect of the lower level of E on exports. If the improvement in the current account had been faster, it could have offset the pressure

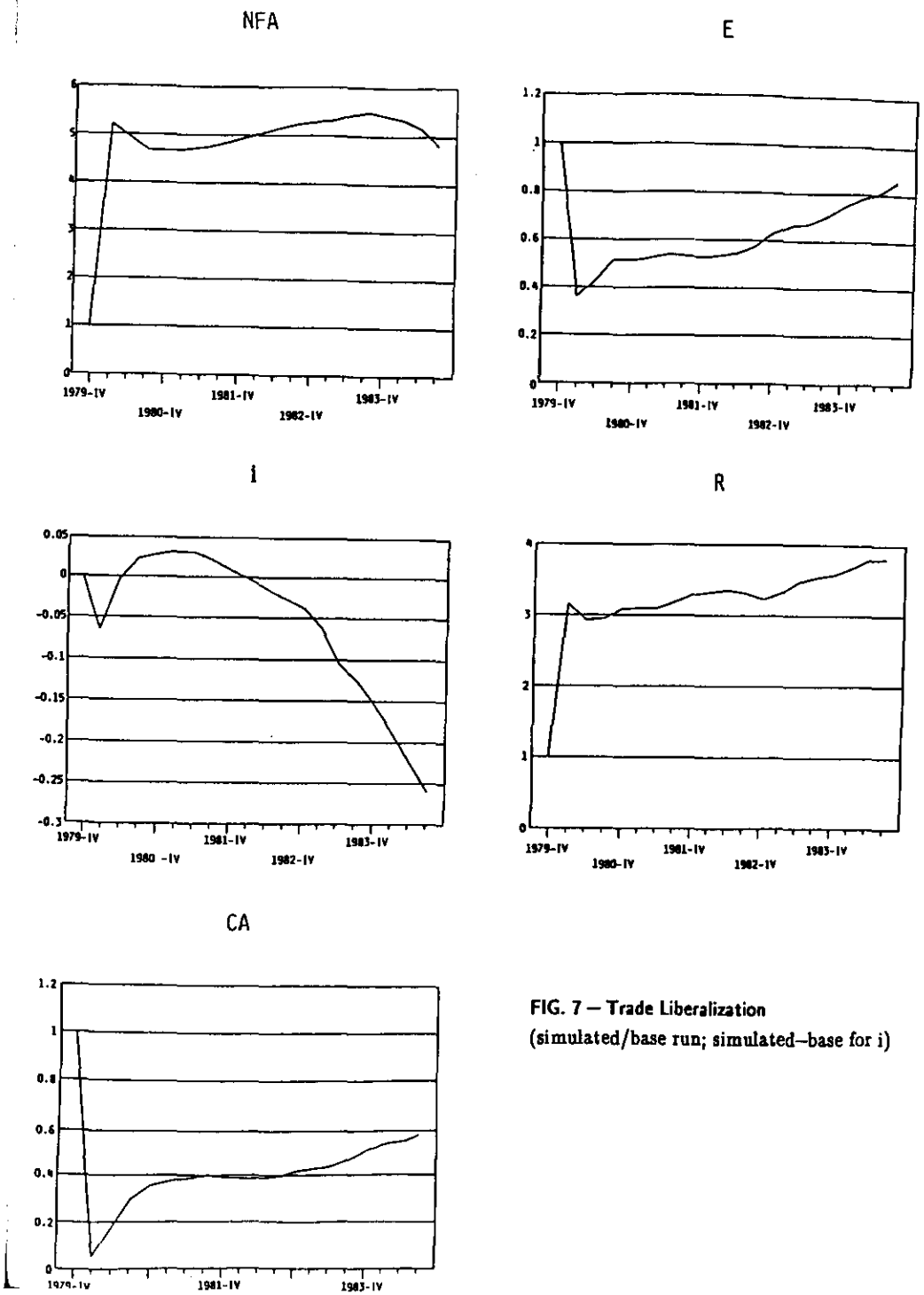

FIG. 7 — Trade Liberalization
(simulated/base run; simulated–base for i)

on the exchange rate. This pressure is due to a level of E which is inconsistent with trade competitiveness. In the end the pressure on the exchange rate leads to instability.

This final experiment confirms that an increase in the adjustment speed of trade flows mitigates the destabilizing effects of financial liberalization. The system, however, still displays instability at the new, more deregulated, regime.

9. Conclusion

In this paper we have shown that the effects of perfect capital mobility ought to be examined in the context of suitable economy-wide macroeconometric models, where we have suggested a precise way of modelling capital liberalization and related questions (such as exchange rate expectations). The results of simulation exercises carried out by means of our continuous time model of the Italian economy have given interesting insights in this issue, that can be summarized as follows.

First of all, capital liberalization alone has a destabilizing effect on the economy in general and on the exchange rate in particular.. What should be stressed is that *instability is not immediate, but comes about after a period (two or three years) of apparent stability.* This result seems to be dramatically confirmed by the events concerning the lira (apparent stability for a couple of years after the liberalization, then huge capital outflows culminating in the devaluation of the lira --realignment on 14 September 1992 and subsequent events). We do not like to play Cassandra, but we have to point out that these delayed destabilizing effects were already stressed in papers of ours well before capital liberalization took place in the Italian economy (Gandolfo and Padoan, 1988a,b).

Secondly, exchange rate expectations have a crucial role to play. Their effect, however, varies greatly according to the relative importance of "extrapolative" with respect to "normal" expectations. The former exert a destabilizing effect while the latter have an opposite influence. The current (September 1992) events in the Italian economy undoubtedly reflect the prevalence of agents with destabilizing expectations. If the government is unable to foster "normal" expectations through appropriate policies, then the inherently destabilizing "one way option" that speculators face in regimes with fixed but adjustable parities and *divergent underlying fundamentals* will take place. All this is well known to any student of the Bretton Woods system and can be carried over to currency areas and prospective monetary unions (Gandolfo, 1992a). Thirdly, a Tobin tax is helpful in stabilizing the system, since it makes purely speculative capital flows (which are typically short term) much less profitable. Finally, trade liberalization is also helpful, but not sufficient. Thus we must conclude that the destabilizing effects of capital liberalization have to be counteracted by a *set of measures* because a single measure might prove to be ineffective.

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APPENDIX

TABLE A.1 - Equations of the Model

Private consumption

$$\mathrm{Dlog}C=\alpha_1\log(\hat{C}/C)+\alpha_2\log(M/M_d), \tag{1}$$

where

$$\hat{C}=\gamma_1 e^{\beta_1 \mathrm{Dlog}Y}(P/PMGS_f\cdot E)^{\beta_2}(Y-T/P),\ \beta_1\gtrless 0,\ \beta_2\gtrless 0;\ M_d=\gamma_2 e^{-\beta_3 i}TIT_P^{\beta_4}Y^{\beta_5},\ \beta_3\gtrless 0, \tag{1.1}$$

Rate of growth in fixed capital stock

$$\mathrm{D}k=\alpha_3[\alpha'\log(\hat{K}/K)-k]+\alpha_4\mathrm{D}a, \tag{2}$$

where

$$\hat{K}=\gamma_3\tilde{Y}, \qquad \gamma_3=\kappa/u, \tag{2.1}$$

Expected output

$$\mathrm{Dlog}\tilde{Y}=\eta\log(\bar{Y}/\tilde{Y}), \tag{3}$$

Imports

$$\text{DlogMGS}=\alpha_5\log(\hat{MGS}/MGS)+\alpha_6\log(\hat{V}/V)+\alpha_7 PCC, \tag{4}$$

where

$$\hat{MGS}=\gamma_4 P^{\beta_6}(PMGS_f\cdot E)^{-\beta_7} Y^{\beta_8}, \qquad \hat{V}=\gamma_5\tilde{Y}, \tag{4.1}$$

Exports

$$\text{DlogXGS}=\alpha_8\log(\hat{XGS}/XGS)-\alpha_9 Da, \tag{5}$$

where

$$\hat{XGS}=\gamma_6(PXGS/PF_f\cdot E)^{-\beta_9} YF^{\beta_{10}}(\gamma_3\tilde{Y}/K)^{-\beta_{11}}, \tag{5.1}$$

Output

$$\text{DlogY}=\alpha_{10}\log(\tilde{Y}/Y)+\alpha_{11}\log(\hat{V}/V), \tag{6}$$

Price of output

$$\text{DlogP}=\alpha_{12}\log(\hat{P}/P)+\alpha_{13}Dm+\alpha_{14}\log(M/M_d), \tag{7}$$

where

$$\hat{P}=\gamma_7(PMGS_f\cdot E)^{\beta_{12}} W^{\beta_{13}} PROD^{-\beta_{14}}, \tag{7.1}$$

Price of exports

$$\text{DlogPXGS}=\alpha_{15}\log(\hat{PXGS}/PXGS), \tag{8}$$

where

$$\hat{PXGS}=\gamma_8 P^{\beta_{15}}(PF_f\cdot E)^{\beta_{16}}, \tag{8.1}$$

Money wage rate

$$\text{DlogW}=\alpha_{16}\log(\hat{W}/W), \tag{9}$$

where

$$\hat{W}=\gamma_9 P^{\beta_{17}} e^{\lambda_4 t}, \tag{9.1}$$

Interest rate

$$Di_{TIT}=\alpha_{17}\log(M_d/M)+\alpha_{18}[i_f+\log(FR/E)-i_{TIT}]+\alpha_{19}\text{DlogE}+\alpha_{20}Dr+\alpha_{21}Dh, \tag{10}$$

Bank advances

$$\text{DlogA}=\alpha_{22}\log(\hat{A}/A)+\alpha_{23}Dk, \qquad \alpha_{23}\gtrless 0, \tag{11}$$

where

$$\hat{A}=\gamma_{10} e^{\beta_{18} i_{TIT}} M, \qquad \beta_{18}\gtrless 0, \tag{11.1}$$

Net foreign assets

$$\text{DlogNFA}=\alpha_{24}\log(\hat{NFA}/NFA)+\alpha_{25}\log(PMGS_f\cdot E\cdot MGS/PXGS\cdot XGS), \qquad \alpha_{25}<0, \tag{12}$$

where

$$\hat{NFA}=\gamma_{11} e^{\beta_{19}[i_f+\log(FR/E)-i_{TIT}]}(PY)^{\beta_{20}}(PF_f\cdot E\cdot YF)^{\beta_{21}}, \tag{12.1}$$

Monetary authorities' reaction function on money supply

$$Dm=\alpha_{26}(\hat{m}-m)+\delta_3 Dh+\delta_4 Dr, \tag{13}$$

where

$$\hat{m}=m^*+\{\delta_1[\text{Dlog}(PY)-(\rho_P+\rho_Y)]+\delta_2 Di_{TIT}\}, \qquad \delta_1\gtrless 0, \quad \delta_2\gtrless 0, \tag{13.1}$$

Taxes

$$\text{DlogT}=\alpha_{27}\log(\hat{T}/T), \tag{14}$$

where

$$\hat{T}=\gamma_{14}(PY)^{\beta_{22}}, \tag{14.1}$$

Public expenditure

$$\text{DlogG}=\alpha_{28}\log(\gamma_{13}Y/G)+\alpha_{29}\text{DlogY}, \qquad \alpha_{29}\gtrless 0, \tag{15}$$

Monetary authorities' reaction function on international reserves

$$DlogR=b\delta_5\log(E_c/E)+(1-b)\delta_6\log(\hat{E}/E)-\delta_7 DlogE+\delta_8\log(\hat{R}/R), \quad (16)$$

where

$$\hat{E}=PXGS/\gamma_{14}PF_f, \qquad \hat{R}=\gamma_{15}PMGS_f\cdot E\cdot MGS, \qquad b=\begin{cases}1 \text{ under fixed exchange rates,}\\ 0 \text{ under floating exchange rates,}\end{cases}$$

Inventories

$$DV=Y+MGS-C-DK-XGS-G, \quad (17)$$

Fixed capital stock

$$DlogK=k, \quad (18)$$

Rate of growth in money supply

$$m=DlogM, \quad (19)$$

Public sector's borrowing requirement

$$DH=PG-T, \quad (20)$$

Rate of growth in international reserves

$$r=DlogR, \quad (21)$$

Rate of growth in bank advances

$$a=DlogA, \quad (22)$$

Rate of growth in H

$$h=DlogH, \quad (23)$$

Balance of payments

$$PXGS\cdot XGS-PMGS_f\cdot E\cdot MGS+(UT_a-UT_p)-DNFA-DR=0. \quad (24)$$

TABLE A.2 - Variables of the Model

Endogenous

A	= nominal stock of bank advances
a	= proportional rate of growth of A
C	= private consumption expenditure in real terms
E	= lira-dollar spot exchange rate
G	= public expenditure in real terms
H	= public sector borrowing requirement
h	= proportional rate of change of H
i_{TIT}	= domestic nominal interest rate
K	= stock of fixed capital in real terms
k	= proportional rate of change of K
M	= nominal stock of money (M2)
m	= proportional rate of change of M
MGS	= imports of goods and services in real terms
NFA	= nominal stock of net foreign assets
P	= domestic price level
PXGS	= export price level
R	= nominal stock of international reserves
r	= proportional rate of change of R
T	= nominal taxes
V	= stock of inventories in real terms
W	= money wage rate
XGS	= exports of goods and services in real terms
Y	= real net domestic product and income
$\tilde{Y}$	= expected real net domestic product and income

Exogenous

E_c	= official lira-dollar parity under fixed exchange rates
FR	= forward exchange rate
i_f	= foreign nominal interest rate
PF_f	= foreign competitors' export price level (in foreign currency)
$PMGS_f$	= import price level (in foreign currency)
PROD	= labour productivity
t	= time
(UT_a-UT_p)	= net unilateral transfers, in nominal terms
YF	= real world income

TABLE A.3 - Characteristic Roots of the Model under Fixed Exchange Rates

Root	Asymptotic standard error	Damping period (quarters)	Period of cycle (quarters)
0.3114	0.2856		
-0.0009	0.0009	1094.092	
-0.0205	0.0021	48.780	
-0.0745	0.0225	13.428	
-0.0927	0.0200	10.784	
-0.3538	0.1857	2.826	
-0.3921	0.1987	2.550	
-0.4304	0.0753	2.323	
-0.9241	0.1230	1.082	
-4.6670	1.1415	0.214	
-0.0231 ±0.0253i	0.0073, 0.0065	43.286	247.845
-0.1674 ±0.0204i	0.0280, 0.0263	5.972	307.220
-0.2596 ±0.4125i	0.1365, 0.0571	3.852	15.232
-0.5202 ±0.14262i	0.0927, 0.0709	1.922	44.064
-1.4270 ±1.4043i	0.1936, 0.1498	0.701	4.474

TABLE A.4 - Characteristic Roots of the Model under Flexible Exchange Rates

Root	Asymptotic standard error	Damping period (quarters)	Period of cycle (quarters)
0.3109	0.2841		
-0.0009	0.0009	1091.703	
-0.0205	0.0021	48.773	
-0.0751	0.0237	13.314	
-0.0925	0.0200	10.814	
-0.4134	0.1209	2.419	
-0.9241	0.1230	1.082	
-4.6669	1.1415	0.214	
-0.0232 ±0.02521	0.0072, 0.0065	43.193	249.357
-0.1675 ±0.02181	0.0276, 0.0259	5.971	287.530
-0.2595 ±0.41111	0.1376, 0.0575	3.853	15.283
-0.3737 ±0.05911	0.1040, 0.0836	2.676	106.280
-0.5278 ±0.13941	0.0914, 0.0573	1.895	45.058
-1.4270 ±1.4043i	0.1936, 0.1498	0.701	4.474

TABLE A.5 - Sensitivity Analysis with Respect to Selected Parameters under Flexible Exchange Rates

Root (μ)	$\partial\mu/\partial\alpha_5$	$\partial\mu/\partial\alpha_8$	$\partial\mu/\partial\alpha_{14}$	$\partial\mu/\partial\alpha_{15}$	$\partial\mu/\partial\alpha_{16}$	$\partial\mu/\partial\alpha_{24}$	$\partial\mu/\partial\beta_6$	$\partial\mu/\partial\beta_7$	$\partial\mu/\partial\delta_8$
0.3109	-0.3153	-1.1513				2.9454			
-0.0009							0.0987	-0.0054	
-0.0751							0.239	-0.076	
-0.1675 ±0.0219i		0.0476	0.3585						
-0.2595 ±0.4111i		-0.5064							
-0.3737 ±0.0591i				0.4899	-0.2342				-0.3068

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