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TRIGGER STRATEGIES AND PRICE DYNAMICS IN EQUITY AND FOREIGN EXCHANGE MARKETS

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ABSTRACT

Trigger strategists may be defined as actors in asset markets who buy or sell when the price reaches a predetermined level; they include participants in portfolio insurance schemes in equity markets and central banks who intervene to defend an exchange rate target zone. This paper presents an approach to modelling the effects of trigger strategists, with emphasis on how target zones affect market expectations. It is shown that commitment to defend a target zone will generate stabilizing expectations within the band, which may generate a "target zone honeymoon", an extended period in which the announcement of a target zone stabilizes exchange rates without any need for action on the part of authorities. However, an imperfectly credible target zone is vulnerable to crises in which the market tests the authorities' resolve.

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A striking feature of financial markets in the 1980s is the presence of important participants who follow what we can call <u>trigger strategies</u> -- that is, who commit themselves to buy or sell when the price reaches some pre-determined level. In equity markets the trigger strategy is followed by private investors participating in portfolio insurance schemes, who order their computers to sell stock when the price drops below a specified level. In foreign exchange markets the trigger strategy is followed by central banks, who intervene when the exchange rate reaches the limit of a target zone.

There are many questions that need to be answered regarding trigger strategies. When followed by private agents, are such strategies rational? When followed by central banks, are they welfare-improving? However, the first question we need to ask is a descriptive one: how does the presence of trigger strategists affect the dynamics of market behavior? Even this is a highly disputed question in practice. Many observers blame portfolio insurance schemes for the massive collapse of world equity prices in October 1987; others dismiss the idea. Defenders of the European Monetary System claim that the presence of intervention limits gives rise to stabilizing expectations; critics believe that the limits create targets for speculative attacks and are ultimately destabilizing.

This paper presents an approach to modelling the effects of trigger strategies on price dynamics. The underlying method is to determine an equilibrium relationship between the "fundamentals" that drive an asset market and asset prices. The presence of a large group of trigger strategists alters this equilibrium in certain characteristic ways, which turn out to have a surprisingly simple geometrical interpretation in terms of the concavity or convexity of the relationship between fundamentals and prices. Similar issues have been discussed in earlier work on price dynamics, notably that of Flood and Garber (1983), but the particular approach taken here is new, and seems to yield simpler results.

The paper begins by laying out a simple model of pricing in an equity market, then shows how this pricing is altered by the presence of a large group of portfolio insurers. It then turns to the more difficult case of exchange rate determination under a target zone regime, including the case where the commitment of central banks to defense of that zone is imperfectly credible. While these two examples are of considerable interest in their own right, the paper has a broader purpose as well: the method developed here seems likely to be useful in a variety of applications.

PROGRAM TRADING AND EQUITY PRICES

A model of equity pricing

We begin by laying out a simple model of the determination of prices in an equity market. This model is in the tradition of financial market modelling associated with Tobin (1969): that is, it is a model of portfolio balance in which asset demands are presumed to arise from some maximizing behavior, but are not explicitly derived from utility maximization under uncertainty. In particular, we will consider only the effects of changes over time in expected returns in affecting asset demands, ignoring the possible effects of changes in higher moments of the return.

Consider, then, an asset which we take to represent the aggregate of an equity market. This asset yields a dividend per period of R_t, which fluctuates over time according to a process to be described below. The asset has a price P_t, so that the expected rate of return from holding the asset from period t to period t+1 is

$$(1)\ \pi_t = ({}_tP_{t+1} + R_t)/P_t - 1$$

where ${}_tP_{t+1}$ is the expected price in t+1 as of period t.

The owners of equity consist of two kinds of people: portfolio insurers, and other investors. The non-insurers are willing to hold a value of equity that depends on the expected rate of return:

$$(2)\ P_tQ = H(\pi_t)$$

where Q is the number of stocks they hold.

To facilitate analysis, we approximate (2) by a log-linear function, so that

$$(3)\ p_t + q = \alpha + \beta(r_t - p_t) + \gamma({}_tp_{t+1} - p_t)$$

where lower-case letters represent natural logarithms. This may be rewritten

$$(4)\quad p_t = (1 + \beta + \gamma)^{-1}[\alpha - q + \beta r_t + \gamma({}_t p_{t+1})]$$

We next introduce the portfolio insurers. They are assumed to initially hold a block of stocks, which they will sell whenever the price drops below a predetermined level p^*. Thus in equilibrium the non-insurers must hold the rest of the stocks until the price first drops below p^*, and all of the stocks thereafter:

$$(5)\quad \begin{aligned} q &= \bar{q} - q^* \quad && \text{if } \min(p) \geq p^* \\ &= \bar{q} && \text{if } \min(p) < p^* \end{aligned}$$

where $\bar{q}$ is the logarithm of the total number of stocks outstanding.

To complete the model, we need to specify how r_t, which is the only "fundamental" in the model, changes over time. It will be assumed that r_t follows a random walk, of the form

$$(6)\quad \begin{aligned} r_{t+1} &= r_t + \delta \qquad && \text{with probability } 0.5 \\ &= r_t - \delta && \text{with probability } 0.5 \end{aligned}$$

This discrete random walk may appear somewhat special. However, it may be defended at three levels. First, it can be used to approximate as closely as one likes a continuous diffusion process, which is a popular assumption in the finance literature; note that the variance of $r_{t+n} - r_t$ is simply $\delta^2 n$. Second, the absence of drift or more complex dynamics in the fundamental can be viewed as a way to eliminate all dynamic complications arising from sources other than trigger strategies, and thus as a useful way to concentrate on the problem at hand. Finally, the discrete random walk assumed here is more convenient than a continuous process when we come to deal with the lack of "smoothness" that we will see is a characteristic feature of markets containing trigger strategists.

We have now laid out the basic elements of the model. The next step is to analyze the dynamics of prices.

Expectations and price behavior

To analyze the dynamics of price behavior, we must move away from representing variables as functions of time. Instead, we think of the fundamental as taking on values corresponding to "steps" of width δ. Let step 0 represent the position corresponding to the value of r_t at some arbitrary date. Then any subsequent realization of r can be labelled by the number of steps i it is from this reference r, with

$$(7)\quad r(i+1) = r(i) + \delta$$

What we now want to look for is a relationship between the returns r(i) and the price of equity p(i). That is, we are looking for a function that relates fundamentals to prices. If we can find a function that will provide incentives to investors to behave in the way the function predicts, we will in fact have found an equilibrium.

As a first step, let us imagine what would happen if the investors who are not portfolio insurers had static expectations, not expecting the price of the equity to change in any predictable way. If ${}_tp_{t+1} = p_t$, then from (4) we have

$$(8)\quad p(i) = (1 + \beta)^{-1}(\alpha - q + \beta r(i))$$

This would lead to the situation illustrated in Figure 1. As long as the portfolio insurers were still in the market, the price of equity would fluctuate along the line E^1E^1, defined by the equation $p(i) = (1 + \beta)^{-1}(\alpha - (\bar{q}-q*) - \beta r(i))$. Once the portfolio insurers had left the market, the price would fluctuate along the line E^2E^2, defined by $p(i) = (1 + \beta)^{-1}(\alpha - \bar{q} - \beta r(i))$. The price after the portfolio insurers have left must be lower for any given dividend rate, because the other investors have to be given an incentive to hold a larger quantity of stock.

In this static expectations world, it is easy to see how portfolio insurance schemes can cause a stock market crash. Suppose that initially the insurers are present, so that the price fluctuates along E^1E^1. Then at some point the random motion of r will bring the market to the point C, precipitating the exit of the insurers and pushing the market into the other regime: that is, a small (perhaps infinitesimal) negative shock to the fundamentals produces the Collapse of the Dow (D).

This may be a pretty good story for what happened on October 19. However, in general we would not expect market dynamics to be so simple, because the non-programmatic investors have an obvious incentive to foresee such events. Thus we next turn to the question of what happens if the market has rational expectations, which take into account the effects of portfolio insurance schemes on future prices.

It is helpful to define a new variable: the deviation of the equity price from what it would have been if expectations were static. This may be written as

$$(9)\quad d(i) = p(i) - (1 + \beta)^{-1}(\alpha - q - \beta r(i))$$

Now from any step i there is an equal probability that the market will move to steps i−1 and i+1. Using this, together with equation (4), we can write a difference equation in d(i):

$$(10)\quad d(i) = (\gamma/2)(d(i+1) + d(i-1))/(1 + \beta + \gamma)$$
$$= (\nu/2)(d(i+1) + d(i-1))$$

Notice that this is <u>not</u> a difference equation over time: it is a difference equation defined over "steps". Its solution will determine the value of p as a funtion of i and thus implictly as a function of the fundamental r(i).

The difference equation (10) has two roots, both real with no imaginary parts:

$$(11)\quad \rho_1 = (1 + (1 - \nu^2)^{1/2})/\nu > 1$$

$$\rho_2 = (1 - (1 - \nu^2)^{1/2})/\nu = 1/\rho_1 < 1$$

The equilibrium relationship between i and d(i) must take the form

(12) $d(i) = A\rho_1^i + B\rho_2^i$

where A and B may change when the regime shifts from one with the portfolio insurers present to one in which they are gone.

To determine equilibrium values of A and B, we need one further, though reasonable assumption. This is that $d(i)$, the deviation of the price from its static expectations level, is bounded to some maximum values both positive and negative. (Any non-infinite bound will do). This is effectively a "no speculative bubbles" assumption, of the kind now very familiar, and it is made without apology.

Given this assumption, we may quickly determine the equilibrium for the regime <u>after</u> the portfolio insurers have sold out. Under this regime, i may take on any value, and will if we give it long enough to walk randomly around. This means, however, that for any nonzero A or B we will see $d(i)$ exceeding its bound: as i goes to $+\infty$ we have ρ_1^i becoming unbounded, while as i goes to $-\infty$ we have $\rho_2^i = 1/\rho_1^i$ doing the same. So in the post-insurance regime the only equilibrium is where $d(i) = 0$ always. This corresponds to the case where the price always lies on the line E^2E^2 in Figure 1.

Until the portfolio insurers drop out, however, we may have a more interesting equilibrium. The reason is that under this regime i has a lower bound -- the point at which the portfolio insurers leave the market. It is still possible that i can range up to $+\infty$, so that to rule out speculative bubbles we must have $A = 0$, but it is still possible to have a nonzero B. Thus in the regime where insurers have not yet sold out we have

$$(13)\quad d(i) = \rho_2 d(i-1)$$

The fundamentals-price relationship in this regime is tied down by the fact that when the price falls below the trigger level, there is a transition to the other regime. So the overall picture must be as shown in Figure 2. The curve labelled E^1 describes the behavior of prices while the portfolio insurers are still in the market. Eventually random walking of r will bring the market to C, leading the insurers to drop out. After that point, the market's behavior will be described by the schedule labelled E^2.

<u>The geometry of trigger strategy equilibrium</u>

The equilibrium illustrated in Figure 2 has a useful interpretation that will be crucial in understanding the more complex case of a target zone system treated in the remainder of the paper. Notice that in the case where portfolio insurers have not yet dropped out, the equity price lies below that which would prevail with static expectations -- that is, it must be the case that the price is expected to fall. But how is this possible, given that earnings follow a random walk? The answer lies in the <u>concavity</u> of the relationship between r and p. Because of the curvature of the relationship, Jensen's inequality applies and the expected change in p is negative. This observation can be turned around: whenever p lies below its static-expectations locus, the fundamentals-price relationship must be concave (and whenever p lies above, it must be convex). This provides a rule for quickly analyzing the qualitative characteristics of price behavior in trigger strategy equilibria, as we will see in the target zone case as well.

Note also what happens at point C, where the portfolio insurers drop out. When the non-insurers have rational expectations, there is no step drop in p; instead, the pre-programmed sale of assets is willingly purchased. The reason for this is the change in the curvature of the fundamentals-price relationship. Just before the sell-out, this relationship is concave; just after, it becomes linear. The expected change in p therefore goes from negative to zero, implying a willingness of investors other than participants in portfolio insurance schemes to hold more equities -- with the equilibrium being constructed so that what they are willing to buy exactly matches what the portfolio insurers proceed to sell.

EXCHANGE RATE BEHAVIOR WITHIN A TARGET ZONE

We now turn to the more elaborate issue of how the presence of an exchange rate target zone -- a band within which the exchange rate is supposed to remain, and which central banks are expected to somehow defend if necessary -- affects exchange rate behavior. Clearly the fact that the exchange rate will not be allowed to go outside the band must have an effect on expectations within the band; we would expect that as the exchange rate nears the top of the band it will be perceived that it has more room to go down than up, and conversely at the bottom of the band. This in turn should produce stabilizing expectations that tend to keep the exchange rate within the band even when the band is not actively being defended. The objective here is to take these vague expectations and justify them with a clear model. As we will see, the possibility of an imperfectly credible target zone, and the corresponding risk of crisis, can also be accommodated within this framework.

The basic model

As in the equity market model, we consider a situation where the exchange rate reflects both fundamentals and expected appreciation and depreciation. In the target zone model, however, it is also useful to make a distinction between the "shadow" exchange rate, which is the exchange rate that would prevail at each moment if there were no action taken by the central banks, and the actual exchange rate. Inside the target zone the shadow rate and the actual coincide, but when the shadow rate lies outside the band the actual rate is constrained to lie at the band's upper or lower limit.

Expressed in natural logarithms, the shadow rate is determined as follows:

$$(14)\quad \hat{s}_t = x_t + \varepsilon({}_t s_{t+1} - s_t)$$

where x_t represents the "fundamentals" that ultimately drive the exchange rate. A pure monetarist approach might identify x with domestic credit, which is allowed to be reflected in money inside the band but is offset by intervention when the limits are reached; however, the model need not be construed in this particular fashion, and x could represent the sum of a more general set of influences.

The relationship between fundamentals, expected future rate, and shadow exchange rate may be rewritten

$$
\begin{aligned}
(15)\quad \hat{s}_t &= (1/(1+\varepsilon))x_t + (\varepsilon/(1+\varepsilon))_t s_{t+1} \\
&= (1-\lambda)x_t + \lambda_t s_{t+1}
\end{aligned}
$$

We assume that the fundamental x_t follows a discrete random walk:

$$
\begin{aligned}
(16)\quad x_{t+1} &= x_t + \delta \quad \text{with probability } 0.5 \\
&= x_t - \delta \quad \text{with probability } 0.5
\end{aligned}
$$

Finally, the actual exchange rate depends on the shadow exchange rate and on the target zone. We assume that the exchange rate is not allowed to go above a maximum value of $\bar{s}$ or below a minimum value of $\underline{s}$. The determination of the actual rate is therefore described by

$$
\begin{aligned}
(17)\quad s_t &= \bar{s} \quad \text{if } \hat{s}_t > \bar{s} \\
&= \hat{s}_t \text{ if } \bar{s} > \hat{s}_t > \underline{s} \\
&= \underline{s} \text{ if } \hat{s}_t < \underline{s}
\end{aligned}
$$

Exactly how this band is enforced will not be specified. Again in a purely monetary model we could envisage unsterilized intervention that offsets domestic credit creation when the exchange rate hits the limits of the band, but the general framework can be considered to apply to other policy measures as well.

It will be helpful if we choose units so that the target zone is centered around a zero logarithm of the exchange rate:

$$(18) \quad \underline{s} = - \bar{s}$$

We can then conveniently label the "step" corresponding to a zero x_t as zero, so that (again using the notation that relates variables to steps rather than time periods)

$$(19) \quad x(i) = i\delta$$

<u>Exchange rate behavior inside the target zone</u>

Inside the target zone the actual exchange rate is equal to its shadow value. What we want to do is find a function relating the exchange rate to i, which is then implicitly a relationshup between s and x. If there were static expectations, s(i) would simply equal x(i); this provides a useful reference line. Define d(i) as the difference between the exchange rate and the fundamentals,

$$(20) \quad d(i) = s(i) - x(i)$$

Then from (15) and (16) we have

$$(21)\quad d(i) = (\lambda/2)d(i+1) + (\lambda/2)d(i-1)$$

This difference equation has two positive, real roots:

$$(22)\quad \rho_1 = \lambda^{-1}[1 + (1 - \lambda^2)^{1/2}] > 1$$
$$\rho_2 = \lambda^{-1}[1 - (1 - \lambda^2)^{1/2}] = 1/\rho_1 < 1$$

Any solution inside the band must take the form

$$(23)\quad d(i) = A\rho_1^i + B\rho_2^i$$

This may be simplified by exploiting the symmetry we have imposed on the problem. Since the band is centered around zero, and since there is no drift in the assumed process generating fundamentals, the exchange rate should be symmetric around zero. In particular, s(0) must equal zero. This can only be true if B = -A, so that the solution takes the form

$$(24)\quad d(i) = A[\rho_1^i - \rho_2^i]$$

We can confirm that this is indeed a symmetric function, by noting that

$$(25)\quad d(-i) = A[\rho_1^{-i} - \rho_2^{-i}]$$
$$= A[\rho_2^i - \rho_1^i]/\rho_1^i\rho_2^i$$

$= -d(i)$

We can immediately make a guess about what the relationship between fundamentals and the exchange rate must look like; this is shown in Figure 3. Within the band the exchange rate must lie along an S-shaped curve, lying below the 45° line in the upper half of the band, above the 45° line in the lower half. In the right hand part of the S the curve is concave, providing through Jensen's inequality the expected decline in the exchange rate that in turn keeps the curve below the 45° line. In the left hand part of the S the curve is convex, providing the expected rise that keeps the rate above the line. A curve of precisely this shape will be generated by equation (24) if A is negative: the deviation of the exchange rate from $x(i)$ will then be negative and growing for $i>0$, and reversed for $i<0$.

We know, then, the general shape of the exchange rate curve within the target zone. We can also see directly that the expectation that the target zone will be defended does stabilize exchange rates within the band. The slope of the S-curve is always less than 45°, so that changes in the fundamentals are reflected less than fully in the exchange rate; correspondingly, the exchange rate will remain within the band <u>without intervention</u> for values of x that would have placed s outside the band in the absence of a target zone.

To go further, it is necessary to tie down the S-curve. Algebraically, this means determining A in equation (24). Geometrically (and economically), what we need to do is determine the level of x (or equivalently the step i) at which the S-curve intersects the band. That is, at what level of the fundamentals do the authorities have to make good on their promise to defend an exchange rate target zone?

Tying down the ends of the S

Let I be the step at which the S-curve intersects the upper limit of the target zone. (It must correspondingly intersect the lower limit at -I, but the symmetry of the problem allows us to focus only on the upper end). The economic meaning of I is that when the fundamental drifts up to x(I) the exchange rate would overstep the bounds of the zone unless the authorities intervene. This implies that I is the lowest value of i such that

$$(26)\quad \hat{s}(I) \geq \bar{s}$$

Consider the elements determining the shadow exchange rate at the upper boundary of the target zone. The shadow exchange rate is a weighted average of the fundamentals, the exchange rate at the next lower step, and the exchange rate at the next higher step:

$$(27)\quad \hat{s}(I) = (1-\lambda)x(I) + (\lambda/2)s(I-1) + (\lambda/2)s(I+1)$$

This may be restated as a relationship between deviations from the fundamental level, as

$$(28)\quad \hat{d}(I) = (\lambda/2)d(I-1) + (\lambda/2)d(i+1)$$

where $\hat{d}(I) = \hat{s}(I) - x(I)$.

Now step I-1 lies inside the band, and therefore is determined by (24). This implies that it can be related to d(I), by the expression

$$(29)\quad d(I-1) = d(I)(\rho_1^{I-1} - \rho_2^{I-1})/(\rho_1^I - \rho_2^I)$$

From step I to step I+1 the actual exchange rate does not change: in both cases it lies at the top of the band, at $\bar{s}$. However, $x(I+1) = x(I) + \delta$. Thus

$$(30)\quad d(I+1) = d(I) - \delta$$

So (28) can be rewritten

$$(31)\quad \hat{d}(I) = (\lambda/2)[d(I)(\rho_1^{I-1} - \rho_2^{I-1})/(\rho_1^I - \rho_2^I) + d(I) - \delta]$$

We can now divide through by d(I) to get an expression for $\hat{d}(I)/d(I)$; the equilibrium is the lowest value of I for which this ratio is lower than one. We have

$$(32)\quad \hat{d}(I)/d(I) = (\lambda/2)[(\rho_1^{I-1} - \rho_2^{I-1})/(\rho_1^I - \rho_2^I) + 1 - \delta/d(I)]$$

The shape of (32) is illustrated in Figure 4. Define $\bar{I}$ as the step at which $x(i) = \bar{s}$. Then at I close to $\bar{I}$, d(I) is negative and close to zero, so that the third term in (32) becomes unboundedly large. On the other side, as I goes to infinity the third term vanishes and the expression approaches a limit of

$(\lambda/2)[1 + 1/\rho_1] < 1$

The curve must therefore cross 1 from above, giving us an equilibrium I.

<u>A numerical example</u>

Figure 5 shows a computation of the relationship between fundamentals and exchange rates based upon some quasi-realistic parameters. The assumptions are as follows:

Period length: 0.01 years

λ: 0.9975 (implies that 1 percent annual rate of expected depreciation reduces actual exchange rate by 4 percent).

δ: 0.02 (implies annual standard deviation of exchange rate in absence of target zone of 20 percent).

$\bar{s}$: 0.10 (target zone 20 percent wide, 10 percent above and below reference exchange rate)

In the absence of a target zone the exchange rate would simply move up and down the 45° line in Figure 5. It would cross the boundaries of the indicated band at "steps" 5 and -5, that is, when the fundamental x got 10 percent off its starting point. The commitment to defending the target zone creates stabilizing expectations that greatly widen the range of fundamentals that lead to an outcome within the band. Specifically, the crossing point I turns out to occur at step 17 -- that is, when the fundamentals are 34 percent away from their starting point.

Because of its strong effect in stabilizing expectations, a commitment to a target zone that is regarded as credible is likely to succeed in stabilizing the exchange rate for an extended period without actually requiring any action from the authorities. One measure of this stabilizing effect is the expected length of time that the exchange rate will remain inside the band without intervention. In this numerical example, there is a 50 percent probability that in the absence of a target zone the exchange rate would lie outside a 20 percent-wide band within 19 periods -- that is, within 0.19 years, or about 10 weeks. With a totally credible commitment by the authorities to defend such a 20 percent zone, there is a 50 percent probability that no action on the authorities' part will be necessary for 219 periods, or more than two years!

This seems to suggest that announcing a commitment to defend a target zone is a highly attractive action for politicians, since large rewards in exchange rate stability will result immediately, while the bill in terms of policy actions will not come due for some time. We can think of this as the "target zone honeymoon"; it is similar in a way to the initial capital inflows that result when a country with a crawling peg slows the crawl in an effort to reduce inflation (Connolly and Taylor 1984). A substantial honeymoon effect may well have taken place in 1987, when markets probably gave politicians more credit for a willingness to act than they deserved. However, in general we would expect the market to discount promises to some extent, so that the next question is what happens when the target zone is only partially credible.

Credibility and crises

Suppose that the market believes that there is only a probability ϕ that the announced target zone will actually be defended if challenged, and that with probability $1-\phi$ the exchange rate will actually be allowed to move beyond the band. This will clearly affect the dynamics of the exchange rate within the band: stabilizing expectations will be weaker, and the expected length of time before the authorities' resolve is challenged will be shorter.

Let I_{PC} be the step on which the target zone is tested in the case of partial credibility. What happens at this step is that an incipient movement of the exchange rate beyond the band either does or does not bring forth the promised defense. If the defense is provided, the authorities are now credible, and the exchange rate jumps to its full credibility level $s(I_{PC})$. If the defense is not provided, the market has discovered that it is living under a free float and the exchange rate jumps to its floating level $x(I_{PC})$. Thus the expected exchange rate at I_{PC}, which must equal the shadow rate at that point, is

$$(33)\quad \hat{s}_{PC}(I_{PC}) = \phi s(I_{PC}) + (1-\phi)x(I_{PC})$$

The challenge to the target zone therefore takes place at the lowest i for which $\hat{s}_{PC}(i) > \bar{s}$. With the expected exchange rate tied down at I_{PC} and $-I_{PC}$, the exchange rate behavior between these bounds is described by a "squeezed" S-curve obeying equation (24) and connecting these end points.

Figure 6 shows the exchange rate's behavior in our numerical example when the market believes that there is only a 50 percent chance that the authorities will actually defend the target zone. The 10 percent band is now challenged after only 8 steps from zero, that is, after fundamentals have moved 16 percent away from their starting point. There is still significant stabilization of the exchange rate within the band, but the expected longevity of the "target zone honeymoon" is greatly reduced: there is now a 50 percent chance that the band will be challenged within 49 periods, or about 6 months.

An interesting feature of the functioning of an imperfectly credible target zone is that more or less continuous movement of the fundamental determinants of the exchange rate gives rise to a discontinuous movement of the exchange rate itself: when the exchange rate drifts up to the edge of the zone, there is a "crisis" in which the exchange rate jumps. The reason why such crises are not ruled out by rational expectations is that the exchange rate may jump either way -- into the band or out of it -- with the expected jump being zero. However, the role of imperfectly credible target zones in generating crises may help explain why there are occasional "eras of turbulence" under managed exchange rates, a point noted by Mussa (1979).

CONCLUSIONS

This paper has offered a general method for analyzing markets containing trigger strategists, and two applications, of which the analysis of target zones is the more extensive and probably the most important.

The method is to look for an equilibrium relationship between the fundamental determinants of an asset price and its actual price. Surprisingly, the curvature of this relationship plays a crucial role, with concavity or convexity creating the expectations of rising or falling asset prices that drive deviations from the static expectations case.

The application to exchange rate target zones reveals three important features of such zones that are widely understood but not reflected in formal analysis. First, the presence of a commitment by authorities to keep the exchange rate within a band tends to stabilize the movement of the exchange rate even inside that band. Second, announcement of a target zone will normally provide a "target zone honeymoon": an extended period of time in which stabilizing expectations keep the exchange rate within the band without any need for official action. Third, an imperfectly credible target zone system will give rise to crises in which the market challenges the commitment of the authorities to defend the zone.

The models offered in this paper are of course highly simplified and abstract. However, the conclusions seem plausible, and the method used here can be applied to more complex and realistic models in the future.

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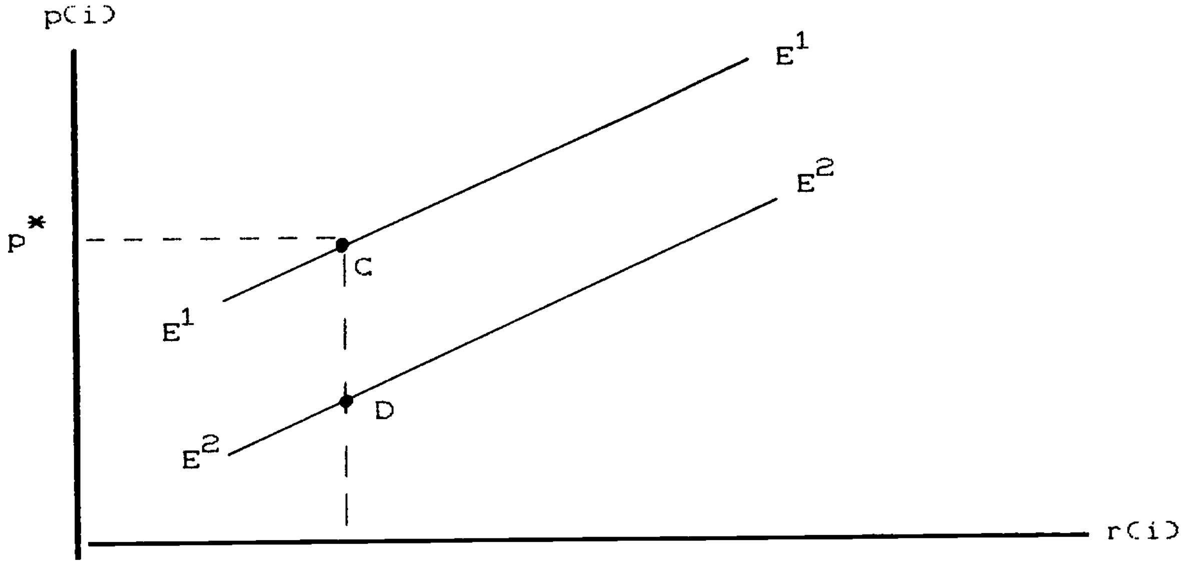


Figure 1: Portfolio insurance with static expectations

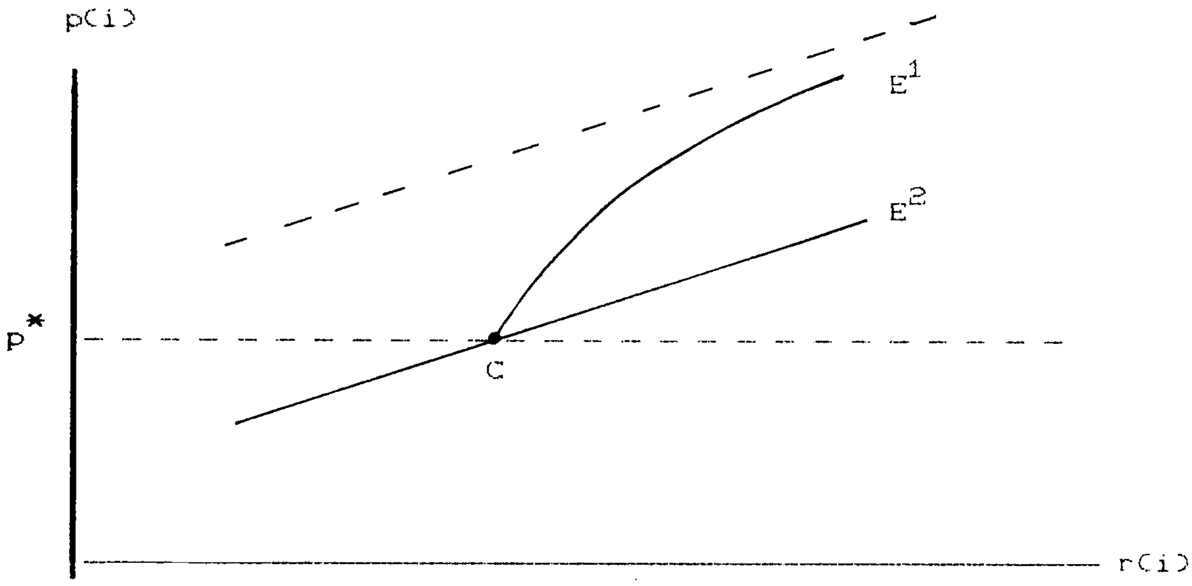


Figure 2: Portfolio insurance with rational expectations

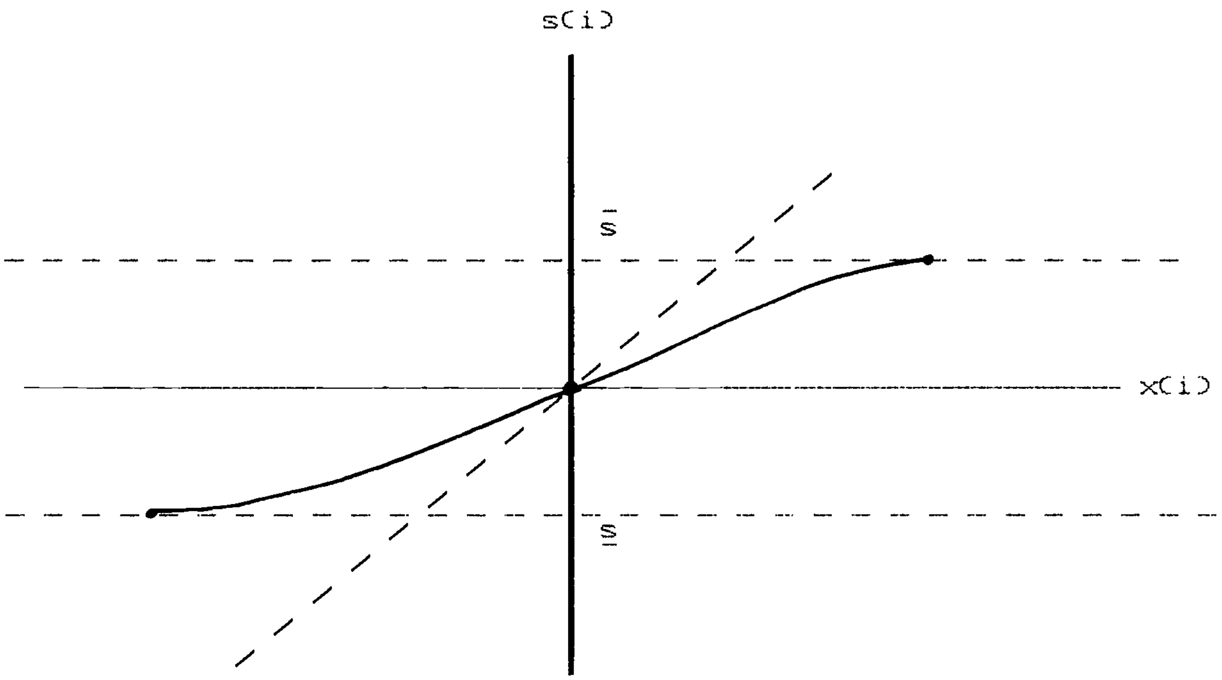
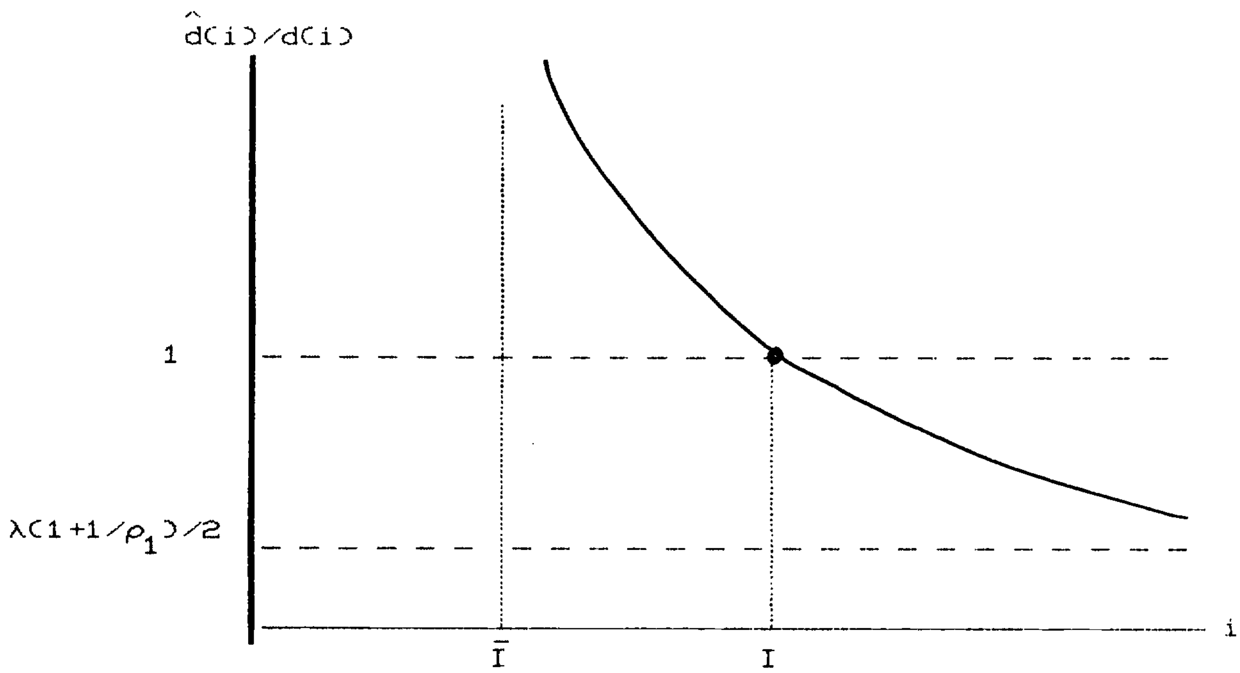


Figure 3: The fundamentals-exchange rate relationship



<u>Figure</u> <u>4</u>: Determination of I

FIGURE 5

Effect of target zone on exchange rate

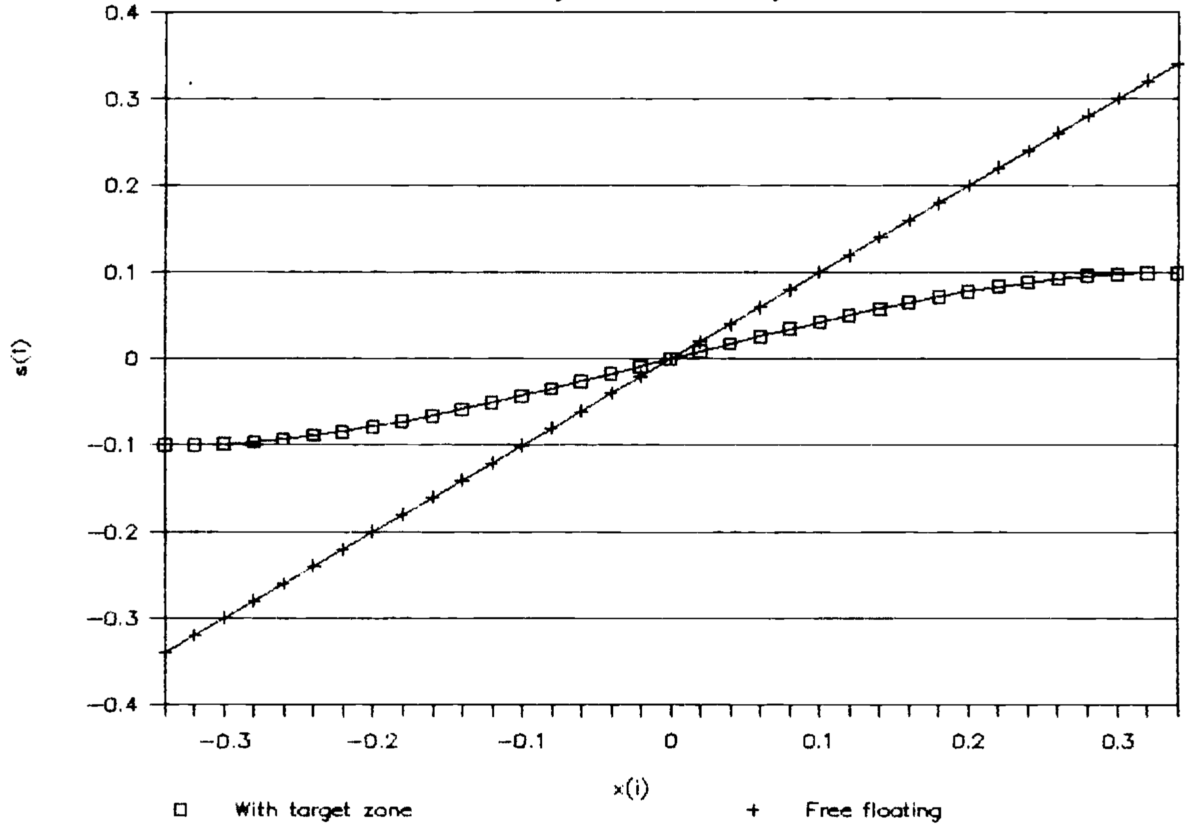
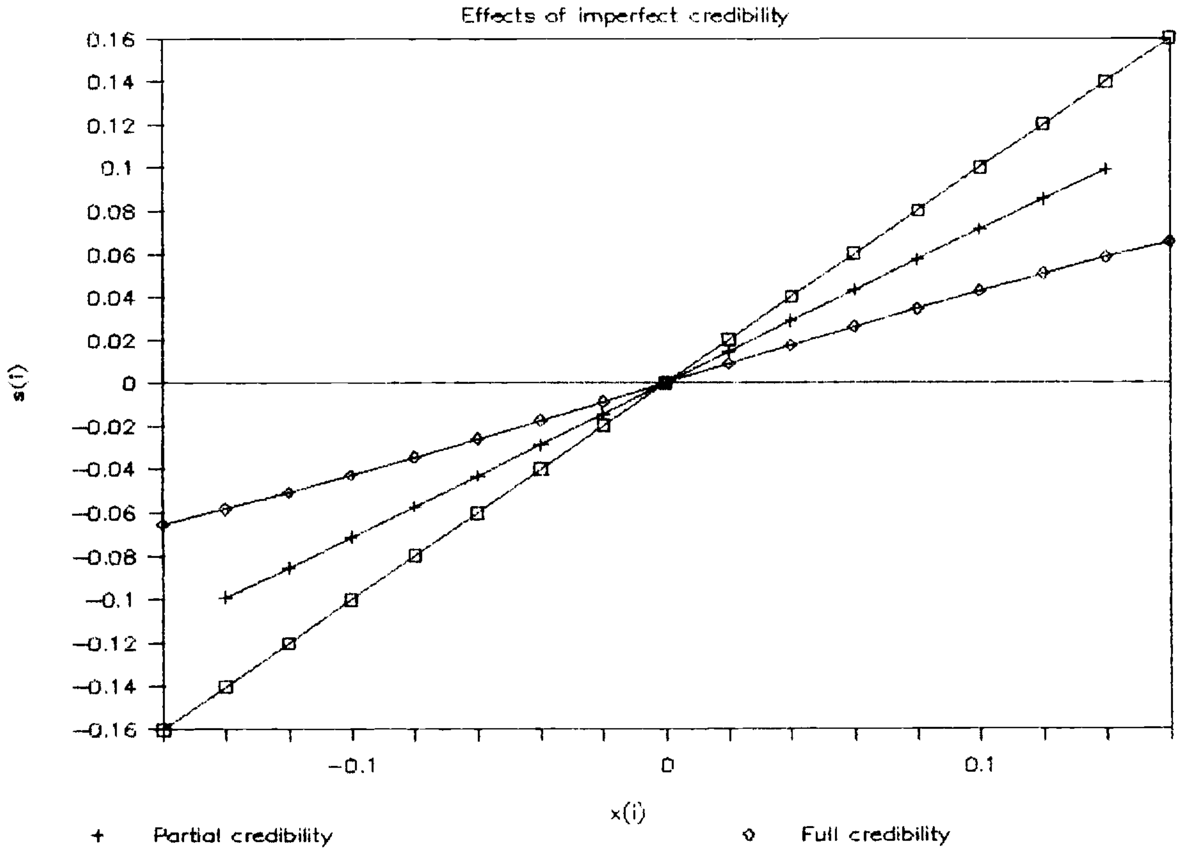


FIGURE 6


Effects of imperfect credibility
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
-0.16
s(i)
-0.1
0
0.1
x(i)
+ Partial credibility
◇ Full credibility