The Impact of Imperfect Credibility in a Transition to Price Stability*

Anamaria Nicolae[†]
University of Durham

Charles Nolan[‡]
University of Durham

May 2003

PRELIMINARY AND INCOMPLETE: PLEASE DO NOT CIRCULATE

Abstract

In this paper we study the impact of a temporary lack of credibility in a transition to price stability. We quantify the effects of a period of disinflation on temporary output losses, and the impact of the lack of credibility on the optimal speed of disinflation. We also demonstrate that the "disinflationary booms" found by Ball (1994) and King and Wollman (1999) disappear in an environment with imperfect credibility.

JEL Classification: E20; E32; F32; F41.
Keywords: Price stability; imperfect credibility; optimal speed of disinflation.

*Acknowledgements: The first-named author would like to acknowledge the support from the European Community's Phare ACE Programme 1998. The content of the publication, however, in no way represents the views of the Commision or its services.

[†]Department of Economics and Finance, 23/26 Old Elvet, Durham DH1 3HY. Tel +44 191 374 1818. E-mail: Anamaria.Nicolae@durham.ac.uk.

[‡]Department of Economics and Finance, 23/26 Old Elvet, Durham DH1 3HY. Tel +44 191 374 7273. E-mail: Charles.Nolan@durham.ac.uk. http://www.dur.ac.uk/charles.nolan/index.html.

1. Introduction

In this paper we study the effects of a disinflationary monetary policy when policy makers are committed to price stability in the strict sense of achieving and maintaining a constant price-level. The analysis takes place in an environment where the supply-side of the economy is characterised by monopolistically competitive firms, and where there is rigidity in the setting of prices. Recent research has revealed much about the effects of monetary contraction in such an environment.

For our purpose, three broad results stand out from this recent work. First, in the periods following a contraction in the money stock, real output is likely to fall below its (now altered) long-run equilibrium level. Second, a gradual disinflation may actually result in output, after its initial decline, rising above its new steady-state level, and remaining so for some time. And finally, it is optimal to end high inflations quickly, low inflations gradually, and maintain inflation at or near zero, thereafter. The key papers that develop these results are due to Ball (1994), Ireland (1997), King and Wollman (1999) and Khan, King and Wollman (2002). Important precursors to the analytical foundations of these results are contained in Danziger (1988), Benabou and Konieczny (1994) and Lucas and Stokey (1983), while the contributions of Sargent (1982) and Gordon (1982), as emphasized by Ireland, provide an important focus on policy implications of differential speeds of disinflation.

The theoretical papers just mentioned, and many others besides, assume perfect foresight (or rational expectations). For some purposes this assumption is obviously appropriate: what other assumption makes sense when one wishes to calculate the optimal inflation rate in, or in the neighborhood of, an unchanging steady state? However, the assumption of perfect foresight may be less attractive when one wishes to characterise the path of output in a transition to price stability, particularly if the initial inflation rate is high. Policymakers may also end up conducting inappropriate monetary policy (disinflating too quickly, perhaps) if they fail to recognise that their policies may not enjoy complete credibility. In this paper, therefore, we extend the above lines of enquiry to the case where monetary policymakers do not enjoy complete credibility initially. We model the monetary policymakers as doggedly pursuing the goal of price stability in the face of this imperfect, but improving, credibility.

Two important recent contributions address some of the issues we do. The first is Ball (1995). He demonstrates that if credibility is sufficiently low, a period of disinflation may lead to expected output losses. In his model agents harbour a nagging suspicion that the authorities will renege and give up on the path of disinflation. He models agents scepticism as a constant conditional probability of reneging. This may be a somewhat rigid way of modelling the evolution of agents' priors. On the one hand, as the disinflation proceeds it is plausible that agents accord increasing weight to the announced path for the money supply. On the other hand, perhaps as the disinflation proceeds and the extent of nominal rigidity in the economy optimally rises, the authorities may be more likely to renege (to exploit a flattening of the Phillips curve). We argue below that both these cases are intuitively plausible, and so we propose an 'expectations updating rule' that nests these alternatives. In addition, Ball (1995) leaves to one side the issue of the optimal speed of disinflation, a topic we take up here.

The second related paper is by Ireland (1995). He also finds that higher output losses are the price of imperfect credibility during a period of disinflation. However, the attainment of price stability is desirable (i.e., welfare enhancing) in general, except when the loss of seigniorage is replaced in the low inflation state by a rise in other distortionary taxes. Again, his modelling of the expectations formation process misses the effects to which we have just referred. In addition, we examine the issue of a lack of credibility in a more complex, but now standard, supply-side with a continuum of monopolistically competitive producers. This set up leads to some computational complexities related to the optimal choice of prices by firms who not only have to forecast future demand and cost conditions, but also have to forecast their covariances. This may be why these other authors focus on somewhat simpler supply-sides in their set-ups. We also extend Ireland's (1997) calculation of the optimal speed of disinflation to the case of imperfect credibility, and enquire whether or not imperfect credibility materially impacts on the optimal speed of disinflation, as compared to the situation under perfect foresight. This is a question of first-order policy importance but which, to our knowledge, has not been addressed hitherto in the class of models employed here, and which are proving popular for policy-oriented analyses.

1.1. Outline of the Paper

In the next section we outline our model and discuss its salient features. In section 3 we display some benchmark results that demonstrate the three key points we mentioned above. In section 4 we propose our expectations updating rule. In section 5 we analyze the impact of imperfect credibility during a period of disinflation. In Section 6 we conclude and offer some thoughts on areas for future research.

2. The Model

2.1. The Representative Agent

Our basic framework extends the perfect foresight model of Ireland (1997). Its component parts are now familiar in the literature and so we can develop the key equations somewhat briskly. The economy consist of many identical consumers. Each period a representative agent makes plans for consumption and leisure/labour such that (expected) present discounted value of utility is maximised. This measure of utility is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\alpha} - 1}{1-\alpha} - \gamma N_t \right\} \qquad \alpha, \gamma > 0, \tag{2.1}$$

and is separable consumption, C_t, and labour supply, N_t. $\beta \in (0,1)$ is a discount factor. Following Dixit and Stiglitz (1977), C_t is defined over a continuum of goods,

$$C_t = \left[\int_0^1 c_t(i)^{\frac{b-1}{b}} di \right]^{\frac{b}{b-1}} \qquad b > 0, \tag{2.2}$$

where $c_t(i)$ denotes, in equilibrium, the number of units of each good i from firm i that the representative agent consumes. b is the price elasticity of demand. $p_t(i)$ is the nominal price at which firm i must sell output on demand during time t. The Dixit-Stiglitz aggregate price level, P_t, at time t is given by:

$$P_t = \left[\int_0^1 p_t(i)^{1-b} di \right]^{\frac{1}{1-b}}. \tag{2.3}$$

Let N_t be given by:

$$N_t = \int_0^1 n_t(i)\, di,$$

where $n_t(i)$ denotes the quantity of labour supplied by the household to each firm i, at the nominal wage W_t, during each period. This assumption means that households effectively supply a portion of labour to *all* firms. The reason why we need such an assumption (and the one below regarding the representative agent's share portfolio) is to ensure that the marginal utility of wealth equalizes across agents.

Each period, the representative agent faces a budget constraint of the following sort:

$$\int_0^1 \left[Q_t(i)\, s_{t-1}(i) + \Phi_t(i)\right] di + W_t N_t \geq \int_0^1 \left[p_t(i)\, c_t(i) + Q_t(i)\, s_t(i)\right] di. \quad (2.4)$$

Here $Q_t(i)$ denotes the nominal price of a share in firm i, s_t denotes the quantity of shares, $\Phi_t(i)\, di = D_t s_t$, where D_t is the dividend associated with a unit share, and $\int_0^1 p_t(i)\, c_t(i)\, di = P_t C_t$ denotes aggregate nominal expenditure. We assume that for $t = 0$, $s_{-1}(i) = 1$, for all $i \in [0, 1]$. In effect, then, we are assuming that each household owns an equal share of all the firms for each good i. The constraint (2.4) says that each period (and, under uncertainty, in each state of nature) income (financial plus labour) can be worth no less then the value of expenditure (on non-durable consumption plus financial investment). The household problem, then, is to choose $c_t(i), n_t(i), s_t(i)$ and 'aggregate' consumption, C_t, such as to maximize (2.1) subject to the sequence of constraints (2.4), and the relevant initial conditions. Optimal household behaviour is described by the requirement that household consumption spending must be optimally allocated across differentiated goods at each point in time (i.e., the optimal $c_t(i)$). It can be shown that the Dixit-Stiglitz preference relation requires that purchases of each good i satisfies:

$$c_t(i) = C_t \left(\frac{p_t(i)}{P_t}\right)^{-b}. \quad (2.5)$$

As in Ireland (1997) it will simplify things somewhat if we let aggregate nominal magnitudes be determined in equilibrium by a quantity equation:

$$M_t = \int_0^1 P_t(i)\, c_t(i)\, di = P_t C_t. \quad (2.6)$$

An interior optimum for the agent's problem will include (2.4) with equality, (2.5) for all i, and the following conditions:

$$C_t^{-\alpha} = \lambda_t P_t; \quad (2.7)$$

$$\gamma = \lambda_t W_t. \tag{2.8}$$

And for all i

$$Q_t(i) = D_t(i) + E_t \beta(\lambda_{t+1}/\lambda_t) Q_{t+1}(i), \tag{2.9}$$

where λ_t is an unknown multiplier.

2.2. The Corporate Sector

There is a continuum of firms indexed by i over the unit interval, each of them producing a different, perishable consumption good. So, goods may also be indexed by $i \in [0,1)$, where firm i produces good i.

Each firm i sells shares, at the beginning of each period t, at the nominal price $Q_t(i)$, and pays, at the end of the period, the nominal dividend $D_t(i)$. The representative household trades the number of shares that it owns, $s_t(i)$, in each of the firms, at the end of each period t. Under market clearing, $s_t(i) = 1, \forall i \in [0,1]$, in each period. Firms are able to change prices each period, subject to a fixed cost. As a consequence, in equilibrium firms will not necessarily be willing to change prices in each period. The criterion for the price-setting decision at time t is to maximize the return to shareholders.

At time t we assume that firms are divided into two categories, such that firms from the first category can freely change their prices, $p_{1,t}(i)$, while the firms belonging to the second must sell output at the same price set a period before, $p_{2,t}(i) = p_{2,t-1}(i)$, unless they pay the fixed cost $k > 0$, measured in terms of labour. We may think of this cost as being associated with information collection and decision making. At time $t+1$, the roles are reversed and the first set of firms keep prices unchanged, $p_{1,t+1}(i) = p_{1,t}(i)$ unless they are willing to pay the fixed cost k while the second set of firms, can freely set new prices.

The model assumes, then, that firms are constantly re-evaluating their pricing strategy, weighing the benefits of holding prices fixed versus the alternative of changing prices and incurring the fixed penalty. However at moment t the firms belonging to the set of firms that can freely change price are able to choose between two strategies, depending on whether the inflation rate is moderate or high. At more moderate rates of inflation, they are more likely to keep their prices constant for two periods and hence avoid the cost k (single price strategy). On the other hand, in the case of a high inflation, to avoid the larger costs of price rigidity, firms choose a new price and pay the cost k (two price strategy).

We assume a simple linear production technology $y_t(i) = l_t(i)$, where $y_t(i)$ and $l_t(i)$ are output of firm i and the labour used to produce it, respectively. Let us denote aggregate out output as Y_t, then equilibrium profits at time t for firm i are given by,

$$D_t(i) = Y_t^{1-b} \left[Y_t^{1-\alpha} \left(\frac{p_t(i)}{M_t} \right)^{1-b} - \left(\frac{p_t(i)}{M_t} \right)^{-b} \right] - I_t(i) W_t(i) k. \tag{2.10}$$

While, in equilibrium, the units of labour supplied to each firm at nominal wage W_t are given by:

$$n_t(i) = Y_t^{1-b} \left(\frac{p_t(i)}{M_t} \right)^{-b} + I_t(i) W_t(i) k,$$

where

$$I_t(i) = \begin{cases} 1, & \text{if the firm pays the cost of price adjustment } k \text{ at moment } t; \\ 0, & \text{if the firm does not pays the cost } k \text{ at moment } t. \end{cases}$$

2.3. Single price strategy

Under this strategy firm i chooses $p_t(i)$ so as to maximize the expected present value of its profit:

$$\Pi(i)_t = D_t(i) + \beta E_t D_{t+1}(i). \tag{2.11}$$

It is straightforward to show that the price of firm i that will be used for two consecutive time periods is:

$$p_t(i) = \frac{b}{b-1} \frac{M_t^b Y_t^{b-1} + \beta E_t M_{t+1}^b Y_{t+1}^{b-1}}{M_t^{b-1} Y_t^{b-\alpha} + \beta E_t M_{t+1}^{b-1} Y_{t+1}^{b-\alpha}}. \tag{2.12}$$

This equation is familiar from the New Keynesian economics. It basically says that the optimal price will be a function of current and future anticipated demand and costs conditions, and where in steady state price will be a fixed mark-up over marginal costs. As is familiar in models of monopolistic competition based on Dixit-Stiglitz preferences, the markup is constant and determined by the elasticity of demand (that is, tied down via the preference side of the model), the lower the elasticity, the higher the mark-up.

2.4. Two price strategy

In this case, the firm needs to maximize the profit for each period, so it needs to choose the price $p_t(i)$ to maximise profits in each period

$$\Pi_t = D_t(i). \tag{2.13}$$

The optimising price in this case is given by:

$$p_t(i) = \frac{b}{b-1} \frac{M_t}{Y_t^{1-\alpha}}. \tag{2.14}$$

Here we see that prices are a mark-up as before, only now it is only current period demand and cost conditions that are relevant.

3. Some Benchmark Results Under Perfect Foresight

The parameterization of the model is relegated to an appendix.

We study the effect of a monetary policy that brings money growth to zero over some horizon. This was the approach adopted in Ireland (1997), following Ball (1994). Specifically, at period 0, the authorities make a surprise announcement about the path for the money supply, $\left\{M_s^A\right\}_{s=0}^T$, such that by time period T inflation will be zero. The superscript A indicates the 'announced' level of the money supply. This announced path for the money supply, in turn, implies a gradual decrease in the growth rate of the money supply. Let θ_t denote the growth rate of the money stock at time t. We study, then, processes for the money growth rate of the following sort:

$$\theta_t = \theta_{t-1} - \frac{\theta - 1}{T}, \tag{3.1}$$

for any value of t from 0 to $T-1$,where θ_{-1} is equal to the initial rate of inflation, and where $\theta_{t\,>\,T} = 1$. So, a horizon of time $T = 1$ entails immediate disinflation, while for $T > 1$ the policymakers engineer a more gradual path towards price stability.

Figure 3.1 shows the effect of an immediate disinflation on output when the initial inflation rate is 3% (the dashed line) and when the initial rate is 200% (the solid line, which is coincident with the x-axis). We see that at relatively low rates of inflation, disinflation is quite costly as firms follow a single-price strategy. The 'hump-shaped' response is due to the fact that the first set of firms to set new prices increase their price as they face a relatively large increase in demand for their products (since the firms that don't re-price have relatively high prices and hence relatively low demand). At higher rates of initial inflation, firms re-price every period (two-price strategy) and hence disinflation can proceed with no relative-price distortion.

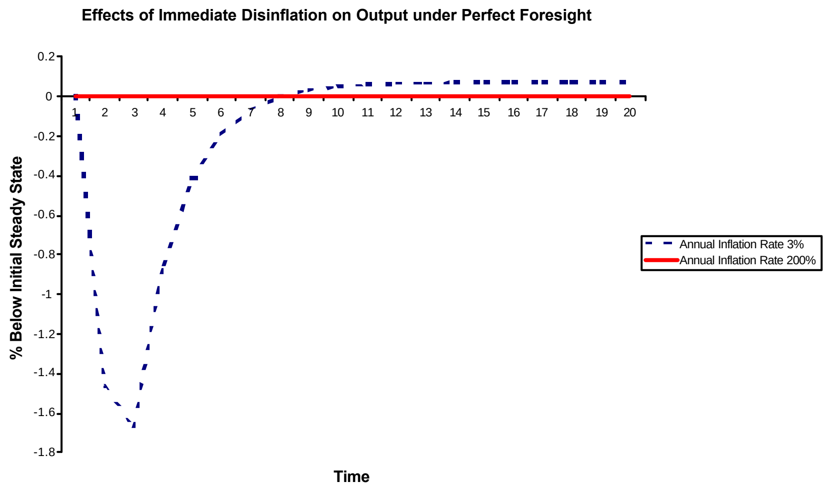

Figure 3.1:

Figures 3.2 and 3.3 show the effects of a gradual disinflation from 3% and 200% respectively. After the initial drop in output, a gradual disinflation leads to a boom in output–a relatively prolonged period of above-equilibrium output. Agents set prices for two periods, and because inflation will be lower in the future, they set lower prices today, causing a boom. At high initial rates of inflation, the loss in output in the initial periods is substantial. The problem is that with gradual disinflation from high rates of inflation, firms do not initially change their prices.

Finally, figure 3.4 shows the optimal speed of disinflation for initial inflation rates of between 1% and 20%. During big inflations firms are more likely to follow a two price strategy and hence under perfect foresight disinflation is costless. On the other hand, at relatively low rates firms are more likely to follow a single-price strategy and rapid disinflation is more likely to be costly.

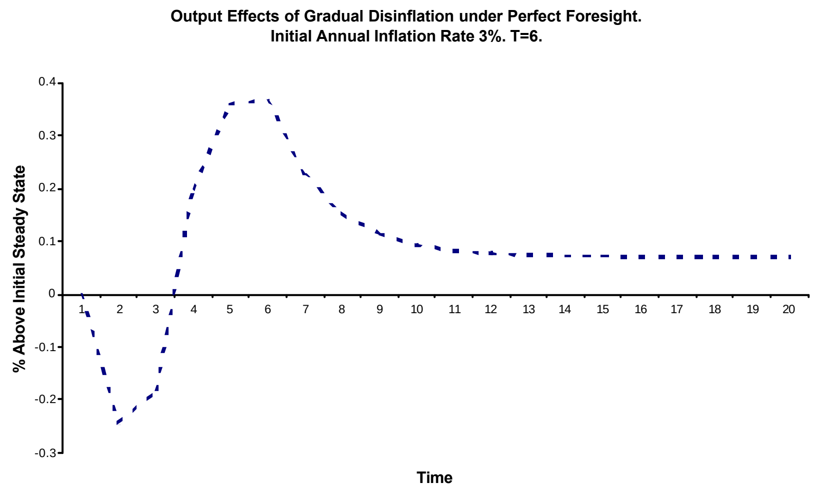

Figure 3.2:

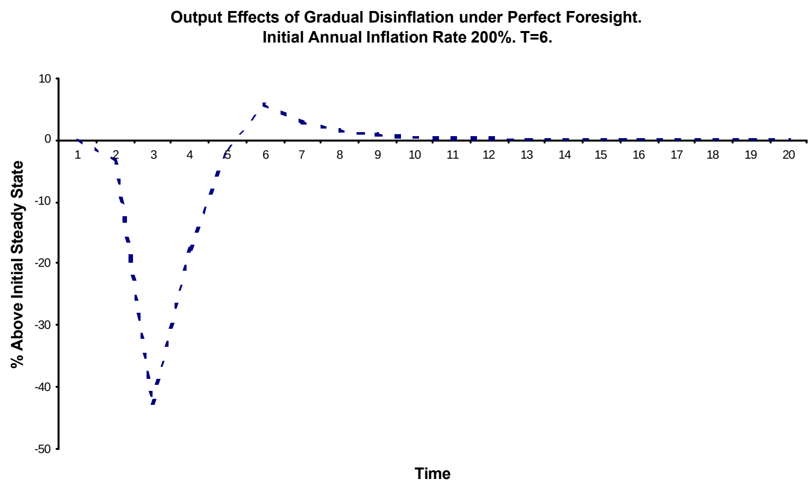

Figure 3.3:

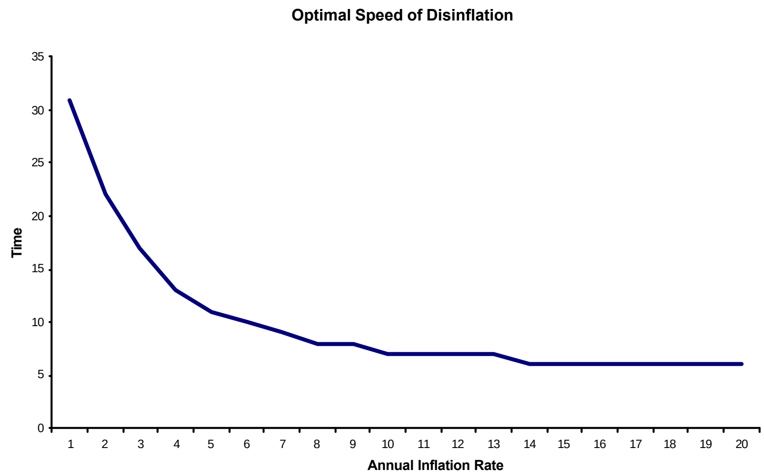

Figure 3.4:

4. Imperfect Credibility

In this section we consider what might happen when credibility is imperfect, but nevertheless improving through time. In other words we run variants of the above experiments in an environment where the probability mass characterising agents' subjective expectations is shifting through time onto the central bank's announced money supply path. Again the policy employed is to lower money growth linearly to zero over some time horizon, $T \geq 1$. To retain computational manageability, we assume that agents perceive of only two possible outcomes. One outcome is the monetary authority's announced path for the money supply. The other outcome is a reversion to an alternative, more inflationary, path for the money supply. There are two obvious choices for this alternative path: First, agents perceive the authorities as reverting to the previous steady state inflation rate. Second, alternatively, they fear the government will 'run out of steam' such that at time t (for $0 < t < T$) the growth rate of the money stock will be equal to the growth rate between $t-1$ and t. Algebraically, we can characterize these alternate expectations as follows:

$$E_{t+j-1}M_{t+j} = \rho_{t+j}\theta_{-1}M_{t+j-1} + (1-\rho_{t+j})M^A_{t+j}; \tag{4.1}$$

$$E_{t+j-1}M_{t+j} = \rho_{t+j}\theta_{t-1}M_{t+j-1} + (1-\rho_{t+j})M^A_{t+j}. \tag{4.2}$$

We will assume that the authorities stick to the announced path of disinflation, so in practice (4.1) and (4.2) may be rewritten as

$$E_{t+j-1}M_{t+j} = \rho_{t+j}\theta_{-1}M^A_{t+j-1} + (1-\rho_{t+j})M^A_{t+j};$$
$$E_{t+j-1}M_{t+j} = \rho_{t+j}\theta_{t-1}M^A_{t+j-1} + (1-\rho_{t+j})M^A_{t+j}.$$

In characterizing $\{\rho_s\}_{s=0}^{T+J}$ we need to decide on ρ_0, a measure of the initial level of credibility, the time it takes until $\rho_{T+J} = 0$, for $J \geq 0$, and the path of ρ_s in the transition between these extrema. One option is simply to let ρ_s converge linearly to zero in the following way:

$$\rho_t = \rho_{t-1} - \alpha\frac{\rho_0}{N} \quad t \geq 1, \tag{4.3}$$

where N the is period of the disinflation (measured in half-years) and $\alpha \in (0,1)$. α captures the time it takes for agents to believe completely the central bank's announcements–i.e., for a perfect foresight equilibrium to obtain. Let τ denote the period after which perfect foresight is obtained, then we see that,

$$\alpha = \frac{N}{\tau}.$$

However, there may be more plausible characterizations[1]. The following function is useful for capturing such paths:

[1] This linear path for ρ leads to results intermediate between those when ρ is concave and those when it is convex. The results showing this are available on request.

$$\rho_t = (-1)^{\delta} k(a^2 - (t - \delta a)^2)^{\frac{1}{2}} + \delta \rho_0, \tag{4.4}$$

where $\delta = 0$ or 1[2]. In the event that $\delta = 0$ it can be shown that ρ_t follows the simple recursive process:

$$\frac{\rho_t}{k} = \left\{ \left(\frac{\rho_{t-1}}{k}\right)^2 + (1 - 2t) \right\}^{\frac{1}{2}}. \tag{4.5}$$

On the other hand, if $\delta = 1$ then we have that

$$\frac{\rho_t}{k} = \left\{ \left(\frac{\rho_{t-1} - \rho_0}{k}\right)^2 + [1 - 2(t - a)] \right\}^{\frac{1}{2}} + \frac{\rho_0}{k}. \tag{4.6}$$

Given ρ_0, (4.5) plots the path $\{\rho_s\}_{s=0}^{T}$ as a concave function. This captures the intuitive idea that agents may be reluctant to update their priors initially. However, as time goes by and the central bank sticks to its announced money supply targets, they increasingly come to believe the announced target path. We shall refer to this case as *concave (expectations) updating*. On the other hand, (4.6) reflects a population who although happy to accept that the monetary authority dislikes the current relatively high rate of inflation worries that as the slope of the short-run Phillips curve flattens, the monetary authority may be tempted to renege. The importance of the exploitability of the Phillips curve has been recognized by Ball, Mankiw and Romer (1988) and is a crucial argument in the high inflation equilibria in games of the Barro and Gordon (1983) sort.[3] We refer to this as *convex (expectations) updating*.

[2] It can be shown that $a = N$ and $k = N/\rho_0$.

[3] Intermediate cases are possible to imagine, such as a truncated bell-shaped path for ρ. This would capture a situation in which agents initially place little weight on the authority's announcements, as in (4.5). However, after some time (characterised by an inflexion in the path of ρ), agents once again become more sceptical, as in (4.6). We ignore these alternate paths.

We still have two difficult questions to answer. First, what is a reasonable value for ρ_0, and at what point T do we have that $\rho_{s \geq T} = 0, \forall s$; how credible is the authority's announcement at date zero, and how long does it take for agents to 'arrive' at perfect foresight? We know of no studies that we can easily draw on to parameterize functions (4.5) and (4.6), so our approach has been to analyze the outcome of various thought experiments under many different parameterizations and to present the results we believe to be robust. We assume that $\rho_0 = 1$ in the rest of this paper.[4] Finally, we assume that $\rho_T = 0$ after three years. That is, agents finally believe the announcements when, and only when, price stability is actually achieved.[5].

5. The Effect of Imperfect Credibility

5.1. Concave Expectations Updating

Inevitably, the impact of imperfect credibility is to make disinflations more costly; the path of output to its new steady state differs from the path under perfect foresight, and the optimal speed of disinflation is likely to be more gradual for any initial inflation rate. And that cost seems likely to be more pronounced under concave updating as agents adjust initially only slowly to the announced new path for the money supply. In all of the charts that follow we assume that perfect foresight is attained in three years. The dashed line is the perfect foresight case, and the solid line is the imperfect credibility case. Figure 5.1 compares the path of output under perfect foresight and concave expectations updating, given an initial inflation rate of 3%.

[4] We experimented with a number of different initial values for ρ_0. The results presented were virtually unchanged for values of ρ_0 as low as 0.5.

[5] Permitting ρ to attain zero in a shorter period does not change our results much. If ρ takes a longer time to reach zero, output obviously also takes a longer time to reach its new steady state level.

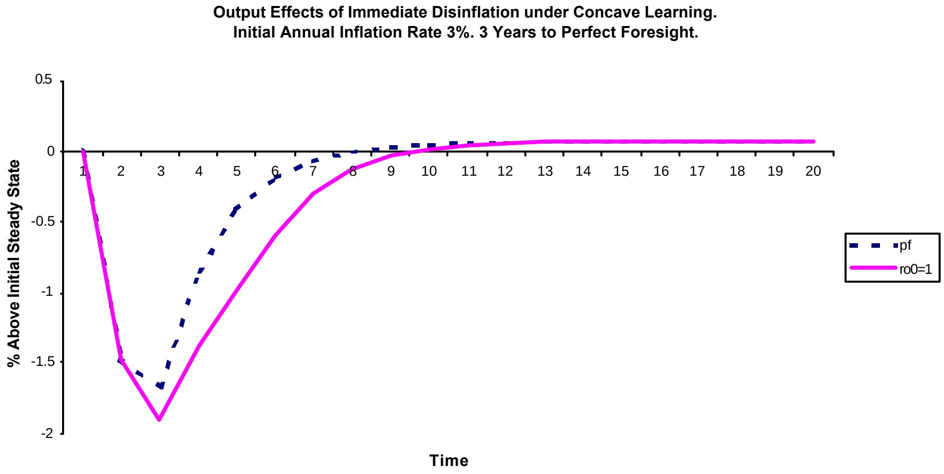

Figure 5.1:

The contraction in output is more pronounced and more protracted under imperfect credibility. And even though by period 6 agents in both economies have the same information, the effects of imperfect credibility remain for some time due to the overlapping nature of price setting.

One of the potentially counterfactual implications of the perfect foresight case was the implication of the 'disinflationary boom': i.e., the tendency for output to rise above its new steady state level under a gradual disinflation as agents anticipate lower future price-levels.

Figure 5.2 shows that under imperfect credibility this effect vanishes as output falls more sharply and does not rise above its new steady state value along the transition path. Agents only gradually come to realise that the price-level is to grow at a zero rate–a realization that is all the more tardy because of the gradualness of the disinflationary process itself. For very high initial inflation rates, the fall in output following an immediate disinflation is catastrophic as

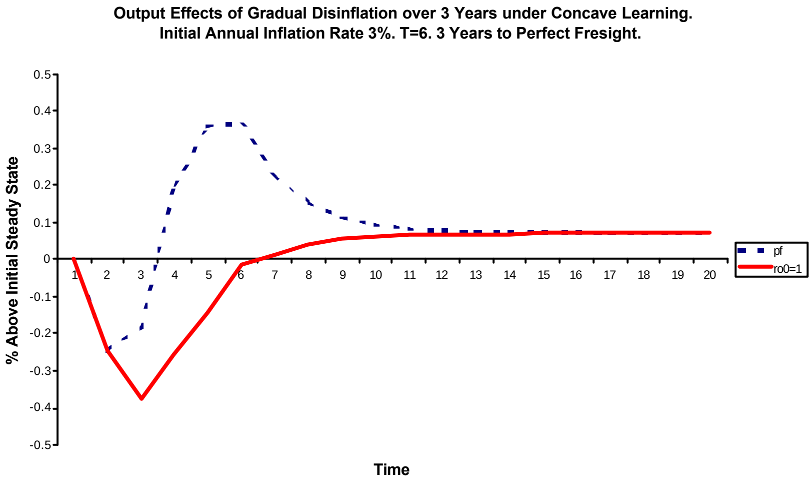

Figure 5.2:

figure 5.3 demonstrates and it is also of a similar order of magnitude under a more gradual disinflation, as figure 5.4 shows.

Given the extra cost imposed by imperfect credibility, what is the quantitative impact on the optimal speed of disinflation? Figure 5.5 reveals that a good ‘rule-of-thumb’ is that disinflations from initial rates between 2%-11% should take an extra year, as compared with the perfect foresight case. In contrast for inflation rates above 12% and less than or equal to 1% the optimal speed of disinflation is indistinguishable from the perfect foresight case.

The key reason that gradual disinflations are attractive is that, with some price stickiness and under perfect foresight, they often imply prolonged periods of above trend output and consumption. However, as the initial inflation rate rises the contraction in output in the early periods of the disinflation is more pronounced, increasingly offsetting the utility gain from the subsequent boom– the optimal speed of disinflation rises.

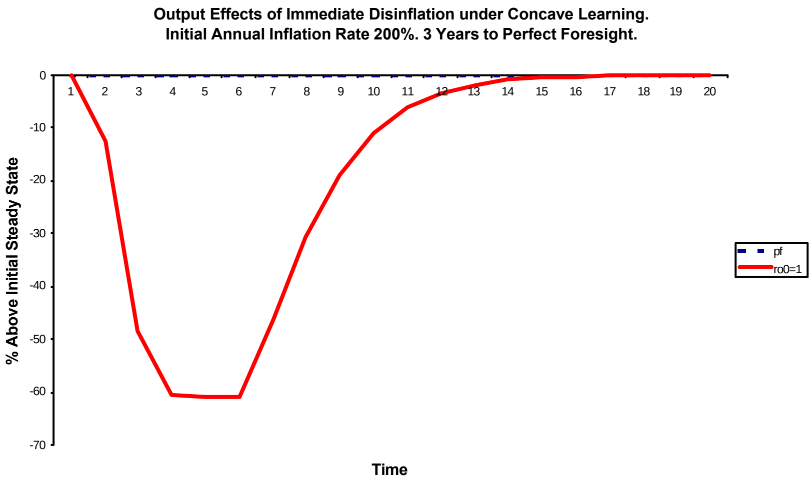

Figure 5.3:

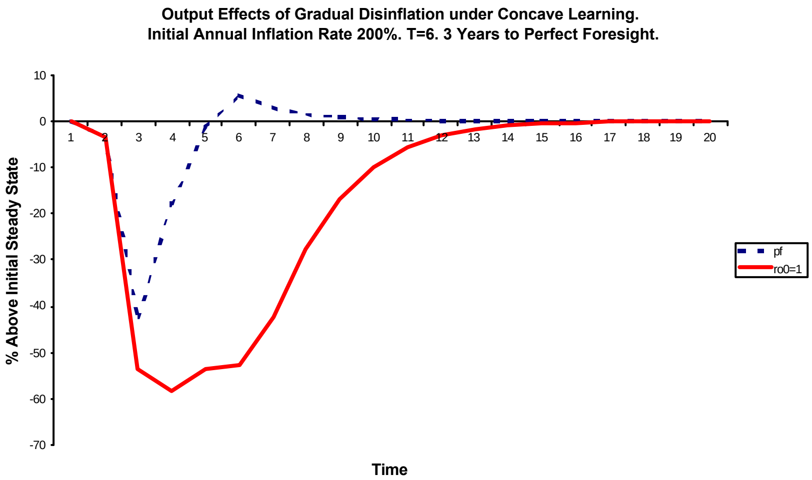

Figure 5.4:

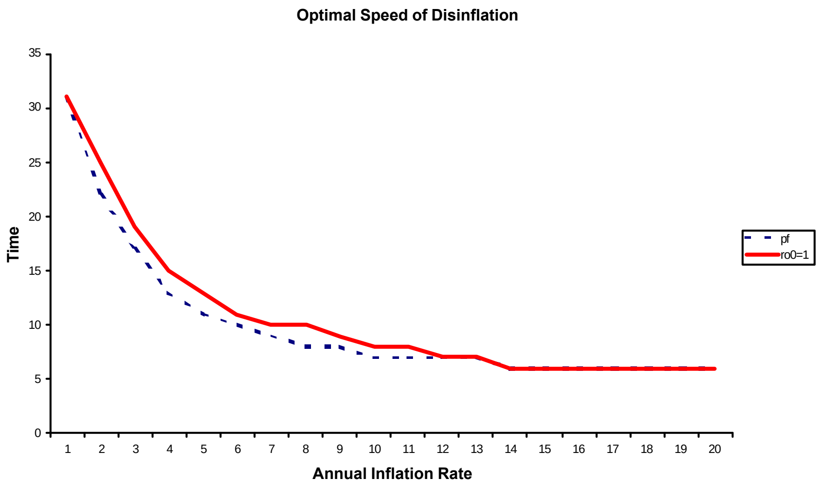

Figure 5.5:

Under imperfect credibility, the initial contraction in output is more severe for any initial inflation rate than is the case under perfect foresight. Furthermore, the utility gain from the disinflationary boom is absent as the disinflationary boom now no longer occurs. It turns out that a more gradual period of disinflation is optimal up until an initial inflation rate of around 12%. For initial inflation rates greater than 12% the optimal speed of disinflation is the same as under perfect foresight.

In short, therefore, under perfect foresight gradual disinflations are primarily about reaping the utility from output gains following an initial contraction in activity, while under imperfect credibility they are primarily aimed at avoiding over sharp contractions in activity in the early period of the disinflation. In this sense, the optimal speed of disinflation is crucially different as between perfect foresight and imperfect credibility.

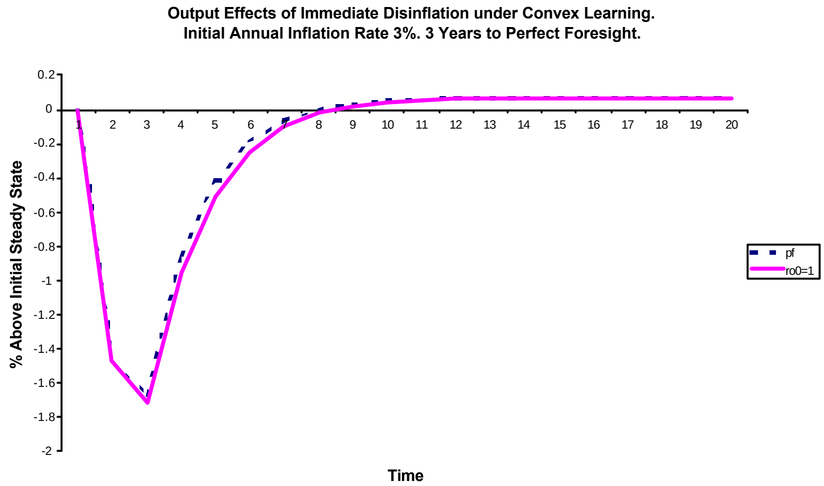

Figure 5.6:

5.2. Convex Expectations Updating

Many of the same qualitative results found under concave updating are present with convex updating. However, as is apparent from Figures 5.6-5.9, the outturns look closer to the case of perfect foresight compared with concave updating. The reason for this is that the convex path of ρ means that agents avoid some of the more costly mistakes early on in the disinflation that occur under concave updating. Figures 5.6-5.9 show the effects of disinflation policies as above only now under the assumption of convex updating.

Figure 5.6 shows that the drop in output under immediate disinflation leads to a drop in output more severe than, but close to, that under perfect foresight.

This tendency for agents to believe the authorities when they announce decreases in the rate of growth of money also permits disinflationary booms to occur, as figure 5.7 shows, for 'moderate' rates of inflation whilst such booms are absent for higher initial rates of inflation, as figure 5.8 demonstrates.

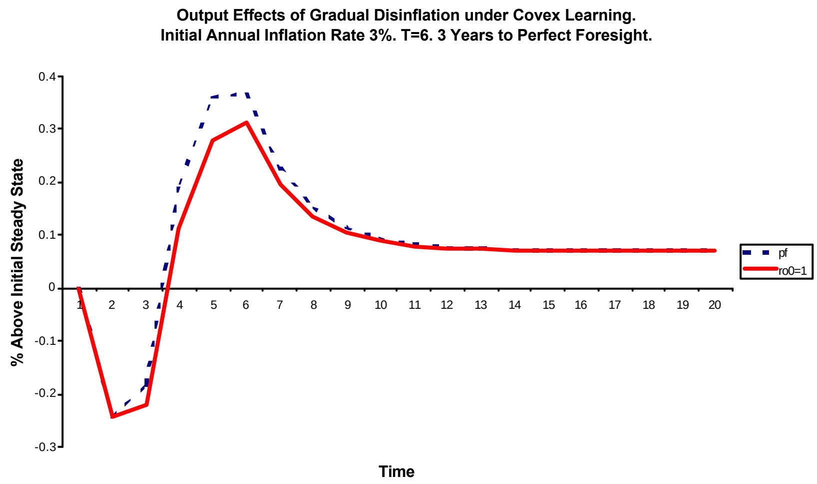

Figure 5.7:

The optmal speed of disinflation is closer to the case of perfect foresight than under concave expectations updating.

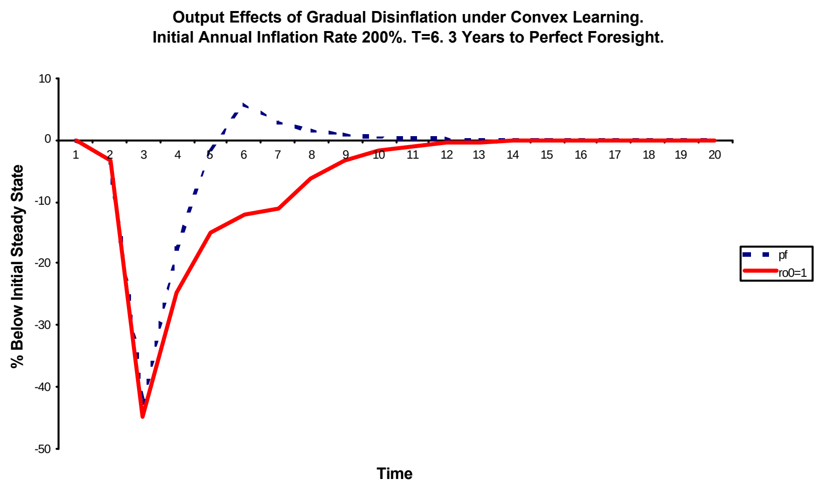

Figure 5.8:

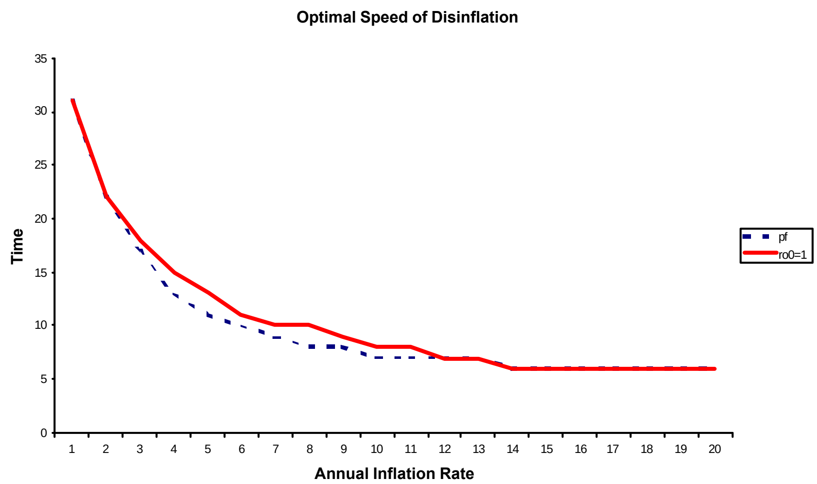

Figure 5.9:

6. Conclusions

TO BE WRITTEN

References

[1] Ball, Laurence (1994), "Credible Disinflation with Staggered Pricing", *American Economic Review*, Vol. 84, No. 1, March, pp.282-289.

[2] Ball, Laurence (1995), "Disinflation with Imperfect Credibility", *Journal of Monetary Economics*, Vol. 35, pp.5-23.

[3] Ball, Laurence, N. Gregory Mankiw and David Romer (1988), "The New Keynesian Economics and the Output-Inflation Trade-Off", *Brookings Papers on Economic Activity*, Vol. 1 pp.1-65.

[4] Barro, Robert J. and David B. Gordon (1983), "A Positive Theory of Monetary Policy in a Natural Rate Model", *The Journal of Political Economy*, Vol. 91, No. 4. August, pp. 589-610.

[5] Benabou, Roland and Jerzy D. Konieczny (1994), "On Inflation and Output with Costly Price Changes: A Simple Unifying Result", *American Economic Review*, Vol. 84, No. 1, March, pp.290-297.

[6] Danziger, Leif (1988), "Costs of Price Adjustment and the Welfare Economics of Inflation and Disinflation", *American Economic Review*, Vol. 78, No. 4, September, pp.633-646.

[7] Dixit, Avinash. K. and Joseph. E. Stiglitz, 'Monopolistic Competition and Optimum Product Diversity', *American Economic Review,* 67(3), pp. 297-308.

[8] Gordon, Robert J. (1982) "Why Stopping Inflation May be Costly: Evidence from Fourteen Historical Episodes", in *Inflation: Causes and Effects*, edited by Robert E. Hall, Chicago University Press. pp.11-40.

[9] Ireland, Peter N., (1995), "Optimal Disinflationary Paths", *Journal of Economic Dynamics and Control*, vol. 19, pp.1429-1448.

[10] Ireland, Peter N., (1997), "Stopping Inflations, Big and Small", *Journal of Money, Credit, and Banking*, Vol.29, No.4 (November, Part 2), pp.759-775.

[11] Khan, Aubik, Robert G. King and Alexander L. Wollman (2002), "Optimal Monetary Policy", *Review of Economic Studies*,

[12] Robert G. King and Alexander L. Wollman (1999), "What Should the Monetary Authority Do When Prices Are Sticky?", in *Monetary Policy Rules* edited by John B. Taylor. NBER Business Cycles Series, Volume 31.

[13] Lucas, Robert E. Jr. and Nancy L Stokey (1983), "Optimal Fiscal and Monetary Policy in an Economy without Capital", *Journal of Monetary Economics*

[14] Sargent, Thomas J. (1982), "The Ends of Four Big Inflations" in *Inflation: Causes and Effects*, edited by Robert E. Hall, Chicago University Press. pp.41-97.

Appendix: Parameterization of the model

The parametrization of the model, follows Ireland (1997). He follows the parametrization derived by Ball, Mankiw and Romer (1988) for the intertemporal elasticity of substitution $\alpha = 0.1$ and Rotemberg and Woodford (1992) for $b = 6$, corresponding to a benchmark value of 1.2 for the steady-state markup. Due to Ball and Mankiw (1994) study, each interval of time in the model corresponds to a period of six months, determining as well the choice of $\beta = 0.97$, consistent with an annual discount rate of 5 percent. k, the inflation rate for which the rigidity of individual goods vanish, firms switching form the single price strategy to the two price strategy, is chosen at the value of 0.1075. The values of the parameters used by Ireland (1997) and implicitly in this model, α, β, b, k,correspond to the most acute case of disinflation. In our case, we assumed $\gamma = 1$.