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MONOPOLISTIC COMPETITION, CREDIBILITY AND THE OUTPUT COSTS OF DISINFLATION PROGRAMS: AN ANALYSIS OF PRICE CONTROLS

Sweder van Wijnbergen

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ABSTRACT

Brazil, Argentina and Israel all used price controls as part of disinflation programs in 1985-1986. In each case they were intended to break an "inertial" component of inflation. This paper focuses on a specific mechanism through which inflation inertia can emerge: the interaction between lack of credibility of government monetary policy announcements and the price setting behavior of forward looking firms. We show that this interaction can lead to inertia extending well beyond the price setting period; that is important since the price setting period is likely to be short in high inflation economies.

We develop an open economy macromodel in which firms set prices before uncertainty about government monetary policy is resolved. Lack of credibility is then shown to lead to output losses during a disinflation program. We demonstrate the effects of price controls and show that their temporary use can be defended on welfare grounds. The paper analyzes asset price behavior during disinflation programs with and without price controls and the influence of credibility problems. We discuss nominal and real interest rates, the stock market and exchange rates. Finally we show that if past government policy has any information content about future government policy, cheating on current announcements of tight policy buys current employment gains during the price control period at the cost of higher inflation afterwards. Sustaining low inflation after the price control period thus requires restrictive monetary policy during the price control period.

Sweder van Wijnbergen
Room S13-141
The World Bank
1818 H Street, N.W.
Washington, D.C. 20433
(202) 473-1060

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1. Introduction

Brazil, Argentina and Israel all used price controls as part of highly visible disinflation programs in 1985-1986. The controls were intended to break an "inertial" component of inflation, and hence planned as temporary measures. Like previous experiences with price controls, the result to date have been mixed. Israel has succeeded in lifting most of them without triggering a resurgence of inflation; Brazil and Argentina failed in repeated attempts to do likewise. This experience raises many questions to which the existing literature does not provide an answer. It is clear there are microeconomic costs, but what are the macroeconomic benefits, if any? Under which circumstances do price controls help in bringing down inflation and when do they just suppress it temporarily? How should they be set up? And taken off? What is the proper supporting role of fiscal and monetary policy during the period controls are in force?

The literature on price controls is very scant. Possen (1978) superimposes wage-price controls on a standard model with competitive behavior by each actor, and adaptive expectations. Blejer and Liviatan (1987) use a similar set up, but with inflation itself adjusting only slowly ("core inflation" moves gradually) and argue controls substitute for the need for restrictive demand management during the transition period towards lower inflation.

Both papers exogenously introduce some form of inertia in the inflationary process, in line with most policy makers' rationale for the use of such controls (cf Arida-Lara Resende (1985)). The concept of inflation inertia and its connotation of price setting behavior naturally leads to the question of whether one should consider non-competitive market structures in analyzing the effects of price controls. Helpman (1986) provides evidence that this should indeed be done. He analyzes the output and trade balance response to price controls, first under the assumption of competitive markets and then under the assumption of monopolistic market structures. He demonstrates that the actual output response in Brazil and Israel is at variance with the predictions of the competitive model, but seems to accord well with what comes out of the non-competitive model. Dornbusch and Simonsen (1986) and Simonsen (1986) also assume non-competitive markets. They explain inflation inertia as a consequence of coordination failure between wage and price setters in the economy after an observed change in monetary policy. The role of wage-price controls is clear in such a world: the government through such controls resolves the coordination failure.

This paper also focuses on the role of price inertia. Like Dornbusch and Simonsen (1986) and Simonsen (1986), we do not assume inertia exogenously. However we will focus on a different mechanism through which inflation inertia emerges: the interaction between lack of credibility of government monetary policy announcements and the price setting behavior of forward looking firms. We show that this interaction can lead to inertia extending well beyond the price setting period; that is important since the price setting period is likely to be short in high inflation economies. In Section 2, the paper develops an open economy macromodel (a variant of the one introduced in Svensson and van Wijnbergen (1986,1987)) in which firms set prices before uncertainty about government monetary policy is resolved. Money demand is based on interest sensitive cash-in-advance requirements like in Lucas (1982) and, especially, Svensson (1985, 1986). Consumers have rational expectations and use intertemporal welfare optimization to decide on consumption patterns, savings rate and portfolio allocation. We use the capital asset pricing model to work out asset prices and interest rates.

The model is used in Section 3 to show how lack of credibility can lead to output losses during a disinflation program. We demonstrate the effects of price controls and show that their temporary use can in fact be defended on welfare grounds. Section 4 analyzes asset prices during the control period, and the influence of credibility problems. We discuss nominal and real interest rates, the stock market and exchange rates. We finally address the question of the appropriate stance of monetary policy during the price controls. We show that, if past government policy has any information content about future government policy, cheating on current announcements of tight policy buys current employment gains during the price control period at the cost of higher inflation afterwards. Sustaining low inflation after the price control period thus requires restrictive monetary policy during the price control period.

2. Analytical Framework

2.1 The Model

There are two countries, home and foreign. Each country is completely specialized in the production of home and foreign goods, respectively. There is production of differentiated products, but at this stage it is sufficient to consider two aggregate goods only. In period t (t = -1, 0,1, ...) world per capita production of each good, Y_t and Y_t^*, respectively, is costless up to an exogenous stochastic capacity level, y_t and y_t^*. When output falls short of capacity, there is underutilization of resources. 1/

1/ Underutilization of resources can be interpreted as unemployment under some simple labor market assumptions (for example fixed coefficients in production and a fixed labour supply).

The (world per capita) supply of home and foreign currency in period t, $\bar{M}_t$ and $\bar{N}^*_t$, respectively, is given by

$$(2.1) \qquad \bar{M}_t = \omega_t \bar{M}_{t-1} \text{ and } \bar{N}^*_t = \omega^*_t \bar{N}^*_{t-1}.$$

ω_t (ω^*_t) is the gross rate monetary expansion of home and (foreign) currency.

y, y* and ω* are serially independently distributed. Their probability distributions are the time-invariant functions $F(y_t)$, $F^*(y^*_t)$ and H^*. There are only two possible values for ω: a high expansionary value, ω_H, and a low value ω_L. ω's distribution function, H, then takes the following form:

$$(2.2) \qquad H(\omega_t) = \begin{cases} 0 & \omega < \omega_L \\ 1-\gamma_H & \omega_L \leq \omega < \omega_H \\ 1 & \omega_H \leq \omega \end{cases}$$

The home and the foreign consumer have identical preferences:

$$(2.3) \qquad E_t \Sigma^{\infty}_{\tau=t} \beta^{\tau-t} u(c_{h\tau}, c_{f\tau}), \ 0 < \beta \ 1.$$

E_t is the expectations operator conditional upon information available in period t; $u(c_{ht}, c_{ft})$ is a standard concave instantaneous utility function of consumption c_{ht} and c_{ft} of home and foreign goods, respectively, in period t.

The home consumer enters period t with stocks of six different assets: home and foreign currency, M_{t-1} and N_{t-1}, shares in home and foreign firms, z_{ht-1} and z_{ft-1} and claims to transfers of home and foreign currency, x_{Mt-1} and x_{Nt-1}.

In the beginning of the period the consumer learns current capacities and monetary expansions. After that, the goods market opens. On the goods market the consumer can buy home and foreign goods. He must pay for home goods with home currency and for foreign goods with foreign currency. 1/ Hence he faces the liquidity constraints

(2.4a) $P_{ht}c_{ht} \leq M_{t-1} + (\omega_t - 1)\,\bar{M}_{t-1}x_{Mt-1}$ and

(2.4b) $P^*_{ft}c_{ft} \leq N_{t-1} + (\omega^*_t - 1)\,\bar{N}^*_{t-1}\,x_{Nt-1}$.

Since nominal goods prices are sticky and do not adjust to the current state of the market, there will be excess demand in some states and excess supply in others. When there is excess demand consumers will be rationed. Thus the home consumer also faces the rationing constraints. 2/

(2.5) $c_{ht} \leq Y_t$ and $c_{ft} \leq Y^*_t$

After the consumer's transactions on the goods market, that market closes and the asset market opens. On the asset market, dividends on shares are distributed, and the consumer can trade assets and liabilities according to the budget constraint:

1/ In the terminology of Helpman and Razin (1984), this is the S-system, where the sellers nationality determines the transactions currency. They also consider the B-system, where the nationality of the buyer determines the transactions currency.

2/ We exploit that in equilibrium either none or both consumers will be rationed, and we assume that in the latter case they receive identical rations.

$$(2.6) \qquad M_t + e_t N_t + Q_{ht} z_{ht} + Q_{ft} z_{ft} + R_{Mt} x_{Mt} + R_{Nt} x_{Nt} \leq$$

$$[M_{t-1} + (\omega_t - 1) \bar{M}_{t-1} x_{Mt-1} - P_{ht} c_{ht}] +$$

$$e_t [N^*_{t-1} + (\omega^*_t - 1) \bar{N}^*_{t-1} X_{Nt-1}] + (Q_{ht} + P_{ht} Y_t) z_{ht-1} +$$

$$(Q_{ft} + e_t P^*_{ft} Y^*_t) z_{ft-1} + R_{ht} x_{Mt-1} + R_{ft} x_{Nt-1}.$$

e_t is the exchange rate, Q_{ht} and Q_{ft} are the home currency prices of claims to transfers of home and foreign currency respectively. After these transactions the asset market closes, and the home consumer leaves period t and enters period t+1 with new stocks of his six assets and liabilities, M_t, N_t, z_{ht}, z_{ft}, x_{ht} and x_{ft}.

The home consumer will maximize expected utility (2.3) subject to the sequence of liquidity, rationing and budget constraints (2.4) - (2.6). The foreign consumer will maximize the same utility function, with the same constraints, only his variables are denoted by '*', like c^*_{ht}, c^*_{ft}, M^*_t, N^*_t.

The solution to this problem solves the dynamic programming problem:

$$(2.7) \qquad \max_{\substack{c_{ht},\, c_{ft},\, z_{ht},\, z_{ft},\\ N_{Mt},\, N_{Nt},\, M_t,\, N^*_t}} \qquad v(w,M,N,M^*,N^*,s) = u(c_{ht},c_{ft}) + v'$$

subject to the constraints (2.4-b). v is a value function and s_t the state vector $(y_t, y^*_t, \omega_t, \omega^*_t)$. w is wealth inclusive asset returns at the time asset markets are open.

Before describing the solution, consider the pricing problem of firms. Home (foreign) firms produce differentiated home (foreign) goods in monopolistic competition along the lines of Dixit and Stiglitz (1977). They set prices in their own currency, and, for some reason left unspecified, must do so before the current values of ω^*, y, y^* and, in the case of uncertainty about ω, ω are known. Hence own-currency goods prices P_{ht+1} and P^*_{ht+1} will depend on period t information only. For convenience we use the inverse price level, $\pi_M = 1/P_h$ and $\pi^*_N = 1/P^*_f$. Firms set prices such as to maximize their stock market value; the solution to this price setting problem is given in Appendix B. Absence of money illusion and of serial correlation in the process generating output y_t implies a functional form for the resulting price setting function:

$$(2.8) \qquad \pi_{Mt+1} = k/(\bar{M}_t\ \omega'_E),\ \pi^*_{Nt+1} = k^*/(\bar{N}_t\ \omega^{*\prime}_E)$$

with k, k* independent of period t+1 actual output (See Appendix B for the determination of k and k*). A subscript E refers to expected value and primes to variables in period t+1.

We consider a perfectly pooled equilibrium, where the home and foreign consumer hold identical portfolios and consume identical quantitities of the goods. Thus the market equilibrium conditions for the goods, money and other asset markets are

$$(2.9a) \qquad c_{ht} = c^*_{ht} = Y_t \le y_t,\quad c_{ft} = c^*_{ft} = Y^*_t \le y^*_t,$$

$$(2.9b) \qquad M_t = M^*_t = \bar{M}_t,\ N_t = N^*_t = \bar{N}^*_t, \text{ and}$$

(2.9d) $z_{ht} = z_{ft} = z^*_{ht} = z^*_{ft} = x_{ht} = x_{ft} = x^*_{ht} = x^*_{ft} = 1.$

Equilibrium first of all requires all liquidity and goods market constraints to be satisfied, so:

(2.10a) $c_h \leq k\omega/\omega_E = K_E\omega \qquad [\mu_h \geq 0],$

(2.10b) $c_h \leq y \qquad [\nu_h \geq 0],$

(2.10a) uses (2.5a), (2.8) and the equilibrium conditions (A.1) (cf Appendix A.1). μ_h and v_h are the Lagrange multipliers of the liquidity and capacity constraints respectively. Furthermore, the marginal utility of home goods equals the marginal utility of wealth in terms of home goods (λ), unless binding liquidity constraints ($\mu_h > 0$) or capacity limits ($\nu_h > 0$) drive a wedge between the two:

(2.10c) $u_h(c_h, c_f) = \lambda + \mu_h + \nu_h,$

The marginal utility of wealth measured in home goods, λ depends only on home monetary expansion. From the asset pricing equation for claims on money tranfers (A4.d in appendix A), one gets:

(2.11) $$\lambda = \beta A\pi_M'/\pi_M$$

$$= \beta A \frac{k}{M_t\omega_E'} \Big/ \frac{k}{M_{t-1}\omega_E}$$

$$= \beta \frac{A}{\omega_E'} \cdot \left(\frac{\omega_E}{\omega}\right)$$

The multiplicative term (ω_E/ω) drops out in the absence of expectational errors. The impact of such errors is obvious:

$$\frac{\partial\lambda}{\partial(\omega_E/\omega)} > 0$$

Overestimating money growth increases the marginal utility of wealth. This is because overestimating money growth leads to unanticipated tight money, and lower prices tomorrow than previously anticipated. But lower prices tomorrow for given prices today raise the marginal utility of a nominal unit of wealth, $\lambda\pi_M$, since it commands more resources tomorrow. Since π is predetermined, λ goes up as a consequence.

A set of expressions similar to 2.10 holds for foreign variables. The variables and equations can be decomposed into two groups, one corresponding to home and one to foreign variables. From (2.10) we can solve for the endogenous variables c_h, λ, μ_h and ν_h as functions of y, ω_E', and ω, and consumption of foreign goods c_f. From the corresponding equations for foreign variables we can solve for c_f, λ_f^*, μ_f^* and ν_f^* as functions of y^*, ω^*, $\omega_E^{*'}$, and c_f.

Finally we need to address the way firms form expectations about future monetary policy. In Svensson and van Wijnbergen (1987) current shocks contain no information value about future shocks. Here we want to focus on disinflation programs: after a period of high inflation and high money growth $(\omega = \omega_H)$, the government announces restrictive money growth targets $(\omega = \omega_L)$ at the time firms need to make pricing decisions. We will explore the case of complete credibility and the case of incomplete credibility. The latter implies that firms assign a positive probability γ_H to the possibility of expansionary money ($\omega = \omega_H$) in spite of the announcement of tight money $\omega_L < \omega_H$.

The formation of γ_H could be based on Kreps-Wilson (1982) type Bayesian updating formulas (see Backus and Driffil (1985a,b) for an example). Alternatively, a signaling equilibrium might exist where a government, by appropriately low choice of ω_L, can make sure that the historically inherited value of γ_H (applied to period t) will switch to 0 or 1 depending on the monetary policy followed during the price control period: see Persson and van Wijnbergen (1987) for such an approach. In this paper we are concerned more with the consequences of credibility problems rather than their cause; we therefore simply adopt the Persson-van Wijnbergen (1987) setup. γ_H therefore has a value determined by past history. Beliefs about the post-control period (γ_H') will then depend on whether actual monetary policy during the controls coincides with the announcement of tight policy ω_L or not. Existence of such a signaling equilibrium requires that ω_L is low enough to make it optimal for the expansionary government not to follow it, in spite of the credibility gains it would get by doing so; but high enough to not make it too costly for the "tight" government to use ω_L as signal (Persson and van Wijnbergen (1987))].

2.2 Interest and Exchange Rate Determination

One over one plus the nominal interest rate equals the present value, measured in money terms, of a sure unit of nominal money paid out next period (after goods markets close; bonds yield no liquidity services):

$$(2.12a) \qquad 1/(1+i) = \beta E\lambda'\pi'_M/(\lambda\pi_M) \quad \text{or } i = E\mu_h'\pi_M'/(E\lambda'\pi_M') \;.$$

The second equality is derived using equation (A.3d).

The nominal interest rate hence equals the ratio between expected future liquidity services of money, $E\mu_h'\pi_M'$, and the expected utility of future nominal wealth, $E\lambda'\pi_M'$. The interpretation is straightforward: both money and a nominal bond have an end of period value equal to one unit of money. During the holding period, money alone yields liquidity services, valued at $E\mu_h'\pi_M'$. To offset that advantage, bonds need to pay interest of equal value, so market clearing requires $iE\lambda'\pi_M' = E\mu_h'\pi_M'$, which yields (2.12). Similar expressions hold for i^*. Note in particular that current prices (π_M) do not influence i.

Real rates can be derived from the present value of a future unit of wealth measured in terms of home (foreign) goods to derive the own rate of interest for home (foreign) goods:

$$(2.13) \qquad 1/(1+r) = \beta E\lambda'/\lambda; \; 1/(1+r^*) = \beta E\lambda^{*\prime}/\lambda^*$$

Consider finally exchange rates. Most high inflation countries that went through a disinflation programs used some form of nominal exchange rate fixing, at least initially (Bolivia 1986 is an exception). However, those countries also has extensive black markets in which foreign assets were traded freely. We therefore assume a floating rate system; the emprirical counterpart of the exchange rate is thus the black market rate.1/

1/ To completely dismiss the official rate as an inframarginal set of trade taxes and subsidies with no real impact other than distributional is clearly overly simplistic. An analysis of dual exchange rate systems would however be outside the scope of this paper. Kiguel and Lizondo (1986) provide a recent survey.

The nominal exchange rate in asset markets is the rate at which a domestic currency denominated nominal unit of wealth can be exchanged for a foreign currency denominated unit of wealth. Hence

$$(2.14) \qquad e = \frac{\lambda^* P_f^*}{\lambda P_h} = \frac{\lambda^* \pi_M}{\lambda \pi_f^*}$$

However, since liquidity and capacity constraints may drive a wedge between the marginal utility of consumption and the marginal utility of wealth, this is not necessarily the exchange rate that would obtain if markets for domestic and foreign money would be open during the goods market.1/ If such markets would open up, it is easy to show that the following would hold for this "goods market" exchange rate:

$$(2.15) \qquad \tilde{e} = \frac{u_f}{u_h} \cdot \frac{P_h}{P_f^*} = e \left(\frac{1 + (\mu_f^* + \nu_f^*) / \lambda^*}{1 + (\mu + \nu) / \lambda} \right)$$

2.3 A Simple Graphical Representation

The "ex post" equilibrium can fall in either one of three regimes for each country's commodity market,2/ depending on the realization of capacity and monetary expansions. In the first regime, the capacity constraint is

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1/ Svensson (1985), section 5, extensively discusses different exchange rates concepts in the context of a similar model.

2/ Giving a total of 9 possible global configuration.

binding and hence $C_h = y$. In this regime, the liquidity constraint is not binding, so $\nu_h > 0$, $\mu_h = 0$, and:

$$(2.16) \qquad c_h < k\omega/\omega_E = K_E\omega$$

and

$$(2.17) \qquad u_h(y, c_f) = \lambda + \nu_h$$

$$> \lambda = A\,\frac{\omega_E}{\omega}\cdot\frac{1}{\omega'} = A\omega_E/\omega^2$$

because the signaling equilibrium implies $\omega' = \omega$. $K_E = k/\omega_E$ by definition. This is regime F in fig. 1; (2.16-17) imply it is to the NW of W in fig. 1.

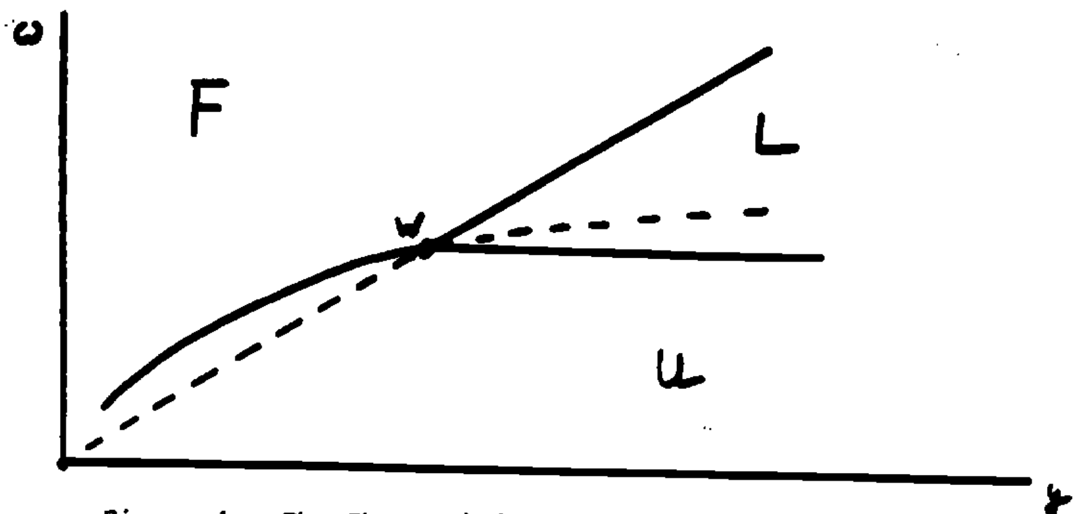

Figure 1: The Three Different Regimes in Home Markets

When liquidity constraints are binding, there is excess capacity and hence $\nu_h = 0$, but the other multiplier is not: $\mu_h > 0$. Hence

$$(2.18) \qquad c_h < y$$

$$(2.19) \qquad U_h(c_h, c_f) = \lambda + \mu_h > \lambda = A\,\omega_E/\omega^2$$

so this regime, labeled L in figure 1, is to the NE of W in fig. 1.

In the third regime, there is excess capacity AND excess liquidity, so both μ_h and ν_h equal zero. Home output is demand determined in this regime:

$$(2.20) \qquad u = c_h$$

and

$$(2.21) \qquad u_h(c_h, c_f) = \lambda = A\omega_E/\omega^2.$$

In this regime, labeled U in fig. 1, there is a true effective demand failure: neither capacity nor liquidity constraints are binding. This happens if monetary policy is very restrictive (ω low). Thus inflationary expectations are low and the return on money commensurately high. This regime is to the SE of W in fig. 1. Svensson (1986) shows that this regime will never obtain if ω is known to firms when they set prices for the next period.

3. Price Controls, Credibility and the Output Costs of Disinflation Programs

We will use the machinery developed in section 2 to analyze the employment costs of disinflation programs, the impact of credibility problems and the role for price controls. Consider an economy where the price level and the money stock have been growing at a high rate ω_H. Then, at the end of period t-1, the government announces a disinflation program that relies on a reduction in the growth rate of money, down to a low rate ω_L. The impact of credibility works through firms' price setting behavior. The government either follows its announcement, so ω_L is actually realized, or it reneges on its announcement. For simplicity we assume that in that case the pre-announcement high money growth rate ω_H is implemented. The firms' assessment of the probability that this happens is γ_H. Expected money growth is

$$(3.1) \qquad \omega_E = \gamma_H \omega_H + (1-\gamma_H)\, \omega_L$$

The impact of credibility can then be assessed by comparing the case of $\gamma_H = 0$ with what happens when $\gamma_H > 0$.

Consider the case of $\gamma_H = 0$ first. Then the government announcement is believed; assume the government also follows through. Hence $\omega_E = \omega_L$. This is equivalent to case where firms actually know monetary policy before setting prices; hence, as shown in section 2 no real variables will be affected by the slowdown in money growth. Firms will offset the drop in ω by an increase in K (fall in future prices). In terms of the diagram, the liquidity constraint line rotates down (figure 2).

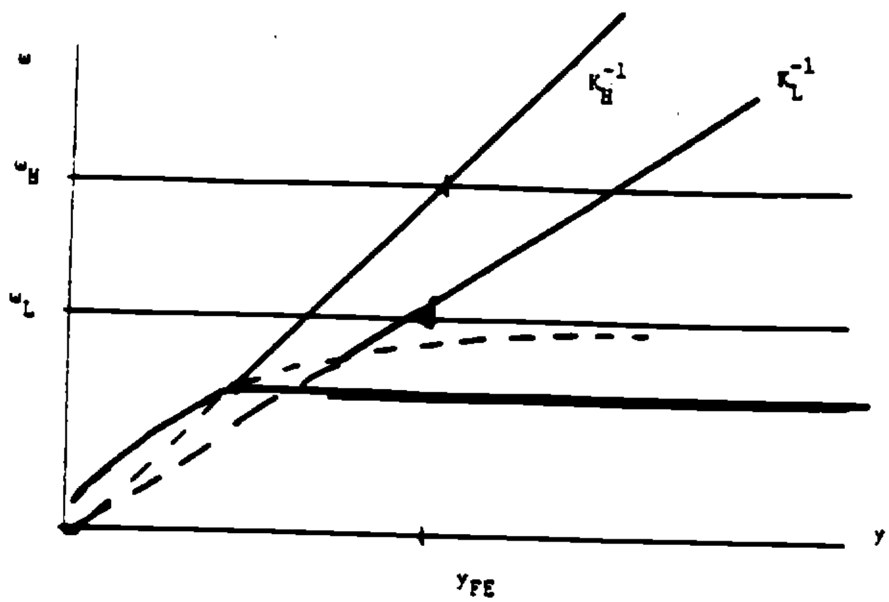

Figure 2. A Credible Reduction in Money Growth

With full credibility, a monetary slowdown will therefore have no more expected output losses than would have obtained otherwise, in spite of the presence of monopolistic firms. Private welfare is also unaffected:

$$(3.3) \qquad u_H(\quad) = \int_0^{F(K_H\omega_H)} \int_S u(y, c_f)\, dF(y)\, dF^*(y^*)\, dH^*(\omega^*) + \int_{F(K_H\omega_H)}^{F(\bar{y})} \int_S u(K_H\omega_H, c_f)\, dF(y)\, dF^*(y^*)\, dH^*(\omega^*)$$

$$= \int_o^{F(K_L\omega_L)} \int_S u(y, c_f)\, dF\, dF^*\, dH^* + \int_{F(K_L\omega_L)}^{F(\bar{y})} \int_S u(K_L\omega_L, c_f)\, dF\, dF^*\, dH^*$$

since $K_L\omega_L = K_H\omega_H$ in the absence of expectational errors. S is shorthand for the domain of y^* and ω^*. Price setting and monopolistic competition in themselves can clearly not explain the output costs of disinflation programs.

Consider however the case of incomplete credibility, $\gamma_H > 0$. In Appendix B, we show that, under the additional assumption of a uniform capacity distribution, firms will set prices as if $\omega_E = \gamma_H\omega_L + (1-\gamma_H)\,\omega_L$ will obtain with certainty. See fig. 3.

Comparison with figure 2 shows the problem a lack of credibility causes. As long as $\gamma_H > 0$, firms set prices as if ω_E rather than ω_L would obtain:

$$(3.4) \qquad K_E < K_L \Rightarrow P_E > P_L$$

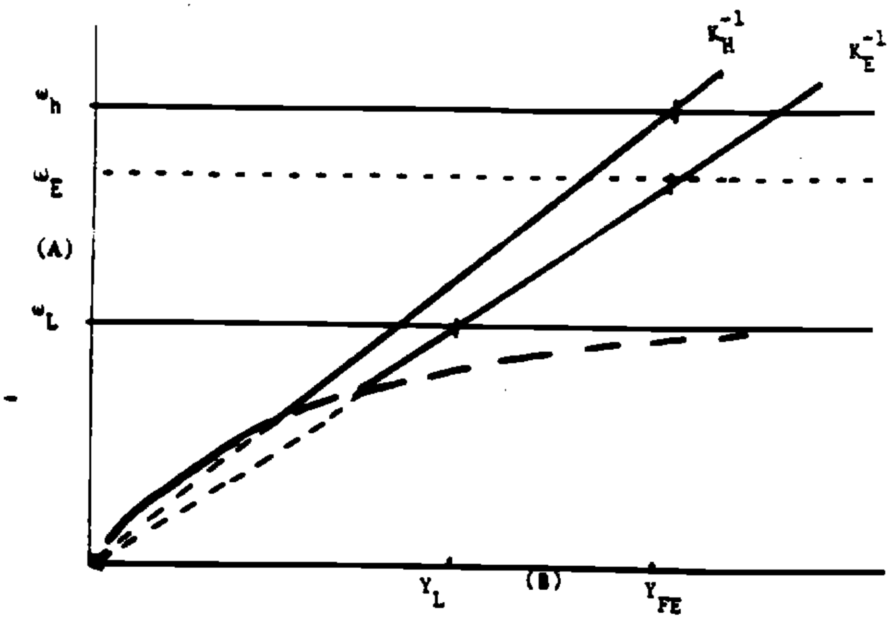

Figure 3: Lack of Credibility and Output Losses Under Disinflation
A: $\gamma_H\ (\omega_H - \omega_L)$ B: $\gamma_H\ k_E\ (\omega_H - \omega_L)$

Hence if the government does follow a tight policy, $\omega = \omega_L$, liquidity constraints start binding at y_L rather than y_{FE}, with

$$(3.5) \qquad y_{FE} - y_L = K_E \gamma_H\ (\omega_H - \omega_L)$$

The probability of unemployment, Pr_u, clearly rises:

$$(3.6) \qquad Pr_u^L - Pr_u^E = \int_{y_L}^{\bar{y}} dF - \int_{y_{FE}}^{\bar{y}} dF$$

$$= \int_{y_L}^{y_{FE}} dF$$

$$= K_E \gamma_H (\omega_H - \omega_L) / \bar{y} > 0$$

So the probability of unemployment goes up more, the larger the cut in money growth $\omega_H - \omega_L$, and the larger the probability that firms attach to the government <u>not</u> following its announcements, γ_H. 1/ The basic problem is straightforward: lack of credibility causes the real money stock to be "too low" on the transition path between the policy announcement and the period at which government credibility is established. It is the interaction between monopolistic price setting and credibility that causes the output losses during disinflation programs.

An important point to note is that the time period during which this problem will persist is <u>NOT</u> the period during which prices are fixed, but the time it takes for γ_H to fall to zero. This may be a substantially longer; in high inflation countries prices will often be adjusted at high frequency, but if information about government fiscal and monetary policy becomes available only gradually, ω_E may exceed ω_L and unemployment may remain high for a period of time well in excess of the price setting period.

Fig. 3 can also be used to show what price controls can do to alleviate this problem. Before we do so one prior point. In models like the one presented here controls can also be used to permanently improve on the full anticipation equilibrium, because the monopolistic competition market structure results in socially suboptimal output levels in some states of nature. A proper analysis of such a policy would however also need to take into account the microeconomic costs such a policy would entail. The symmetry assumptions made in this paper prevent a satisfactory analysis of such costs which are related to the relative price distortions controls unavoidably introduce. We therefore do not consider their possible permanent use here but impose that they are used for transitional purposes only.

1/ $K_E\gamma_H(\omega_H - \omega_L) = k/(1+\omega_L/(\gamma_H(\omega_H-\omega_L)))$. Simple differentiation establishes the claims made in the text.

Price controls take the pricing decision out of the firms' hands; in terms of fig. 3 they rotate the K^{-1} line (see fig. 4).[1/] The government now sets K, say at K_C. If K_C is set below the no-controls solution K_E, controls will never bind; if K_C is set above K_E, the LL line rotates down and expected output <u>increases</u> because of the controls whenever they are binding. It is clearly possible to set prices such that the full credibility solution is reproduced: this involves setting K_C equal to K_L, rotating the liquidity constraint line as indicated in fig. 4. Transitional umemployment losses are avoided when binding price controls are imposed in that manner, basically because price controls allow a higher real money stock during the transition period towards full credibility.

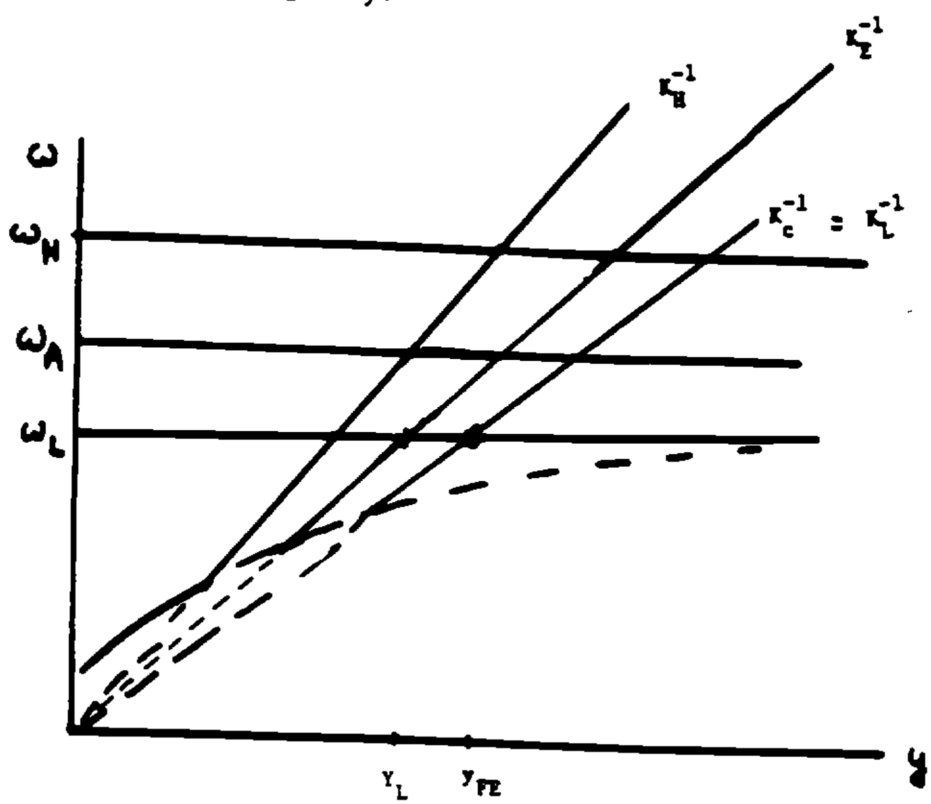

Figure 4: Output Effects of Price Controls

1/ In fact they also shift the curve between the F and the U regime (see 2.11 and 2.16-21). This shift is irrelevant for our analysis and therefore ignored.

Welfare will clearly improve (see Appendix A.2 for proof): $u^C(c_h, c_f) > u^E$. Price controls therefore increase welfare if credibility problems cause transitional unemployment without such controls.

The argument for government intervention in the case of mistaken beliefs has also been made by Calvo (1986). The nature of the welfare losses in his example is different, however. There consumers underestimate the true intertemporal terms of trade because they mistakenly expect a trade reform to be reversed. Hence too much expenditure is shifted towards today, and a wedge opens up between the intertemporal terms of trade and the intertemporal rate of substitution in consumption. The associated welfare costs are proportional to the intertemporal substitution elasticity, in standard "Harberger triangle" fashion. Mistaken beliefs do not lead to underutilization of resources however, contrary to the example provided here. Finally, the result that under monopolistic competition price controls incrase output also emerges in the analysis of Helpman (1987), although not through the same mechanism. Credibility plays no role in his paper.

4. Asset Prices, Intertemporal Inflation-Unemployment Trade Offs and the Appropriate Conduct of Monetary Policy During Price Controls.

Asset prices depend crucially on firms' beliefs about government policy in the next period, t+1, and onwards. This can, for period t+1, again be summarized in the parameter γ_H'. γ_H' > in turn, will be based on prior information as summarized in γ_H, supplemented by any new information about the government that has become available during period t. Clearly, the particular way in which γ_H will be updated depends on the incentive structure the government faces, the particular informational asymmetries that exist, and so on.

Cheating on announcements by announcing ω_L but implementing ω_H leads to employment gains in period t; after all, prices were set based on the expectation $\omega_E < \omega_H$. However, since the same incentive problem arises next period, firms will subsequently increase γ_H' above γ_H and set next period's prices accordingly. In that sense price controls lead to an intertemporal trade off between current unemployment and future inflation.

The informational asymmetry arises because firms need to set prices after monetary policy is announced, but before its realization can be observed. This could lead to uncertainty about actual policy if firms have incomplete information about the government's preferences. For example firms could be uninformed about the government's rate of time preference. A more impatient government may be more inclined to sacrifice future inflation for current employment gains by cheating on its monetary policy announcements for the price control period (Persson and van Wijnbergen (1987)).

In such circumstances it is possible that a signaling equilibrium exists, as argued in Section 2.1; then γ_H would switch to zero or one depending on whether ω in the price controls period coincides with the announced value ω_L or not. This is explored further in Persson and van Wijnbergen (1987), and simply assumed here.

4.1 Interest Rates, Exchange Rates and the Stock Market During Disinflation

To determine the behaviour of asset prices during disinflation controls consider first the marginal utility of wealth, λ. Since both expected monetary expansion and expectational errors influence λ, we need to distinguish the case where the government implements its announcement ($\omega = \omega_L$) and the case where it cheats: $\omega = \omega_H$. Call the two cases L and H respectively. I label the benchmark cases of full credibility at ω_L FCLY and full credibility at ω_H FCH. Applying (2.12) yields the results given in Table 4.1.

Table 4.1: MONETARY POLICY AND THE MARGINAL UTILITY OF WEALTH DURING A DISINFLATION PROGRAM

	L	H	FCL	FCH
ω	ω_L	ω_H	ω_L	ω_H
$\lambda = \beta \frac{A}{\omega'} \cdot \frac{\omega_E}{\omega}$	$\frac{\beta A}{\omega_L} \cdot \frac{\omega_E}{\omega_L}$	$\frac{\beta A}{\omega_H} \frac{\omega_E}{\omega_H}$	$\frac{\beta A}{\omega_L}$	$\frac{\beta A}{\omega_H}$

with $\omega_E = \gamma_H \omega_H + (1-\gamma_H)\omega_L$. Clearly,

$$(4.6) \qquad \lambda_L > \lambda_{FCL} > \lambda_{FCH} > \lambda_H \qquad \text{if } \gamma_H > 0.$$

Because of credibility problems, an announced disinflation program that is actually implemented raises the marginal utility of wealth: $\lambda_L > \lambda_{FC}$ if $\gamma_H > 0$. The opposite happens if the government cheats on its announcement and actually implements ω_H: $\lambda_H < \lambda_{FCH} < \lambda_{FCL}$.

This has implications for both real interest rates and stock market behaviour during the control period. Stock market valuation is inversely proportional to the current marginal value of wealth: share prices give the value of claims on future output in terms of current utility of wealth:

$$Q_h = \beta \frac{E\lambda'(Q_h' + Y')}{\lambda} = B_h/\lambda$$

Hence the result that stockmarkets will be depressed during a disinflation program that is actually implemented, but buoyant if the government cheats and follows expansionary policies instead:

$$(4.7) \qquad \lambda_L > \lambda_H \rightarrow Q_{hL} = B_h/\lambda_L < B_h/\lambda_H = Q_{hH}$$

The intuition is straightforward: a high current marginal utility of wealth lowers the <u>relative</u> value of future claims on output with respect to current wealth and hence depresses the stock market. The reverse happens after an unanticipated monetary expansion, as when the government cheats on its announcement and implements ω_H instead.

A more conventional presentation draws on real interest behaviour. Real rates equal the expected rate of decline in λ (cf Section 2.2); Table 4.2 follows from (2.14) and Table 4.1.:

Table 4.2: REAL INTEREST RATES DURING DISINFLATION

	L	FCL	FC	H
$r = \frac{\lambda}{\beta E \lambda^{+}} - 1$	$(1 + \rho)\ \omega_E/\omega_L$	ρ	ρ	$(1 + \rho)\ \omega_E/\omega_H$

Hence

$$(4.8) \qquad r_L > r_{FCL} = r_{FCH} > r_H$$

This is an important result: during a disinflation program, real interest rates will be high if the disinflation program is in fact implemented, and low if the government cheats and plays ω_H instead. Note that this is a more fundamental result than the often-heard claim that credibility problems only raise ex-post but not ex-ante real rates, since inflationary expectations exceed inflation. r is the return on an indexed bond, so inflation surprises do not affect it. Cheating by implementing a more expansionary policy than announced will thus lower the real interest rate and shift consumption forward into the current period.

Consider next the nominal interest rate. This is non-trivial since simple relations between real and nominal rates and inflation break down in the presence of monetary policy uncertainty (Svensson (1985)). Applying the asset pricing equ. 2.13a and Table 4.1 yields Table 4.3:

<u>Table 4.3</u>: **NOMINAL INTEREST RATES DURING DISINFLATION**

	L	FCL	FCH	H
$1+i = \frac{\lambda\pi_M}{\beta E\lambda'\pi'_M}$	$(1+\rho)\omega_L$	$(1+\rho)\omega_L$	$(1+\rho)\omega_H$	$(1+\rho)\omega_H$

Table 4.3 shows that, contrary to real interest rates, nominal rates of interest are <u>not</u> affected by credibility problems during the period of controls. This is because <u>current</u> surprises in the level of the moneystock affect the future price level, but this influences the future liquidity service of money in the same way it affects the marginal utility of wealth. Hence the relative attractiveness of money and bonds is not affected by such surprises and hence neither is the nominal interest rate.

For similar reasons, the asset market exchange rate is not affected by credibility problems either. The exchange rate results are straightforward: expansionary policy leads to a depreciating rate, and tight policy to an appreciating rate:

$$(4.9) \qquad e = \lambda^* \pi_F^* / (\lambda \pi_M) = \frac{M_t E\omega'}{N_t^* \omega^{*'}}$$

$$\Rightarrow e_H = \frac{\omega_H}{\omega_L} e_L > e_L$$

e_H is the exchange rate under expansionary and e_L the rate under tight policy.

The commodity market exchange rate will be affected by credibility problems and the associated tightening of liquidity constraints:

$$(4.10) \qquad \tilde{e} = \frac{u_f}{u_h} \cdot \frac{P_h}{P_F^*} = \frac{u_f}{u_h} \cdot \frac{M_{t-1}\, \omega_E}{N_{t-1}^*\, \omega_E^*}$$

Clearly, credibility problems have a <u>direct</u> impact on $\tilde{e}$ since they raise ω_E. In addition, for $y > y_A$ output and thus home consumption is equal to what consumption would be in the case of disinflation with full credibility. Hence u_h will not be affected for those realizations of y. However, with credibility problems liquidity constraints start binding earlier: between y_A and y_{FE} home consumption in the no credibility case (NC) falls short of what it is in the full credibility case (FC). Hence in that region $u_h^{NC} > u_h^{FC}$; also $K_E < K_L$ so even for $y > y_{FE}$, with liquidity constraints binding in both the NC and the FC case, u_h^{NC} will exceed u_h^{FC}. The resulting decline in demand for home goods takes pressure off commodity markets and off the goods market exchange rate. This will reduce the depreciation credibility problems cause through their impact on expected money growth ω_E. By how much depends on the degree of curvature of u_h.

4.2 Price Controls and Asset Prices During Disinflation Programs

Since the marginal utility of wealth, λ, depends on current and future prices, price controls have a direct impact on it. But since λ in turn has a direct impact on both interest rates and the stock market, price controls have an important influence on asset prices too. Consider the impact on λ first.

We will assume that price controls are set such that prices are compatible with the announced disinflation program ω_L:

$$(4.11) \qquad \pi_M^C = k/(M_{t-1}\omega_L) = K_L/M_{t-1}$$

instead of $k/(M_{t-1}\omega_E) = K_E/M_{t-1}$, the market solution π_{Mt}. Obviously, $\pi_{Mt}^C > \pi_{Mt}$. To assess the impact on λ, we have to consider γ_H', since λ depends on current and future prices. Under our signaling assumption, $\gamma_H' = 0$ or 1, depending on whether $\omega = \omega_L$ (announcement actually implemented) or $\omega = \omega_H$ (cheating on tight money announcement). Consider each case.

Table 4.4: Marginal Utility of Wealth During the Control Period

$\omega =$	ω_L	ω_H
$\lambda = \beta A \frac{\pi_M'}{\pi_M}$	$\frac{\beta A}{\omega_L}$	$\frac{\beta A}{\omega_H} \cdot \frac{\omega_L}{\omega_H}$
$1+r = \lambda/(\beta\lambda')$	$1+\rho$	$(1+\rho)\ \omega_L/\omega_H$

The results are intuitive: if monetary policy does not deviate from its announced values, with which the controls are compatible ($\omega = \omega_L$), the marginal utility of wealth equals what would obtain under a fully credible implementation of ω_L. Since price controls remedy the problem of a too low real money stock on the transition path towards credibility, they also prevent the high real interest rates that we showed characterize the no-controls disinflation programs (see section 4.1 and tables 4.2 and 4.4). Hence an important result: a disinflation program, combined with price controls set to be compatible with the announced tight money policy, will work if the restrictive policy is indeed followed. It will work in the sense that mistaken beliefs will now not cause intertemporal distortions and the associated high real interest rates and transitional output losses that restrictive policies alone would cause in the presence of credibility problems.

Cheating on the announcement (i.e. announcing ω_L and setting the price controls accordingly, but implementing ω_H) would cause deviations from the full credibility results. Table 4.4 shows that the resulting increase in the real money stock during the transition period lowers λ during that period. Cheating will thus also cause a temporary fall in the real interest rate (cf. table 4.4) and an increase in expected output. However, because of the signaling function of actual monetary policy, γ_H' will now switch to one and inflation in the post-control period becomes therefore unavoidable. Cheating on the announcement-cum-controls package therefore indeed buys current employment gains at the cost of future inflation losses.

The results are very different for nominal interest rates. As we saw in section 4.1, current prices do not influence nominal interest rates (equ. 4.1b); the nominal interest rate equals the ratio between expected future liquidity services and the expected utility of future nominal wealth. Using 2.12 and 2.13b it becomes obvious that the results from table 4.3 apply independent of the imposition of price controls. Price controls will affect real interest rates, not nominal rates.

Consider finally exchange rates. Clearly price controls applying to the goods market in period t will not affect the exchange rate obtaining while the asset market operates afterwards. Thus, the results from the previous section apply: expansionary policy during the control period set γ_H' to one (lead to expectations of future expansion) and hence the exchange rate will fall (depreciate):

$$(4.12) \qquad e_t^H = \frac{M_t}{N_t^*} \quad \frac{\omega_H}{\omega^{*'}} \qquad > \frac{M_t}{N_t^*} \cdot \frac{\omega_L}{\omega^{*'}} = e_t^L$$

e_t^H is the asset market exchange rate under expansionary policy, and e_t^L the corresponding rate when policy is restrictive, i.e. in accordance with announcements.

The commodity market exchange rate $\tilde{e}$ does depend on the imposition of controls, and also on the actual realization of capacity y:

$$(4.13) \qquad \tilde{e} = \frac{u_f}{u_h} \cdot \frac{\pi_f^*}{\pi_M}$$

Price controls raise π_M (lower P_h) compared to what would obtain without them. But, by relaxing liquidity constraints, they also influence home goods consumption and thus u_h. The interesting region to look at is the region above y_A, since there price controls do in fact affect output and consumption.

There are two offsetting effects:[1/] a direct effect through π_M and indirect one through u_h. For $y > y_{FE}$,

$$(4.14) \qquad \tilde{e} = \frac{u_f \; \pi_f^*}{u_h(K\omega, c_f)} \cdot \frac{M_{t-1}\omega_L}{k}$$

so the net effect depends on the elasticity of u_h. Controls raise K so $u_h.K$ will rise or fall depending on whether $\varepsilon_{c_h}^{u_h} \gtrless 1$. All diagrams in this paper have been drawn for the case of high intertemporal substitution, $\varepsilon_{c_h}^{u_h} > 1$; in that case the controls lead to a higher exchange rate (more appreciated) than would obtain without the controls for the same monetary policy and output levels (as long as $y > y_{FE}$):

$$(4.15) \qquad \begin{matrix} \varepsilon_{c_h}^{u_h} > 1 \\ y > y_{FE} \end{matrix} \Rightarrow \tilde{e}_{NC} > \tilde{e}_C$$

where the subscript NC refers to the no control case and C to the case of price controls. Also, (4.14) shows that expansionary monetary policy during the control period (ω_H) will depreciate the exchange rate one for one.

Since these rates are free market rates, their empirical counterpart is probably the black market exchange rate. Expansionary policy during the control period could therefore lead to a rising black market premium, while controls with tight policy should lead to a fall in that premium.

1/ In fact there is a third effect: changes in c_h will in general also affect u_f. If the intertemporal substitution elasticity σ exceeds the intratemporal elasticity s, this spillover is positive and vice versa. (See Svensson and van Wijnbergen (1987) for a discussion). We will assume $\sigma = s$ in our exchange rate discussion, thus eliminating such international spillover effects.

5. Conclusions

The notion of price inertia naturally leads to an imperfect competition framework. In this paper, we focus on the interaction between lack of credibility of government policy announcements and the price setting behavior of forward looking firms in monopolistic competition. We show that this interaction can lead to inflation inertia extending well beyond the price setting period. The latter is important, because the price setting period is likely to be short in highly inflationary economies.

We do this within the framework of an open economy macro model in which firms have to set prices before uncertainty about government policy is resolved. This model is used to analyze the precise nature of output losses during a monetary stabilization program, and the potential role for price controls in avoiding them. We show that with full credibility, the monetary disinflation will not cause output losses, in spite of price setting by firms. If firms assign a positive probability to the government not implementing its announcements, however, output losses will arise. The basic problem is straightforward: lack of credibility causes the real money stock to be "too low" on the transition path between the policy announcement and the period in which government credibility will finally be established. It is the interaction between monopolistic price setting and credibility that causes the output losses during disinflation programs.

If the government does not renege on its announcements, money will be lower than anticipated, and hence the real money stock too tight. The ensuing tightening of liquidity constraints lowers consumption and raises the marginal utility of wealth. This effect dies away as credibility improves and the gap between actual and anticipated money disappears (in this paper the information structure is set up such that that only takes one period). The temporary impact on the marginal utility of wealth also explains the behavior of asset prices during the transition period. The stock market valuation of home firms measures the value of claims on future output plus future resale value in terms of current marginal utility of wealth; hence the result that stock markets will be depressed during a disinflation program that is incompletely believed but actually implemented. Similarly, real interest rates will be high during a disinflation program plagued by credibility problems but actually implemented. The real interest rate on an indexed bond equals the rate at which the marginal utility of a real unit of wealth, λ, declines over time; thus a declining λ implies a high real rate of interest. This is a more fundamental result than the often heard claim that credibility problems raise the ex-post real rate but not the ex-ante one, because inflationary expectations are higher than actual inflation. But we have derived the result for an indexed bond, which is not affected by such inflation surprises.

We finally discuss nominal interest rates and the exchange rate. Nominal interest rates are not affected by surprises in the level of the money stock: the nominal interest rate equals the ratio between the value of future liquidity services of money and the marginal utility of a future unit of nominal wealth, and a money stock level surprise affects both the in the same way. Thus there is no impact of credibility problems on nominal rates. They will be high when actual monetary policy is expansionary and low when it is not, irrespective of credibility problems.

For a similar reason, there will be no impact of credibility problems per se on asset markets exchange rates (i.e. the relative price of a unit of foreign and domestic currency traded when asset markets are open). Expansionary policy will depreciate the exchange rate, and contractionary policy appreciate it, irrespective of credibility problems. This is not the case with the commodity market exchange rate however. The latter is the rate that would obtain during the time commodity markets are open if there were continuous trading in home and foreign currency. We show that for that exchange rate concept, the rate will appreciate because of credibility problems for those output realizations where liquidity constraints become binding.

All these intratemporal and intertemporal relative price effects carry true economic welfare losses; they cause wedges between rates of substitution and terms of trade available in commodity and asset markets. Price controls avoid these problems by taking the pricing decisions out of the firms' hands. Thus anticipations of reneging on tight money announcements will not be passed on in prices that will then be too high if the government in fact does not renege. As a consequence there will be no output losses during a disinflation program with properly administered price controls, and no increase in the marginal utility of wealth, credibility problems notwitstanding. Hence high real interest rates will be avoided.

However, we also show the importance of restrictive policies during the price control period. If price controls are compatible with the announced monetary disinflation program, and actual monetary policy does not deviate from its announced values, the relative price distortions mentioned are avoided, but exploiting price controls to relax monetary policy beyond its announced values reintroduces them. Moreoever, we show that if current actual monetary policy has any information content about future monetary policy, expansionary monetary policy during the price control period leads to the same anticipatory price setting problems after the control period that these controls were designed to resolve. In that sense, credibility and price controls together introduce an intertemporal trade off between current employment gains and future inflationary costs. Sustaining low inflation beyond the period of price controls thus requires restrictive monetary policy during the price control period.

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APPENDIX A:

A.1 Derivation of the Equilibrium Equations

We consider a perfectly pooled equilibrium, where the home and foreign consumer hold identical portfolios and consume identical quantities of the goods. That is, they hold the same per capita share of world asset stocks and consume the same per capita share of world output of each good: half of world quantities. Then the market equilibrium condition for the goods, money and other asset markets can be written

(A.1a) $$c_{ht} = c^*_{ht} = Y_t \le y_t \text{ and } c_{ft} = c^*_{ft} = Y^*_t \le y^*_t,$$

(A.1b) $$M_t = M^*_t = \bar{M}_t \text{ and } N_t = N^*_t = \bar{N}^*_t, \text{ and}$$

(A.1c) $$z_{ht} = z_{ft} = z^*_{ht} = z^*_{ft} = x_{Mt} = x_{Nt} = x^*_{Nt} = 1.$$

Introduce the notation

(A.2) $$x = x_t,\ x_{-1} = x_{t-1},\ x' = x_{t+1},\ \pi_M = 1/P_h,\ \pi_N = e/P_h,\ p = eP^*_f/P_h,$$

$$q_h = Q_h/P_h,\ q_f = Q_f/P_h,\ r_M = R_M/P_h \text{ and } r_N = R_N/P_h.$$

Then the budget, liquidity and rationing constraints can be rewritten

(A.2a) $$c_h + pc_f + \pi_M M + \pi_N N + q_h z_h + q_f z_f + r_M x_M + r_N x_N \le w,$$

(A.2b) $$w' = \pi_M' M + \pi_N' N + (q'_h + Y_h') z_h + pY_f^{*\prime}) z_f +$$

$$+ [r_M' + \pi_M' (\omega' - 1)\overline{M} x_M + [r_N' + \pi_N'(\omega^{*\prime} - 1)\overline{N}^*] x_N ,$$

(A.2c) $$c_h \le \pi_M[M_{-1} + (\omega-1)\overline{M}_{-1} x_{M,-1}],$$

(A.2d) $$pc_f \le \pi_N[N_{-1} + (\omega^*-1)\overline{N}^*_{-1} x_{N,-1}],$$

(A.2e) $$c_h \le Y \text{ and}$$

(A.2f) $$c_f \le Y^*.$$

In a stationary stochastic rational expectations equilibrium the endogenous variables in period t will be functions of the state variables in period t, $(s,\overline{M}_{-1},\overline{N}^*_{-1},\pi_M,\pi_N^*)$. Then the home consumer's decision problem to maximize (2.4) subject to (A.2) defines, in the usual way, the value function $v(w,M_{-1},N_{-1},x_{M,-1},x_{N,-1},s,\overline{M}_{-1},\overline{N}^*_{-1},\pi_M,\pi_N^*)$ as the maximum of $u(c_h,c_f) + \beta E[v(w',M,N,x_M,x_N,s',\overline{M},\overline{N}^*,\pi_M',\pi_N^{*\prime})]$ subject to (B.2). The first-order conditions together with the market equilibrium conditions (2.9), give

(A.3a) $$c_h \le \pi_M\overline{M} \qquad [\mu_h \ge 0],$$

(A.4a) $$pc_f \le \pi_N\overline{N}^* \qquad [\mu_f \ge 0]$$

(A.3b) $$c_h \le y \qquad [\nu_h \ge 0],$$

(A.4b) $$c_f \le y^* \qquad [\nu_f \ge 0],$$

(A.3c) $$u_h(c_h,c_f) = \lambda + \mu_h + \nu_h.$$

(A.4c) $$u_f(c_h,c_f) = \lambda p + \mu_f p + \nu_f,$$

(A.3d) $$\lambda\pi_M = \beta E[(\lambda' + \mu_h')\pi_M'],$$

(A.4d) $$\lambda\pi_N = \beta E[(\lambda' + \mu_f')\pi_N'],$$

(A.3e) $$\lambda q_h = \beta E[\lambda'(q_h' + Y')],$$

(A.4e) $$\lambda q_f = \beta E[\lambda'(q_f' + p'Y^{*'})],$$

(A.3f) $$\lambda r_M = \beta E[\lambda' r_M' + (\lambda' + \mu_h')\pi_M'(\omega'-1)\overline{M}] \text{ and}$$

(A.4f) $$\lambda r_N = \beta E[\lambda' r_N' + (\lambda' + \mu_f')\pi_N'(\omega^{*'}-1)\overline{N}^*].$$

Here λ, μ_h, μ_f, ν_h and ν_f are Lagrange multipliers of the constrains (A.2a), (A.2c), (A.2d), (A.2e) and (A.2f), respectively. Equations (A.3c) - (A.3f) are the partials of the Lagrangean with respect to c_h, M, z_h, and x_M, whereas (A.4c) -(A.4f) are partials with respect to c_f, N, z_f and x_N. By the definition of the value function it will fulfill

(A.5) $$v_w = \lambda, v_M = \mu_h\pi_M, \ v_N = \mu_f\pi_N, \ v_{x_M} = \mu_h\pi_M(\omega-1)\overline{M}_{-1} \text{ and}$$

$$v_{x_N} = \mu_f\pi_N(\omega^*-1)\overline{N}_{-1},$$

which has been exploited in (A.3) and (A.4).

Equations (A.3a) - (A.3d), together with the pricing equation (2.9), give (2.11a) - (2.11d).

A.2 Welfare During Disinflation Programs with and without Price Controls.

u^c is period t welfare during a disinflation program with price controls in place; u^E is the same but for the case without price controls. In both cases credibility is an issue: $\gamma_H > 0$.

$$Eu^C(c_h, c_f) = \int_0^{F(K_L\omega_L)} u(y,c_f)\, dF\, dF^*\, dH^*$$

$$+ \int_{F(K_L\omega_L)}^{F(\bar{y})} u(K_L\omega_L, c_f)\, dF\, dF^*\, dH^*$$

$$= \int_0^{F(K_E\omega_L)} u(y, c_f)\, dF\, dF^*\, dH^*$$

$$+ \int_{F(K_E\omega_L)}^{F(\bar{y})} u(K_E\, \omega_L, c_f)\, dF\, dF^*\, dH^*$$

$$+ \int_{F(K_E\omega_L)}^{F(K_L\omega_L)} (u\, (y,c_f) - u(K_E\omega_L, c_f))\, dF\, dF^*\, dH^*$$

$$+ \int_{F(K_L\omega_L)}^{F(\bar{y})} (u\, (K_L\omega_L, c_f) - u(K_E\omega_L, c_f))\, dF\, dF^*\, dH^*$$

$$= E\,u^E$$

(A) $$+ \int_{F(K_E\omega_L)}^{F(K_L\omega_L)} \int_s (u\,(y\,, c_f) - u(K_E\omega_L,\ c_f))\ dF\ dF^*\ dH^*$$

(B) $$+ \int_{F(K_L\omega_L)}^{F(\bar{y})} \int_s (u\,(K_L\omega_L,\ c_f) - u(K_E\omega_L, c_f)\ dF\ dF^*\ dH^*$$

$$> Eu^E$$

The inequality obtains since, for $y > K_E\omega_L$, $u\,(y,\ c_f) > u(K_E\omega_L,\ c_f)$ and since $K_L\omega_L > K_E\omega_L$.

APPENDIX B: The Price Setting Problem

We consider a continuum of firms defined over the unit interval, each producing a unique differentiated good indexed by j, $0 \leq j \leq 1$. Home preferences for differentiated goods are described by a CES subutility function separable in the home and foreign aggregates with corresponding CES prices indices, P_h and P_f^*. It follows that per capita demand for home product j is:

$$\text{(B.1)} \qquad C_{hj} = (P_{hj}/P_h)^{-\sigma_h} C_h.$$

Actual output is the minimum of capacity and demand:

$$\text{(B.2)} \qquad Y_j = \min\,(y, C_{hj}).$$

The home currency stock market value of firm h is:

$$\text{(B.3)} \qquad Q_{hj} = \beta E(\lambda' \pi_M' \,(Q_{hj}' + P_{hj}' \; Y_j')/ \; \lambda \pi_M$$

using the asset pricing equation (A.3e) from Appendix A. This can be simplified using (2.11d):

$$\text{(B.4)} \qquad Q_{hj} = P_{hj}' \; E\,(Y_j'/\omega')/\delta$$

with $\beta = 1/(1+\delta)$.

Consider first the case where the firm actually knows that ω' will equal say ω_E'. Then (2.20) can be written as:

$$\text{(B.5)} \qquad Q_{hj} = \frac{P'_{hj}}{\omega'_E} \left(\int_0^{F(K\omega'_E)} y\,dF + \int_{F(K\omega'_E)}^{\infty} K\omega'_E \left(\frac{P'_{hj}}{P_h}\right)^{-\sigma_h} dF \right)$$

The expression between parentheses equals Ey'. Equation (2.21) immediately shows one important result: if ω' is known in advance, expected output depends on $K\omega'$, but not on ω'. Maximizing the stock market valuation Q_{hj} requires that the following holds:

$$\text{(B.6)} \qquad \frac{1}{\omega'_E} \qquad \frac{P'_{hj}}{\omega'_E} \quad \frac{\partial}{\partial P'_{hj}} \quad \overset{\infty}{F(K\omega'_E)} \quad hj \quad h \quad {}^{-\sigma_h} \quad E$$

Simple manipulation of (2.22) shows that firms set the price such that the elasticity of demand equals minus one. The price influences that elasticity because it determines the probability of excess capacity. Without excess capacity, the elasticity is zero; with excess capacity it equals σ_h; the first order condition, once symmetry across firms has been imposed, implies a choice of P'_{hj} such that the output weighted expected value of the demand elasticity equals one:

$$\text{(B.7)} \qquad \frac{\frac{1}{\omega'_E} \; K\omega'_E \; Pr(y > K\omega'_E)}{\frac{1}{\omega'_E}\; Ey'} \, \sigma_h = 1$$

Consider next the case of policy uncertainty. We take a simple case, in anticipation of the analysis of disinflation programs in the next section: monetary expansion can be either high or low and the firm attaches probability γ_H to the possibility of an expansionary monetary policy:

$$\text{(B.8)} \qquad Pr(\omega' = \omega_H) = \gamma_H, \; Pr(\omega' = \omega_L) = 1 - \gamma_H \,.$$

In appendix C we show that, for a uniform distribution of y over the interval $(o, \bar{y})$, firms will set prices as if $\omega'_E = \gamma_H \omega_H + (1-\gamma_H) \omega_L$ obtains with certainty. Therefore, for this particular demand structure, policy uncertainty itself does not affect the probability of unemployment:

$$(B.9) \qquad \int_{F(y_E)}^{F(\bar{y})} dF = \gamma_H \int_{F(y_H)}^{F(\bar{y})} dF + (1-\gamma_H) \int_{F(y_L)}^{F(\bar{y})} dF$$

y_L and y_H are the output realization levels at which the liquidity constraints become binding in the restrictive (ω_L) and expansionary (ω_H) case respectively (cf.figure 1 in section 2.3).

APPENDIX C: Monetary Policy Uncertainty, Price Setting and Unemployment

Define K_E as the value of K for which the firm's first order condition hold if monetary expansion, ω_E, is known to them before they set prices:

(C.1)
$$\frac{1}{\omega_E} \quad \overset{F(\bar{y})}{F(y_E)} \quad E\ E$$
$$\frac{1}{\omega_E} \quad E\ y' \qquad h$$

By construction, ω_E equals the expected value of ω in the monetary uncertainty case:

$$\text{(C.2)} \qquad \omega_E = \gamma_H\, \omega_H + (1-\gamma_H)\, \omega_L$$

The FO condition in the uncertainty case then equals:

(C.3)
$$\frac{\gamma_H}{\omega_H} \int_{F(K\omega_H)}^{F(\bar{y})} K\omega\ dF + \frac{1-\gamma_H}{L} \int_{F(K\omega_L)}^{F(\bar{y})} K\omega \quad dF$$
$$\frac{\gamma_H}{\omega_H} \quad H \quad \frac{(1-\gamma_H)}{\omega_L} \quad L \qquad h$$

I will show that for a uniform distribution of y over $(Y, \bar{y})$, k_E satisfies C.3. It will be convenient to reproduce figure C.1.

First, the FO condition can be simplified; if ω is known with certainty, C.1 becomes

$$1 = \frac{\sigma_h\ K_E(1 - F\ (K_E\omega_E))}{E\ (y|\omega_E)/\omega_E}$$

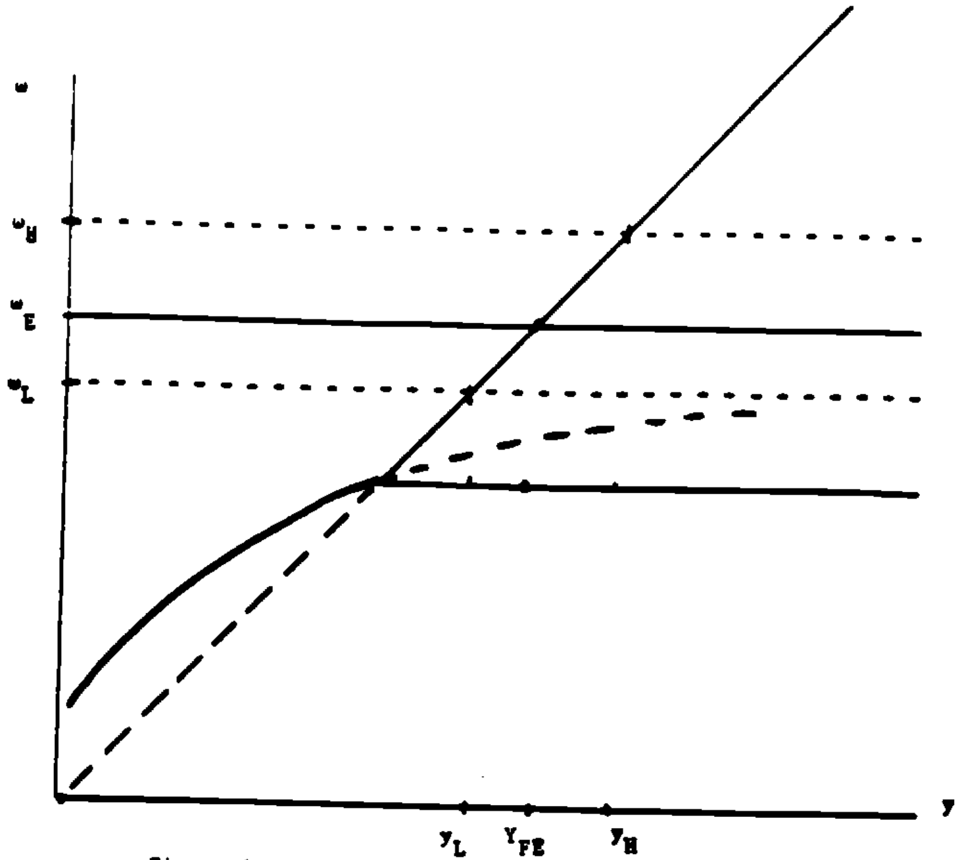

Fig. c.1 Monetary Policy Uncertainty and Unemployment

Similar simplification is possible for the uncertainty case. The numerator of (C.3), call it N.C3, becomes

$$N.C3 = K\sigma_h \left(\gamma_H(1- F(K\omega_H) + (1-\gamma_H)\ (1-F(K\omega_L))\right)$$

(C.5A) $$= K\sigma_h \left(1 - \gamma_H\ F(K\omega_H) - (1 - \gamma_H)\ F(K\omega_L)\right)$$

Assume (c.1): $K = K_E$,

(c.2): $\omega_E = \gamma_H\ \omega_H + (1 - \gamma_H)\ \omega_L$, and

(c.3): a uniform distribution of y over $(y, \bar{y})$. I will assume $y = 0$ for notational convenience.

(c.1-3) imply:

(C.6) $$(c.1\text{-}3) \Rightarrow F(K_E\omega_E) = \gamma_H\, F(K_E\omega_H) + (1 - \gamma_H)\, F(K_E\omega_L)$$

Hence the numerator of C.4 equals N.C3 under those conditions. Therefore, K_E solves the FO conditions for the uncertainty case too, given (c.1-3), if

(C.7) $$\frac{1}{\omega_E} \quad E \quad \overset{?}{\ } \quad \frac{E}{\omega_H} \quad E \quad \frac{\quad H}{\omega_L} \quad L$$

Consider first the left hand side, LHS:

(C.7) $$\frac{1}{\omega_E} \quad E \quad \frac{1}{\omega_E} \int_{F(0)}^{F(K_E\omega_E)} \quad \frac{1}{\omega_E} \int_{F(k_E\omega_E)}^{F(\bar{y})} \quad E\ E$$

$$= \frac{1}{\omega_E}\ \frac{K_E\omega_E}{2} + K_E\ (F(\bar{y}) - F(K_E\omega_E))$$

$$= K_E\ (1/2 + (\bar{y} - K_E\omega_E)/\bar{y})$$

The RHS concerns the policy uncertainty case:

$$RHS = \gamma_H \frac{1}{\omega_H} E(y|\omega_H) + (1 - \gamma_H) \frac{1}{\omega_L} E(y|\omega_L)$$

Consider the first term first:

$$\frac{\gamma_H}{\omega_H} \quad H \quad \frac{\gamma_H}{\omega_H} \int_{0}^{F(K_E\omega_E)} \quad \frac{\gamma_H}{\omega_H} \int_{K_E\omega_H}^{\bar{y}} \quad E\ H$$

(C.9) $$= \gamma_H\, K_E\ (1/2 + (\bar{y} - K_E\omega_H)/\bar{y})$$

Similarly for the restrictive money realization:

$$\text{(C.10)} \qquad \frac{(1-\gamma_H)}{\omega_L} \quad L \quad \frac{1-\gamma_H}{\omega_L} \quad {}^{F(K_E \omega_L)}_{0} \qquad \frac{1-\gamma_H}{\omega_L} \quad {}^{F(\bar{y})}_{F(K_E \omega_L)} \; E \; L$$

$$= (1-\gamma_H)\ K_E\ (1/2 + (\bar{y} - K_E \omega_L)\bar{y})$$

Adding (B.9) and (B.10), and using (b.2), then yields:

$$\text{RHS} = \gamma_H\ K_E\ (1/2 + (\bar{y} - K_E\ \omega_H)/\bar{y})$$

$$+ (1-\gamma_H)\ K_E\ (1/2 + (\bar{y} - K_E \omega_L)/\bar{y})$$

$$\text{(C.11)} \qquad = K_E\ (1/2 + (\bar{y} - K_E \omega_E)/y)$$

Hence LHS = RHS and K_E solves the FOC of the firm in the monetary uncertainty case too. Given (c.1-3) therefore, the existence of policy uncertainty does not in itself affect the probability of unemployment.