A Further Contribution towards Explaining Why Disinflation through Currency Pegging May Cause a Boom

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Abstract
We revisit the question of why exchange-rate-based (ERB) disinflation is often expansionary. We use an analytical DGE model in discrete time with staggered wages. If the policy is unanticipated, and if the currency is pegged at the level it would have reached under unchanged policies, then a boom occurs. For preannounced ERB disinflation, our model also predicts a boom. The explanation for both is that when wages are staggered, wage-setters have to be forward-looking. Anticipating lower future inflation, they reduce wages before the change in the exchange rate, causing a favourable supply-side effect on output.

Keywords Exchange-rate-based disinflation, money-based disinflation, staggered wages, preannouncement.

JEL Classification Codes E52, F41.

1. Introduction

One of the most tantalising facts about simple disinflation rules is that whereas money-based (MB) disinflations have tended to cause slumps in the short run, exchange-rate-based (ERB) disinflations have tended to cause booms.[1] By MB disinflation is meant a policy of reducing the growth rate of the money supply, and by ERB disinflation a policy of pegging the exchange rate. The puzzle is particularly the boom, since, from a traditional Keynesian perspective, a policy that reduces inflation would be expected to cause a slump. A considerable literature has tried to explain this contrast theoretically.[2] In the present paper we highlight a factor which, while also present in several other analyses, has not yet been seen, we believe, in its most fruitful context. This is forward-looking wage setting.[3] We show that forward-looking wage setting can explain a boom under ERB disinflation even without additional factors such as lack of credibility.[4]

Our aim in the present paper is the analytical one of dissecting the forces at work in these two common types of disinflation policy using a dynamic general equilibrium model. We study a small open economy with tradeable and nontradeable sectors, in which wages are set in a staggered fashion. Agents optimise intertemporally and obey the relevant budget constraints. Although this is a 'DGE' approach, our objective is not to construct a large-scale model and to compare it to the data. Instead it is to develop an apparatus which is sufficiently simple that the mechanisms at work can be inspected directly using algebra, rather than having to be guessed at using the output of numerical simulations. With such a strategy it will not be possible to match all the empirical regularities associated with MB and ERB disinflations. The factor on which we focus here is offered, not as a complete explanation of actual experience, but as an important contributory one, which has so far been neglected.

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[1] Many empirical studies have documented this; for example, Calvo and Végh (1999) and Fischer et al. (2002).

[2] Useful surveys are Rebelo and Végh (1995) and Calvo and Végh (1999).

[3] Our focus on wage setting is not fundamental: our analysis could easily be recast in terms of price setting.

[4] A prominent explanation which uses the latter notion, interpreted as 'temporariness' of the disinflation programme, is by Calvo and Végh (1994).

We first use our framework to study unanticipated policy. In the case of ERB disinflation, there is a range of values at which the exchange rate could be pegged which are all broadly consistent with the notion of fixing it at its ‘current’ level. We show that while some of these cause a slump, others cause a boom. In particular, if the exchange rate is fixed at the level which it would have reached under unchanged policies, there is a boom. The exact level of the peg is hence shown to be very important. In the case of MB disinflation, by contrast, we find that the policy always causes a slump. This result can be related to the previous one. We can generalise the notion of an unanticipated ERB disinflation to allow for an arbitrary value of the peg, not just one in which the exchange rate is fixed at its ‘current’ level. Doing this, it turns out that in our model an MB disinflation is the special case of a generalised ERB disinflation in which not only is the trend depreciation of the exchange rate halted, but also a last-minute revaluation is imposed. There is thus an equivalence between ERB and MB disinflation, up to the level of the exchange rate peg. The presence of the revaluation makes it easy to understand why an MB disinflation is always more contractionary than a standard ERB disinflation.

Most real-world disinflations are not the simple ‘cold-turkey’ policies just discussed. Typically they are more gradual, such as the Latin American ‘tablitas’ which announced a schedule of progressive reductions in the rate of exchange-rate depreciation. Such a policy involves an element of ‘preannouncement’, in that some of the measures to be taken are only implemented some time after they are announced. Nevertheless, in a world of forward-looking agents, if such announcements are credible they have an immediate effect. Later in the paper we study a simple type of preannounced ERB disinflation, in which it is announced at time zero that the exchange rate will continue to depreciate at its present rate until time T, after which it will be pegged at the level then reached. We show that in our model such a policy *always* leads to a boom in the announcement period, and moreover output continues to expand until just before the date of implementation. We also use this to explain why an apparently unanticipated ERB disinflation may cause a boom, as discussed above. The reason is that, in such a case, the exchange rate does not deviate significantly in the impact period from the value which it would have taken anyway. It is the expectation of a lower path for the future exchange rate which causes the boom.

The expansionary force underlying a preannounced ERB disinflation is, as we have indicated, forward-looking wage setting. When wage setting is staggered, wage-setters react to expected future values of the price level (and thus, indirectly, of the exchange rate). They start to moderate wage inflation ahead of the reduction in the rate of currency depreciation. This has a favourable supply-side effect on output, by lowering firms' costs. A similar effect also operates in Ball's (1994) model, and explains why he too obtains a boom. However, Ball considers a closed economy, and his is an MB disinflation policy. The boom outcome is an embarrassment there, since, as noted, in practice MB disinflations have invariably caused slumps. Ball concludes that his model is a failure. In our model, on the other hand, a preannounced MB disinflation would cause a slump.[5] The reason is that under MB disinflation, in a model with a reasonably developed monetary side, expectations of lower future inflation also affect aggregate demand, and not just aggregate supply. They turn out to have a negative effect which outweighs the positive effect through aggregate supply. Ball fails to obtain a contractionary effect because he postulates a completely interest-inelastic money demand function.

We have acknowledged that our analysis does not explain all aspects of typical ERB disinflation experiences. In our exposition we point out where other factors must be appealed to. Thus we do not claim to be offering a completely new alternative to other contributions in the literature. These have indeed been valuable. We simply seek to draw attention to a force which is already potentially present in a number of existing models, and which can be an important contributory factor, but which has not so far been identified as such in this context. It has been overshadowed by a concern with other factors, such as an inertial component in

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[5] We do not show this in the present paper, but it can be proved on very similar lines to the proof given in Ascari and Rankin (2002), which uses a closed-economy version of the present model.

inflation expectations, anticipated collapse of the policy, or beneficial supply-side effects from the removal of inflation distortions.[6]

The structure of the rest of the paper is as follows. Section 2 presents the basic elements of the model. In Section 3 we look at the general macroeconomic equilibrium and derive a loglinearised version. The analysis of unanticipated disinflation is conducted in Section 4, while preannounced policy is studied in Section 5. Section 6 concludes.

2. Structure of the Model

There are two output sectors: nontradeables and tradeables. We use subscripts N and T to denote these sectors, respectively. We adopt the simplifying assumption that output of the tradeable sector is exogenous, constant and given by 1.[7] Nontradeable output at time t is Y_{Nt}. Labour is the one variable factor of production; the production function for nontradeables is:

$$Y_{Nt} = N_t^{\sigma}, \qquad (0 < \sigma \leq 1) \tag{1}$$

where N_t is a composite of labour inputs (defined below).

Markets for both types of good are perfectly competitive. In the tradeable sector, the law of one price holds, i.e., $P_{Tt} = E_t$, where P_{Tt} is the domestic-currency price of tradeables and E_t is the nominal exchange rate, the domestic currency price of foreign exchange. (We normalise the foreign-currency price of tradeables to unity.) In the nontradeables market, the price P_{Nt} adjusts to equate demand and supply. In the labour market, where we locate the market imperfection of the model, there is a continuum of labour skills, indexed by $j \in [0,1]$. A household controls the supply of each type of labour and sets its money wage for two periods, subject to a demand function presented below.

There are two currencies, home and foreign, held only by the residents of the countries concerned. International borrowing and lending may take place between home and foreign

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[6] Examples of papers which emphasise these factors are, respectively, Rodriguez (1982), Calvo and Végh (1994) and Uribe (1997), to cite just a few.

[7] This sector could be thought of as extracting a natural resource such as oil, which requires a negligible amount of labour. The assumption of exogenous tradeable output is helpful in ensuring a tractable analysis, and is commonplace in the theoretical literature, including Calvo and Végh (1994, 1999), Celasun (2006), Hernández (2007) and Senay (2008). Taking tradeable output to be unity is merely a normalisation.

private agents, by issue or purchase of bonds. The initial stock of bonds is assumed to be zero, and as there is no uncertainty after the policy change at $t = 0$, their currency of denomination is immaterial. Domestic and foreign interest rates are linked by the interest parity condition, $I_t = I_t^*(E_{t+1}/E_t)$, where I_t (I_t^*) is the domestic (foreign) gross interest rate.

We turn now to the optimisation problem of individual agents. A typical firm in the nontradeable sector allocates its spending across labour types, where the wage of type j is W_{jt} and the quantity of labour each household supplies to the typical firm is L_{jt}, so as to minimise the cost of achieving a certain amount of a composite labour input given by:

$$N_t = \left[\int_0^1 L_{jt}^{(\varepsilon-1)/\varepsilon} dj\right]^{\varepsilon/(\varepsilon-1)}, \quad \varepsilon > 1. \tag{2}$$

Here ε is the elasticity of technical substitution across labour types. Solving the problem gives a standard conditional demand function for labour of type j:

$$L_{jt} = N_t (W_t / W_{jt})^{\varepsilon}, \tag{3}$$

where $W_t \equiv [\int_0^1 W_{jt}^{1-\varepsilon} dj]^{1/(1-\varepsilon)}$ is the wage index. Combined with (1), this implies the following supply function for nontradeable output:

$$Y_{Nt} = (W_t / \sigma P_{Nt})^{\sigma/(\sigma-1)}. \tag{4}$$

Household j is representative of all households supplying labour skill j. It obtains utility from consumption of both types of goods and from real balances, and disutility from supplying labour. As the sole supplier of type-j labour, it is effectively a monopoly union for that labour type. However, since there is a continuum of households over $j \in [0,1]$, each household is 'small', and thus a price taker, in every other market. The household's preferences over goods are represented by a Cobb-Douglas sub-utility function:

$$C_{jt} = C_{Njt}^{\alpha} C_{Tjt}^{1-\alpha}, \qquad 0 < \alpha < 1. \tag{5}$$

This is maximised subject to a given aggregate nominal expenditure, Ω_{jt}, defined by $\Omega_{jt} \equiv P_{Nt}C_{Njt} + P_{Tt}C_{Tjt}$. The resulting demand functions are then:

$$C_{Njt} = \alpha\Omega_{jt} / P_{Nt}, \qquad C_{Tjt} = (1-\alpha)\Omega_{jt} / P_{Tt}. \tag{6}$$

The indirect utility function is written as $C_{jt} = \Omega_{jt}/P_t$, where P_t is the consumer price index:

$$P_t = P_{Nt}^{\alpha} P_{Tt}^{1-\alpha} / \alpha^{\alpha}(1-\alpha)^{1-\alpha}. \tag{7}$$

This spending allocation problem may now be embedded in household j's higher-level optimisation problem. Wage staggering is introduced, as in Taylor (1979), by assuming that households are divided into two sectors: A, comprising labour types $j \in [0,½)$ and B, with types $j \in [½,1]$. The money wage must be set for two successive periods at the same level. Households in sector A choose their wage in even periods, and solve the following problem:

$$\text{maximise} \quad U_j \ = \ \Sigma_{t=0}^{\infty}\beta^t \left[\delta \ln C_{jt} \ + \ (1-\delta)\ln(M_{jt}/P_t) \ - \ \eta L_{jt}^{\zeta}\right] \qquad (\beta < 1,\ \zeta \geq 1) \tag{8}$$

$$\text{s.t. } M_{jt-1} + I_{t-1}B_{jt-1} + W_{jt}L_{jt} + \Pi_t + S_t \ = \ P_t C_{jt} + M_{jt} + B_{jt}, \tag{9}$$

$$L_{jt} = (W_t / W_{jt})^{\varepsilon} N_t, \quad \text{for } t = 0,1,2,...,\infty; \tag{10}$$

$$W_{jt} = W_{jt+1} \equiv X_t, \quad \text{for } t = 0,2,4,...,\infty. \tag{11}$$

The problem of a sector-B household is the same, except that its wage is given at time 0 and chosen in odd periods. According to (8), a household derives positive utility from consumption and real money balances, but receives disutility from working. ζ is the elasticity of this disutility with respect to labour supplied. The LHS of the budget constraint (9) states that the household's resources in period t consist of money (M_{jt-1}) and the interest on and principal of bonds ($I_{t-1}B_{jt-1}$) brought forward from the previous period as well as labour income earned in the period ($W_{jt}L_{jt}$), an equal share in firms' profits (Π_t), and a lump-sum subsidy from the government (S_t). These resources are allocated between consumption, money balances and bond holdings, as shown on the RHS. Equation (10) is the demand function for labour of type j, derived above, and equation (11) is the wage-setting constraint, that newly set wages obtain for two periods. We denote the 'new' wage by X_t.[8] Agents have rational expectations; completely unanticipated policy changes may occur, but (as is standard in the literature) once they have occurred, agents put a zero probability on any further policy change and have perfect foresight about the future development of the economy.

The above optimisation problem gives rise to the following first-order conditions:

$$C_{jt+1} = \beta[I_t P_t / P_{t+1}]C_{jt}, \tag{12}$$

$$M_{jt}/P_t = [(1-\delta)/\delta]C_{jt}I_t/(I_t - 1), \tag{13}$$

[8] The lack of the j subscript anticipates the point that all households in sector A, though acting independently, will choose the same new wage, as will be seen below.

$$X_t = \frac{\varepsilon}{\varepsilon - 1}\frac{\eta\zeta}{\delta}\frac{L_{jt}^{\zeta} + \beta L_{jt+1}^{\zeta}}{L_{jt} / P_t C_{jt} + \beta L_{jt+1} / P_{t+1} C_{jt+1}}. \tag{14}$$

The first two equations are the optimality conditions for intertemporal consumption choice and money holding, respectively. The third gives the new wage as a mark-up ($\varepsilon/(\varepsilon$-1) > 1) over a weighted average of the two wages which would apply in each period were the labour market competitive and not subject to the constraint that the wage is fixed for two periods.

The third type of agent in the model is the government, whose role is to determine either the exchange rate or the growth of the money supply, which is implemented through lump-sum subsidies to households. The government's budget constraint is hence

$$S_t = M_t - M_{t-1}. \tag{15}$$

We now turn to the market equilibrium conditions. The aggregate demand for money can be found by summing the individual demands, given by (13), across all households *j*. Denoting aggregate values by dropping the *j* subscript (i.e., $C \equiv \int_0^1 C_j dj$, $M \equiv \int_0^1 M_j dj$), the equilibrium condition is then:

$$M_t / P_t = [(1-\delta)/\delta] C_t I_t / (I_t - 1). \tag{16}$$

Whether or not the money supply M_t is exogenous will depend on the policy rule, as discussed below. Market clearing for nontradeables requires that supply as determined by (4) should equal demand as determined by the aggregate version of (6):

$$(W_t / \sigma P_{Nt})^{\sigma/(\sigma-1)} = \alpha \Omega_t / P_{Nt}. \tag{17}$$

Thus P_{Nt} is an implicit function of (W_t, Ω_t). Domestic supply of tradeables is fixed exogenously at 1, and may in principle differ from domestic demand as determined by the aggregate version of (6), resulting in a trade surplus or deficit. We denote the surplus by:

$$T_t = 1 - C_{Tt}. \tag{18}$$

Over time, deficits must be balanced by surpluses (appropriately discounted) plus any initial net foreign assets. The national intertemporal budget constraint states this:

$$-I_{-1} B_{-1} = \Sigma_{t=0}^{\infty} [I_0 I_1 ... I_{t-1}]^{-1} P_{Tt} T_t. \tag{19}$$

B_{-1} denotes the exogenous total initial private bond holdings. The home government issues no bonds, so B_{-1} is also the home country's initial net foreign assets.[9]

Turning to the labour market, by substituting out L_{jt} and L_{jt+1} from the wage-setting condition (14), using the labour demand function (10) and the wage-setting constraint (11), we obtain the following expression for the new wage:

$$X_t = \left[\frac{\varepsilon}{\varepsilon - 1} \frac{\eta\zeta}{\delta} \frac{W_t^{\varepsilon\zeta} N_t^{\zeta} \; + \; \beta W_{t+1}^{\varepsilon\zeta} N_{t+1}^{\zeta}}{W_t^{\varepsilon} N_t / P_t C_{jt} \; + \; \beta W_{t+1}^{\varepsilon} N_{t+1} / P_{t+1} C_{jt+1}} \right]^{\frac{1}{1+\varepsilon(\zeta-1)}} . \qquad (20)$$

Note that W_t, which appears in this, can be expressed as:

$$W_t = [0.5(X_t^{1-\varepsilon} + X_{t-1}^{1-\varepsilon})]^{1/(1-\varepsilon)} . \qquad (21)$$

This follows from the formula for the wage index and the facts (see below) that $W_{jt} = X_t$ for all j in sector A, $W_{jt} = X_{t-1}$ for all j in sector B (when t is even; the sectors are reversed when t is odd). A necessary last step in elaborating the expression for X_t is to relate C_{jt} to aggregate C_t. Since there is symmetry amongst the preferences and constraints of households, and since we henceforth assume that all households start with common asset stocks, it is clear that $C_{jt} = C_{kt}$, $W_{jt} = W_{kt}$ for any j,k in the same sector. We now in addition assume that $C_{jt} = C_{kt}$ for any j,k in *different* sectors. This can be justified by assuming complete domestic asset markets, allowing agents to insure against any initial shocks that would affect agents in different sectors differently because of the staggering structure.[10]. Under these assumptions $P_t C_{jt}$, which appears in (20), can be equated to Ω_t, average (and aggregate) nominal consumption.

3. General Equilibrium

To study the model's properties, we take a log-linear approximation around the zero-inflation steady state (ZISS). Note that the reference steady state (whose values we denote by an R subscript) is not the same as the initial steady state. As we are studying disinflation

[9] Equation (19) is derived from the aggregate version of equation (9), applied for all time periods, with a no-Ponzi-game condition imposed, ensuring that debt does not go to infinity

[10] Without this assumption, such shocks would have permanent effects on different sectors' consumption, which would complicate the solution in a way not obviously relevant to the results of interest. Note that we do not make the more demanding assumption of complete international asset markets.

policies, we assume that the economy is initially in a constant-inflation steady state (CISS). In addition, we assume that net foreign assets are zero both initially and in the reference steady state (i.e., $B_{-1} = B_R = 0$). The trade balance is then also zero in these steady states, since there are no net international interest receipts or payments which could sustain a permanent non-zero trade balance.

The loglinearised equations are given below. Derivations (where they are at all complex), as well as some other technical material, are given in a Technical Appendix.[11] Except where noted, lower-case symbols represent log-deviations of variables from their reference steady-state values, so $v_t \equiv \ln(V_t/V_R)$, where V_t denotes any variable, and V_R its value in the reference steady state.

$$\mu_{t+1} \equiv m_{t+1} - m_t \tag{22}$$

$$\omega_t \equiv p_t + c_t \tag{23}$$

$$z_t \equiv m_t - \omega_t \tag{24}$$

$$z_t = -[\beta/(1-\beta)]i_t \tag{25}$$

$$z_{t+1} = (1/\beta)z_t + \mu_{t+1} \tag{26}$$

$$e_{t+1} - e_t = i_t \tag{27}$$

$$y_{Nt} = [\sigma/(1-\sigma)](p_{Nt} - w_t), \qquad y_{Tt} = 0 \tag{28}$$

$$c_{Nt} = \omega_t - p_{Nt} = y_{Nt}, \qquad c_{Tt} = \omega_t - e_t \tag{29}$$

$$p_t = \alpha p_{Nt} + (1-\alpha)e_t \tag{30}$$

$$y_t = \alpha y_{Nt} \tag{31}$$

$$\tau_t = -c_{Tt} \tag{32}$$

$$\Sigma_{t=0}^{\infty}\beta^t \tau_t = 0 \tag{33}$$

$$x_t = \frac{1}{1+\varepsilon(\zeta-1)}\left\{\frac{1}{1+\beta}[\omega_t + \varepsilon(\zeta-1)w_t + (\zeta-1)n_t] + \frac{\beta}{1+\beta}[\omega_{t+1} + \varepsilon(\zeta-1)w_{t+1} + (\zeta-1)n_{t+1}]\right\} \tag{34}$$

$$w_t = 0.5(x_t + x_{t-1}) \tag{35}$$

$$n_t = (1/\sigma)y_{Nt}. \tag{36}$$

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[11] Available from the authors on request, or at

http://www.economics.bham.ac.uk/fender/fenderrankin.techappx.pdf

Equations (22) – (24) define monetary expansion (μ_t), nominal consumption (ω_t) and money demand per unit of consumption (z_t), respectively. The negative relationship of z_t to the nominal interest rate, shown in (25), can be interpreted as the 'money demand' function. It comes from the aggregate version of the first-order condition, (13). Equation (26) shows how z_t evolves over time when μ_t is exogenous. It is obtained by combining the aggregate versions of first-order conditions (12) and (13). Equation (27) is the uncovered interest parity (UIP) condition, under the assumption (made henceforth) that the log-deviation of the foreign interest rate is zero. Turning to goods markets, the nontradeables supply function (28) is a logged version of that in (4) above. Equation (29) gives the two sectoral demand functions, which depend on nominal consumption and the relevant price; the nontradeable goods market equilibrium condition is also included. The consumer price index, (30), is obtained by taking logs of (7). Real gross domestic product is defined in levels as $Y_t \equiv (P_{Nt}Y_{Nt} + P_{Tt}Y_{Tt})/P_t$. When loglinearised with coefficients evaluated in the balanced-trade steady state we obtain (31). For the trade balance, τ_t, defined as T_t, the 'levels' trade balance scaled by tradeables output (which is unity), is related to the log-deviation of tradeables consumption by (32). The approximated version of (19), the national intertemporal budget constraint, is given by (33) (in which we have already set initial net foreign assets, the right-hand side, to zero). Turning to the labour market, the wage-setting equation (20) becomes (34) upon loglinearisation, and the wage index formula (21) becomes (35). Lastly, equation (36) relating employment and nontradeable output is derived from equation (1).

The dynamics of our model are third-order. However, a special property of the model, due to the particular utility function used, is that we can solve for the time paths of some monetary sector variables separately from those in the rest of the economy. We next explain how this separability comes about. We then exploit it in order to solve for perfect-foresight time paths in a partially recursive manner. The dynamics become second-order, and we can derive our results analytically. In such a way we can shed more light on the underlying mechanisms at work than an approach based on numerical simulations can.

The monetary sector equations are (22) - (27). How we solve them depends on the monetary policy regime. Suppose first that the monetary growth rate is fixed at the value μ

(some exogenous initial value for m_t also being chosen). It is then clear that (26) is an autonomous first-order difference equation in z_t (money demand per unit of consumption). z_t is a non-predetermined state variable and this equation must hence be solved in a forward-looking manner. It is evidently unstable in the forward dynamics (noting $\beta < 1$), whence the unique non-divergent solution is for z_t to take its steady-state value, namely:

$$z = \beta(\beta - 1)^{-1}\mu \,. \tag{37}$$

It then follows from the money demand function (25) that:

$$i = \mu \,. \tag{38}$$

Knowing i, depreciation of the exchange rate is pinned down by the UIP condition (27):

$$e_{t+1} - e_t = \mu \,. \tag{39}$$

Lastly, nominal consumption spending must move together with the exogenous money supply, being given from (24) by:

$$\omega_t = m_t + \beta(1-\beta)^{-1}\mu \,. \tag{40}$$

Thus the time paths of money demand per unit of consumption, the nominal interest rate and nominal consumption are completely pinned down by the monetary-sector equations and are independent of what is happening elsewhere in the economy. Moreover, so long as monetary policy itself is time-invariant, these variables are always at their steady-state levels, or on their steady-state growth paths. The same is true for the exchange rate as regards its *depreciation rate*. However, the *overall level* of the exchange rate is not tied down in the monetary sector alone: it must be solved for using other equations, as we explain below.

In the case where monetary policy is used instead to control the exchange rate, a similar separability result applies. Suppose that the government chooses an initial level of the exchange rate and a devaluation rate, d. UIP then fixes i at d; the money demand function thence fixes z at $\beta(\beta\text{-}1)^{-1}d$; and, using this, the difference equation for z_t serves to tie down the endogenous monetary growth rate, yielding $\mu = d$. In summary, if we call the devaluation rate μ, instead of d, all of (37)-(40) still hold. The key difference is that the overall level of the exchange rate is now exogenous, while the overall level of the money supply becomes endogenous. The money supply thus swaps places with the exchange rate in how we solve the model, and we again need to appeal to equations outside the monetary sector to complete the determination of its time path.

A second property of the model under our assumptions is that the equilibrium value of the trade balance is always zero. We can show this as follows. From (32) and (29) we have:

$$\tau_t \;=\; -c_{Tt} \;=\; e_t - \omega_t. \tag{41}$$

This shows that the trade surplus depends only on the difference between the nominal exchange rate and nominal consumption. First differencing gives:

$$\tau_{t+1} - \tau_t \;=\; (e_{t+1} - e_t) - (\omega_{t+1} - \omega_t)\,. \tag{42}$$

Now, by UIP (equation (27)), $e_{t+1} - e_t = i_t$. We can also show that $\omega_{t+1} - \omega_t = i_t$: this is simply the Euler equation for consumption. (Such a relationship is embedded in (26).) So the trade balance is time-invariant along the perfect-foresight path. Inserting this constant value - τ, say - into the national intertemporal budget constraint, (33), it follows that τ must be zero. In turn this implies, from (41), that the exchange rate is given by:[12]

$$e_t = \omega_t. \tag{43}$$

The forces governing the wage dynamics can be examined more closely by substituting for w_t and n_t in the wage-setting equation, (34). By combining (28), (29), (34), (35) and (36) we can derive the following second-order difference equation in the 'new' wage x_t:

$$x_t \;=\frac{1}{(1+\beta)(1+\gamma)}\left[(1-\gamma)x_{t-1} + \beta(1-\gamma)x_{t+1} + 2\gamma\omega_t + 2\beta\gamma\omega_{t+1}\right], \text{ where } \gamma \equiv \zeta/\left[1+\varepsilon(\zeta\text{-}1)\right]. \tag{44}$$

Note that we do not impose the assumption that nominal consumption is constant over time, although this will usually be the case for the policies we consider. Equation (44) is essentially the same equation as in Taylor (1979). It tells us that the new wage set today depends positively on both the new wage set in the previous period and that rationally expected to be set next period. This is because of overlapping wage setting – the new wage set last period is still in force in the current period, hence affecting the current wage index and the new wage it is rational for wage-setters to choose. Similarly, current wage-setters need to anticipate what next period's wage-setters will do as the wage they set this period lasts for two periods. The difference from Taylor here is that the parameter γ (which captures the responsiveness of the

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[12] Another implication is that nominal consumption, ω_t, always equals nominal GDP, $p_t + y_t$.

new wage to the level of economic activity) is derived from the underlying microeconomic parameters, rather than being postulated directly.

As in Taylor, and as is necessary for existence and uniqueness of a non-divergent perfect foresight equilibrium, equation (44) is 'saddlepath' stable, meaning one eigenvalue lies outside, and one inside, the unit circle. λ, the stable eigenvalue, is given by:

$$\lambda = \frac{(1+\beta)(1+\gamma) - \sqrt{(1+\beta)^2(1+\gamma)^2 - 4\beta(1-\gamma)^2}}{2\beta(1-\gamma)}. \tag{45}$$

As γ tends to zero, λ tends to 1 and adjustment to the steady state is slow, whereas as γ tends to 1, λ tends to zero[13] and adjustment is rapid. Slow adjustment to the new steady state is thus associated with a low value of γ, and hence with a high elasticity of substitution amongst labour types (ε) and a high elasticity of disutility of work with respect to labour supply (ζ).[14]

Before we turn to disinflation policy, where we shall be concerned mainly with short- and medium-run effects, we note that in this model there is a positive steady-state relationship between inflation and output. It is straightforward to derive:

$$y_N = \frac{\sigma(1-\beta)}{2(1+\beta)\gamma}\mu. \tag{46}$$

So, to the extent that $\beta < 1$, inflation has a positive effect on output in the long run. This could be interpreted as implying a non-vertical long-run Phillips curve, which has been discussed by some other authors in the context of staggered-price models.[15] The mechanism is as follows. When wages must be set for two periods at the same level, a wage-setter chooses a 'compromise' between his two ideal flexible wages. If prices are rising, the later ideal flexible wage will be greater than the earlier one. If the discount factor, β, equals one, the chosen wage will be exactly half-way between these, but if β is less than unity it will be biased towards the earlier one. Under discounting, then, inflation lowers the average real wage. Together with the demand for labour function, this raises employment and output. This

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[13] Application of l'Hôpital's Rule to (45) demonstrates this.

[14] See Ascari (2000) for a detailed discussion of the microeconomic determinants of 'output persistence' in a staggered-wage DGE model.

[15] For example, Calvo (1983), Ascari (1998), Graham and Snower (2008).

effect is unlikely to be empirically significant, as is shown by the numerical example in Table 1. Nevertheless, it is unavoidably present in the model since we cannot set $\beta = 1$.

4. Unanticipated Disinflation and the Level of the Exchange-Rate Peg

Suppose the economy is in an initial steady state with constant inflation $\mu_I > 0$. (Subscript I denotes an initial CISS value.) Other nominal variables (the money supply, the exchange rate, nominal consumption and nominal GDP) must also be growing at this rate. It is immaterial whether we think of monetary policy in this initial steady state as being one of fixing the monetary growth rate, the devaluation rate or the nominal GDP growth rate.

The policy of disinflation is introduced at $t = 0$. It takes the form of pegging the exchange rate from $t = 0$ onwards at $e_t = \bar{e}$. We assume that this change is unanticipated and fully credible. We will study the effect of various alternative values of $\bar{e}$. It is helpful to parameterise $\bar{e}$ in relation to its own lagged value and rate of growth by:

$$\bar{e} \;=\; e_{-1} + \chi\mu_I \,. \tag{47}$$

A standard type of ERB disinflation policy might be where $\chi = 0$: the exchange rate is pegged at its value in the previous period. Equally plausibly, however, it might be where $\chi = 1$: the exchange rate is pegged at the value it would have reached under unchanged policies. Both are roughly consistent with the idea of pegging the exchange rate at its 'current' value. Since it is not obvious a priori which deserves greater attention, we shall study both. The formulation (47) also allows us to study intermediate cases where $0 < \chi < 1$. Cases in which χ lies outside the interval [0,1] are also of interest, as we will show.

Our particular concern is with the impact effect of the disinflation on output. By combining the supply and demand functions for nontradeables, (28) and (29), we have:

$$y_{Nt} = \sigma(\omega_t - w_t)\,. \tag{48}$$

Thus, the effect on nontradeable (and total) output depends on the difference between nominal consumption spending and the wage. These are demand-side and supply-side factors, respectively. Output in the impact period relative to its initial CISS value is obviously:

$$y_{N0} - y_{NI} \;=\; \sigma[(\omega_0 - \omega_{-1}) \;-\; (w_0 - w_{-1})]\,. \tag{49}$$

Whether a boom or slump occurs therefore just depends on whether nominal consumption growth exceeds or falls short of wage inflation initially. We now look at the determinants of these.

First, we know from (43) that $\omega_t = e_t$. Nominal consumption growth in the impact period hence just equals the exchange rate depreciation in that period:

$$\omega_0 - \omega_{-1} \; = \; \bar{e} - e_{-1} \; = \; \chi\mu_I \, . \tag{50}$$

ω_0 - ω_{-1} is therefore determined by the level of the exchange-rate peg: if $\chi = 0$, consumption spending levels off abruptly, but if $\chi = 1$, it continues along its old path for one final period.

Second, from (35), wage inflation in the impact period can be expressed as:

$$w_0 - w_{-1} \; = \; (1/2)(x_0 - x_{-1}) \; + \; (1/2)(x_{-1} - x_{-2}) \, . \tag{51}$$

The term x_{-1} - x_{-2} in (51) is predetermined and equals μ_I, reflecting inflation in the new wage still 'in the pipeline'. The term x_0 - x_{-1} is endogenous, since x_0 is set knowing the policy announcement in period 0. The perfect foresight solution for x_0 is readily derived by standard reasoning. Its derivation is outlined in the Appendix. Substituting the resulting expression for x_0 - x_{-1} into (51) and using (50), we obtain:

$$w_0 - w_{-1} \; = \; (1/2)(1-\lambda)(\bar{e} - e_{-1}) \; + \; (1/2)\left[(1/2)(1-\lambda)\left(\frac{1-\beta}{1+\beta}\frac{1}{\gamma} - 1 \right) \; + \; 1 \right]\mu_I \; . \tag{52}$$

This shows that, like consumption growth, wage inflation in the impact period is increasing in the exchange-rate depreciation in that period, $\bar{e} - e_{-1}$. Unlike consumption growth, it is less than proportional to such depreciation.

Figure 1 depicts period-0 consumption growth and wage inflation as functions of the chosen period-0 exchange-rate depreciation. It is apparent that whether there is a boom or a slump in the impact period depends on the size of this depreciation (i.e. on χ). When $\chi = 0$ ($\bar{e}$ is pegged at e_{-1}), the sudden fall of nominal consumption growth from μ_I to zero in the impact period causes a slump. Although there is also some reduction in wage inflation, the latter does not drop immediately to zero, and its continuation hence reduces output. On the other hand, when $\chi = 1$ ($\bar{e}$ is pegged at $e_{-1} + \mu_I$), there is no fall in consumption growth in the impact period: it continues along trend for one more period. Wage inflation begins to fall, though by less than before.[16] However any fall is now enough to cause a boom, given that nominal consumption has not yet deviated from its old trajectory. In summary, despite the fact that both χ = 0 and χ =1 appear, broadly speaking, to be cases of pegging the exchange rate at its 'current' value, they have opposite implications for the impact effect on output. Below we will argue that χ = 1 provides a closer approximation to real-world ERB disinflations.

Having seen that whether the short-run outcome is a boom or slump is sensitive to the exact value of the exchange-rate peg, it is easy to calculate the value which would ensure neither. This is where the ω_0-ω_{-1} and w_0-w_{-1} schedules cross in Figure 1. It obviously occurs at a value of χ strictly between 0 and 1. We can calculate this critical value as:

$$\chi_A \;=\; \frac{1}{2} \;+\; \frac{(1-\lambda)(1-\beta)}{2(1+\lambda)(1+\beta)\gamma}. \tag{53}$$

Notice that χ_A tends to 1/2 as β tends to one. Since we expect β to be close to 1, χ_A is about halfway between the two values just considered. It should be noted that, although setting χ equal to χ_A would avoid any immediate disturbance to output from an ERB disinflation, it would not prevent a disturbance in periods $t > 0$. This point will be taken up below.

Now consider what happens to the path of the endogenous money supply under the above policies. In Section 3 we showed that, under a constant devaluation rate policy, the money supply would jump immediately to a constant growth path, with a growth rate, μ, equal to d, the rate of devaluation. Since d = 0 under ERB disinflation, it follows that μ = 0: i.e., the money supply goes straight away to its new steady-state value. From (24), this value can be calculated as:

$$m \;=\; z + \omega \;=\; \bar{e}. \tag{54}$$

(We have used (37) and (43) here.) A similar calculation yields an expression for m_{-1}, the money supply in the initial CISS, whence the monetary growth rate in period 0 (the last period before it drops to zero) is:

$$m - m_{-1} \;=\; [\chi + \beta(1-\beta)^{-1}]\mu_I\,. \tag{55}$$

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[16] To show generally that w_0-$w_{-1} < \mu_I$ when χ =1, some algebra is required. However it is already apparent from (52) that it holds as $\beta \to 1$. For general values of β, the proof in part (iii) of the Appendix applies: see Section 5.

So, if the exchange rate is pegged at the level it would have reached under unchanged policies (χ = 1), money growth will *increase* (i.e. exceed μ_I) in the impact period. There is a final period of acceleration before the money supply levels out. This is illustrated in Figure 2. Even if χ = 0, monetary growth will still be positive in the impact period, and will almost certainly still exceed μ_I (this occurs if β is greater than ½). This final upward jump in the money supply is the 'remonetisation' effect, noted by Fischer (1986): the announcement of the peg immediately reduces the nominal interest rate via the UIP condition, causing a rise in demand for real money balances. The latter is met by an increase in the nominal money supply, which has to be determined passively given that the government fixes the exchange rate.

Armed with this analysis, it is easy to see what will happen if, instead of conducting an ERB disinflation, the government carries out an MB disinflation. In this case, the monetary growth rate is reduced from μ_I to zero in t = 0 and held at zero thereafter (i.e., the money supply is kept at the level it reached at time t = -1 indefinitely). The exchange rate floats. Having just seen that under an ERB disinflation monetary growth endogenously drops to zero in periods t = 1 onwards, while in t = 0 it is given by (55), it is clear that the time path of m_t required for an MB disinflation can be exactly reproduced by carrying out an ERB disinflation and using (55) to choose $\bar{e}$ (or χ) such that m - m_{-1} = 0. In other words, in our model an MB disinflation is just a particular type of ERB disinflation in which:

$$\chi = -\beta(1-\beta)^{-1} \quad (\equiv \chi_B, \text{ say}). \tag{56}$$

Clearly χ_B is negative. Therefore to bring monetary growth to zero $\bar{e}$ must be chosen to be below e_{-1}, so not only must the trend depreciation in the exchange rate be halted in t = 0, but there must be a once-and-for-all *appreciation* of the exchange rate at the start of the disinflation. This is illustrated in Figure 3. The reason for this is to stop the upward jump in the money supply which occurs under a standard ERB disinflation, as seen above. The appreciation provides an alternative mechanism of 'remonetisation': the higher demand for real balances due to the fall in inflation cannot be satisfied by a jump in the nominal money supply, so it must be satisfied by a drop in the general price level. An exchange-rate appreciation achieves this by lowering the domestic price of tradeables, which also switches demand away from nontradeables and puts downward pressure on the price of the latter.

A comparison of the different paths of the exchange rate and money supply in Figures 2 and 3 now makes it clear why an MB disinflation is more contractionary than a standard ERB disinflation. The exchange rate follows a more appreciated trajectory in the former, and also the money supply is lower. Figure 1 is also relevant. Since an MB disinflation is associated with a negative value of χ, it is clear from Figure 1 that for such a policy wage inflation exceeds nominal consumption growth by a greater margin than it does for an ERB disinflation with $\chi = 0$ or $\chi = 1$. Hence the forces tending to depress output are clearly more powerful.

Returning to the case of a standard ERB disinflation, we have argued that there is some discretion over what could be considered as a pegging of the exchange rate at its 'current' level. Roughly speaking, any value of χ in the interval [0,1] satisfies this. The most striking result is that, for any value of χ in the sub-interval $(\chi_A,1]$, a boom, rather than a slump, in output occurs in the impact period.[17] This matches the stylised fact that ERB disinflations have tended to cause booms rather than slumps. In the next section we will delve deeper into the mechanism underlying the boom. Before doing so, however, we pause to examine how well our simple story for the case $\chi = 1$ fits the facts of a typical ERB disinflation experience in a developing country. As emphasised in the Introduction, our main aim in this paper is a qualitative elucidation of the forces at work, not a quantitative exercise of maximising the fit of the model to the data, so this examination will be only rough and ready.

First, one might wonder whether the boom can be of significant magnitude . In Table 1, the first two rows present some very simple numerical calculations for the case of an economy with an initial per-period inflation rate of 10% ($\mu_I = 0.1$). If one period is 6 months long - so wages are fixed for a year - this is an initial annual inflation rate of 21%. As

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[17] One might argue that it is unsurprising that a boom may result when the value of the exchange rate peg is chosen freely, since a large enough devaluation just before pegging could produce such an outcome. Notice, however, that so long as $\chi \leq 1$, the exchange rate's path never lies above the path it would have taken in the absence of the disinflation, i.e. it is never devalued relative to its old path.

reasonably plausible values of the other parameters we take $\beta = 0.99$, $\varepsilon = 13$, $\zeta = 4$ (which imply $\gamma = 0.1$ and $\lambda = 0.52$) and $\sigma = 1$. When $\chi = 0$ the impact effect is a slump, while when $\chi = 1$ it is a boom. A rise of 3.75% in nontradeable output, as occurs in the latter case, is a sizeable expansion, suggesting that even a basic staggered-wage DGE model can explain some of the boom typically experienced by countries conducting ERB disinflations.

The response of variables other than output is also of interest. Inflation in practice responds with a lag to attempts to reduce it. Authors such as Fuhrer and Moore (1995) and Mankiw and Reis (2002) have criticised basic staggered-price models for failing to exhibit 'inflation persistence'. The predictions of our model on this score therefore merit attention. We focus on wage inflation because this is closer to the core of the inflation-generating process in our model.[18]

The dynamics of wage inflation are governed by those of the 'new wage', x_t (recalling (35)). The perfect-foresight solution for x_t following an unanticipated disinflation in $t = 0$ is the saddlepath solution of (44):

$$x_t - x = \lambda^{t+1}(x_{-1} - x). \qquad (57)$$

Here x is the new steady-state value of x_t, whereas x_{-1} is the predetermined lagged value of x_t in the period in which the policy begins. It is clear that if $x > x_{-1}$, then, since λ is less than unity, x_t rises during the transition to the new steady state, and so wage inflation is positive during the transition. This is what we will call 'inflation persistence'. On the other hand, if $x < x_{-1}$, there is negative inflation during the transition. In this case inflation converges to zero from below and hence must drop from its initial positive value to a negative one at the start of the policy. This empirically less plausible behaviour we will call 'inflation overshooting'.

We can calculate $x - x_{-1}$ as (see Appendix):

$$x - x_{-1} = [\chi - 1/2 + (1-\beta)/(1+\beta)2\gamma]\mu_I . \qquad (58)$$

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[18] Tradeables price inflation is just equal to the rate of exchange-rate depreciation, while nontradeables price inflation is a weighted average of wage inflation and the rate of exchange-rate depreciation. It follows that overall price inflation is simply a weighted average of the rates of exchange rate depreciation and of wage inflation. Simple manipulations yield $p_{Nt} = (1-\sigma)e_t + \sigma w_t$ and $p_t = (1 - \alpha\sigma)e_t + \alpha\sigma w_t$.

If $\chi = 0$ then this is negative, given our general presumption that β is close to 1. That is, if the exchange rate is pegged at its lagged value, there is no inflation persistence. This is true a fortiori if $\chi < 0$, which we saw to hold under MB disinflation. The time path of wage inflation following an MB disinflation is depicted in Figure 3. Similar predictions in other staggered-wage or -price models of an implausibly rapid drop in inflation have been noted by other authors, such as those cited above. This perceived weakness has motivated a number of modifications to the standard assumptions about the staggering of wages or prices - see again the cited authors.[19] If $\chi = 1$, however, it follows from (58) that x - x_{-1} is positive. In this case inflation persistence *does* occur. Hence the version of our model which generates a boom following an ERB disinflation also has no problem in generating inflation persistence. The time path of wage inflation following an ERB disinflation with $\chi = 1$ is depicted in Figure 2. This provides a second reason for why a value of χ close to 1 helps fit the facts of ERB disinflations.

A corollary of the above is that there is a critical value of χ which avoids both inflation persistence and inflation overshooting. This is the value which equates (58) to zero, i.e.:

$$\chi \ = 1/2 \ - \ (1-\beta)/(1+\beta)2\gamma \ \ (\equiv \ \chi_C, \ \text{say})\,. \tag{59}$$

With this value of χ, as (58) shows, x_t moves straight to its new steady-state value. Wage inflation, w_t - w_{t-1}, reaches zero in $t = 1$ and stays there. Moreover, all other dynamics are also eliminated, so that the economy is in its new steady state from $t = 1$ onwards. As can be seen from the fact that $\chi_C < \chi_A$, however, this is at the cost of a slump in the impact period.

Disinflations, whether of the ERB or MB type, have usually been accompanied by short-run real exchange rate appreciations in practice.[20] The real exchange rate here is the relative price of tradeable to nontradeable goods, or e_t - p_{Nt} (a rise indicating a real depreciation). In our model, this simply moves one-for-one with nontradeables output:[21]

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[19] Another study, close to ours in that it focuses on exchange-rate pegging, is by Miller and Sutherland (1993). They also find a lack of inflation persistence in the basic model, and conclude that it is best explained by imperfect credibility of the policy.

[20] See again the surveys by Calvo and Végh (1999) or Fischer et al. (2002).

[21] This is easily seen from the market-clearing condition for nontradeables in (29), plus the fact that $\omega_t = e_t$.

$$e_t - p_{Nt} = y_{Nt}. \tag{60}$$

It follows that an MB disinflation, which causes a slump, is indeed accompanied by a real appreciation. However an ERB disinflation with $\chi = 1$, which causes a boom, is accompanied by a real depreciation. It is not hard to see intuitively why our explanation for the boom must be associated with a real depreciation. In the Introduction we foreshadowed the point, developed more fully below, that the boom is due to the effect of anticipation of lower inflation on wage setting, which creates a supply-side stimulus. When $\chi = 1$, exchange rate depreciation continues along its old trend in the impact period, while wage inflation begins to moderate immediately. This reduction in wage inflation causes nontradeables inflation to begin to moderate too,[22] whence $e_t - p_{Nt}$ must rise.

The counterfactual response of the real exchange rate indicates that our story of the boom should be seen as a contributory, rather than a complete, one. A further factor which seems important is some source of initial stimulus to aggregate demand. This would tend to raise the price of nontradeables, rather than lower it as occurs with a stimulus to aggregate supply, and thus cause a real appreciation rather than a real depreciation, given that the domestic price of tradeables is fixed in the impact period by the pegged exchange rate. Other authors have advanced theories as to why an ERB disinflation may create an aggregate demand boom. Best known is the argument of Calvo and Végh (1994) that it could be caused by a rationally anticipated breakdown of the disinflation policy. In their analysis, the nominal interest rate is expected to rise again, and the currently lower rate acts like a temporary reduction in a tax on consumption, motivating consumers to bring forward their spending. Alternatively, De Gregorio et al. (1998) propose that there is a boom in consumer durables demand, resulting from 'lumpy' adjustment costs. Other sources of stimulus could be the (temporary) real interest rate reduction and the (permanent) reduction in nominal interest rates; the latter could be expansionary in the presence of credit market imperfections because of 'front loading' effects even with an unchanged real interest rate. We would not deny that such mechanisms creating a demand boom should also be considered. Our aim in the present

[22] Recall that the nontradeables price is a weighted average of the wage and of the exchange rate.

paper is just to point out that supply-side effects arising from forward-looking wage setting also have a role in explaining the boom. If both types of effect were operating, the latter would merely be preventing an even bigger appreciation of the real exchange rate.

5. Preannounced Exchange-Rate Pegging

In Section 4 we saw that our model can explain the widely documented fact that MB disinflations tend to cause slumps on impact whereas ERB disinflations tend to cause booms. However it also revealed that the outcome is sensitive to the level of the exchange-rate peg. For some interpretations of what it means to peg the exchange rate at its 'current' level (namely, the cases where $\chi \in [0,\chi_A)$), the outcome is a slump, not a boom. In practice, however, ERB disinflations have usually been more gradual than in the simple representation we have used here. A typical feature of Latin American ERB disinflations of the 1970s, 1980s and early 1990s was the use of a 'tablita': the announcement of a schedule of progressive reductions in the rate of devaluation of the exchange rate. For example, the Mexican exchange rate was allowed to 'crawl' against the US dollar at a rate of 1 peso a day between January 1989 and March 1990 (equivalent to a 16% annual devaluation rate); this was reduced to 80 centavos a day between January and December 1990, and further reduced to 40 centavos a day between December 1990 and December 1991, after which a target zone was introduced where the ceiling, but not the floor, was allowed to depreciate further.[23] In such a case, parts of the policy change are 'preannounced': they are announced in one period for implementation in a later one. Of the two simplest cases of a basic type of ERB disinflation which we have considered (χ = 0 and χ = 1), the χ = 1 case could in fact be argued already to contain an element of 'preannouncement'. This is because the exchange rate in the first period of the new policy, e_0, does not immediately differ from the value it would have taken anyway; it is only in periods $t > 0$ that it differs. This is why, amongst simple ERB disinflations, we consider the χ = 1 case to be more realistic. It is also why it would be of interest to analyse preannounced ERB disinflation policy more generally. We do this in the present section.

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[23] See, for example, Dornbusch and Werner (1994), pp. 288-9.

We now assume that at $t = 0$ the authorities announce that at $t = T$ (≥ 1) and thereafter the exchange rate will be pegged such that $\bar{e} = e_{T-1}$. For $t = 0,...,T-1$, we assume the exchange rate continues to be devalued at its old trend rate, μ_I, so that over this interval it follows the same path that it would have followed under unchanged policies. There are hence two phases: the 'pre-implementation' phase, from $t = 0$ to $T-1$; and the 'post-implementation' phase, from $t = T$ to ∞. The equations governing the dynamics of the economy are different in each phase.

Focusing on the impact effect of the announcement on output, equation (49) remains valid, telling us that the change in output is proportional to the gap between nominal consumption growth and wage inflation in $t = 0$. Nominal consumption growth still equals exchange rate depreciation, by virtue of (43), and such depreciation continues to equal μ_I until the disinflation policy is implemented. Therefore whether or not there is a boom depends on whether wage inflation in the impact period drops below μ_I. Our previous expression for this, (52), must be modified to allow for the preannouncement. The calculations required are straightforward but tedious, so we reserve them for the Appendix. Substituting the resulting expression for $w_0 - w_{-1}$ into (49), we obtain:

$$y_{N0} - y_{NI} = (\sigma/2)(1/\lambda')^{T-1}\left\{\lambda + (1-\lambda)[1-(1-\beta)(1+\gamma)/2\gamma](1+\beta)^{-1}\right\}\mu_I, \qquad (61)$$

where λ' (>1) denotes the unstable eigenvalue of equation (44). It is clear that $y_{N0} - y_{NI}$ is positive for β sufficiently close to 1. In fact we can show (see the Appendix) that it is positive for *all* β. A preannounced ERB disinflation therefore always causes a boom. As is also evident, the boom is smaller the greater is T, i.e., the farther into the future is the planned implementation. As we reduce T, the size of the boom increases. The lowest value of T for which (61) is valid is $T = 1$. It can readily be checked that in this case, (61) exactly reproduces the result of Section 4 for the case $\chi = 1$. This hence shows that an 'unanticipated' ERB disinflation, in which the exchange rate is pegged at the value it would have reached under unchanged policies, is equivalent to a preannounced ERB disinflation with an interval of only one period between announcement and implementation. Like the cases of more obvious preannouncement where $T > 1$, it generates a boom; and unlike the case of an unanticipated pegging of the exchange rate at its lagged value, it does not generate a slump.

We have already pointed to the mechanism underlying the boom in the Introduction. As previously observed with reference to equation (49), the effect of the policy change on output depends on the difference between the effect on aggregate demand, represented by current exchange rate depreciation, and the effect on aggregate supply, represented by current wage inflation. When the policy is preannounced, there is no immediate effect on aggregate demand. But there *is* an immediate effect on aggregate supply, because wages are set in a forward-looking manner, and anticipation of the reduction in inflation causes workers to start reducing wage inflation ahead of the change in the path of the exchange rate. This is a result of wage setting being staggered: the optimal wage to set depends partly on one sector's forecast of the other sector's wage which will be set next period, with which it overlaps; and so on into the future.

This can be contrasted with what happens under a preannounced MB disinflation.[24] There the exchange rate floats, and can change immediately when the policy is announced. There is a jump appreciation, and thus an instantaneous negative effect on aggregate demand. There is also an immediate fall in the nominal interest rate. Another way to understand the contractionary demand-side effect, which applies equally well in a closed economy, is to note that the fall in the interest rate causes a rise in money demand in $t = 0$. However, the path of the money supply has not yet changed, and nominal rigidity in wages prevents the price level from falling by enough to generate the necessary higher supply of real balances. For money market equilibrium, consumption and output then have to fall, to reduce money demand. Hence, under preannounced MB disinflation, there is a contractionary effect of lower anticipated inflation working through the demand side of the economy which counteracts the expansionary effect working through the supply side described above. The former turns out to dominate. Another perspective is to note, as in the unanticipated case, that under preannounced ERB disinflation the money supply is endogenous. This permits it to rise to

[24] For reasons of space, we do not present a formal analysis of this here. Ascari and Rankin (2002) do so in a closed-economy version of the present model.

satisfy money demand, eliminating the contractionary demand-side effect of the anticipated fall in inflation.

Light is hereby shed on unanticipated ERB disinflation. When $\chi = 1$, this is exactly the same as an ERB disinflation announced one period in advance, as just noted. The force causing the boom is thus the supply-side stimulus coming from anticipatory wage reduction. When $\chi < 1$, there is also some aggregate demand contraction in the impact period, because the exchange rate is lower than it would have been under unchanged policies. However, if χ is close to one, this is still too weak to prevent a boom. For χ substantially below one, on the other hand, the immediate implementation of a contraction in aggregate demand dominates and output falls. This is notably the case if $\chi = 0$, as we have seen.

The source of the boom in our model under preannounced ERB disinflation is essentially the same as in Ball (1994). Ball used a directly postulated closed-economy, staggered-price model and studied a disinflation policy where the monetary growth rate is scheduled to decline linearly over time until it reaches zero. Preannouncement is involved, because tighter monetary growth is announced, but implemented only gradually. As in our paper, Ball's boom is due to forward-looking price-setters who start to reduce prices (compared with what they would otherwise have set) in advance of the monetary slowdown. However, despite considering an MB disinflation, Ball obtains no negative anticipatory effect on aggregate demand to counteract the positive effect on aggregate supply. This is because he postulates an *ad hoc* money demand function with zero interest elasticity, which makes aggregate demand independent of expectations about the future. In the present paper, by looking at preannounced ERB disinflation, we have also eliminated the negative impact effect of preannounced disinflation policy on aggregate demand, but in doing so we have made the model match a key empirical regularity, rather than contradict one.

The evolution of the economy after the impact period can also be calculated. We can show algebraically that output increases throughout the pre-implementation phase, peaking in $t = T$-1. Thereafter it declines monotonically to its new steady-state level. We depict this in Figure 4. The expansion occurs because the anticipation of lower future inflation by wage-setters causes wage inflation throughout this phase to be below what it would have been under unchanged policies, while the path of the exchange rate is the same, and so there is a cumulative increase in the gap between the exchange rate and the wage. Figure 4 also illustrates the time paths of the money supply and of wage inflation. The inflation persistence which we observed in the case of an unanticipated ERB disinflation with $\chi = 1$ is now even stronger.

To provide a rough idea of the possible magnitude of the output boom under preannouncement, rows 3 and 4 of Table 1 show, for the same parameter values as before, the effect of a 10% disinflation on nontradeable output in the cases of $T = 2$ and $T = 4$. When $T = 4$ the increase in output at its peak reaches 7.70%. This is a substantial boom, roughly double that which occurs in the case of an unanticipated disinflation.

6. Conclusions

We have revisited the question of why disinflating through pegging the currency may cause a boom, using a simple analytical DGE model with staggered wages. First of all, we found that such a policy could be expansionary even when unanticipated, depending on the level at which the exchange rate is stabilised. If stabilised at the value it would have reached under unchanged policies in that period, then a boom occurs. Our approach also explains why an MB disinflation always causes a slump. In our model, an MB disinflation is exactly equivalent to an ERB disinflation in which there is a last-minute currency revaluation. The latter has a negative effect on aggregate demand, and this is the dominant effect. In reality ERB disinflations - such as many in Latin America – usually prescribe a gradual reduction in the currency's rate of depreciation, meaning that a large part of the policy is 'preannounced'. We extended our analysis to allow for explicit preannouncement, and found that our model then always predicts a boom. We explained this by the fact that, when wages are staggered, wage-setters are forward looking, and anticipation of lower future inflation means they start lowering wages ahead of the change in the exchange rate. This also explains our earlier result that an unanticipated ERB disinflation is expansionary when the peg is at or near the value the exchange rate would have reached anyway, since in this case the policy is effectively preannounced by one period. Under a preannounced MB disinflation, by contrast, although there is again an anticipatory reduction in wages, there is also an anticipatory increase in money demand, which, since the money supply does not change in the short run, must be offset by a fall in output. Our analysis contributes new insights, but we see these as adding to, rather than replacing, other explanations, since we acknowledge that it does not account for all the observed features of ERB disinflations, one of which is the initial appreciation of the real exchange rate.

We have used quite specific assumptions about preferences in deriving our results. These have enabled us to obtain analytically tractable solutions and to reveal clearly the mechanisms at work. Nevertheless it might be asked whether more general preferences could improve the explanatory power of the model, in a qualitative sense. We explored this during the research and, at least as regards the most straightforward generalisations, our answer is in the negative. First, the assumption that utility is logarithmic in real money balances, combined with the assumptions of additive separability in real balances, consumption and labour supply, are what make it possible to separate (in the manner pointed out) the solution of the monetary sector of the model from the rest. In turn this is what generates equivalence, up to the value of the exchange rate peg, between unanticipated ERB and MB disinflations. In macroeconomic terms, such equivalence can be thought of as the property of absence of exchange-rate 'overshooting' in the manner of Dornbusch (1976), since, under MB disinflation, where the exchange rate floats, it jumps immediately to its new steady-state value. Although, by using a different utility function, we could break the equivalence and introduce overshooting, this would add little to our analysis of ERB disinflation. It would mainly just affect the behaviour of the money supply, a variable which is not our principal interest.[25] Second, the assumption that utility is additively separable in tradeables consumption, combined with exogenous output in the tradeables sector and zero initial net foreign assets, is what makes the trade balance always zero in general equilibrium. This greatly simplifies the solution of the model; otherwise we would need to take account of the dynamics due to changes in the stock of net foreign assets. However, ERB disinflations in

[25] Absence of exchange-rate overshooting is a common feature of several well-known open-economy DGE models: for example, the baseline version of Obstfeld and Rogoff's (1995) model.

practice have usually been accompanied by short-run trade deficits and corresponding capital inflows, something which our model fails to capture. By generalising preferences it may be possible to make good this omission. Nevertheless, to pursue this within the present paper would be too complicated, since the technical solution issues are likely to cloud the relatively clear analytical picture obtained here.[26]

Appendix

(i) Derivation of (52): impact effect on wage inflation

As explained in the main text, (52) is the result of substituting the perfect-foresight solution for x_0 (less its pre-disinflation value) into (51). The perfect-foresight solution for x_t for general $t \geq 0$ is given by (57). Setting $t = 0$ in (57) and rearranging, we have:

$$x_0 - x_{-1} = (1-\lambda)(x - x_{-1})\,.$$

An expression for x - x_{-1} is given in (58), and is derived in part (ii) of this Appendix. Using this in the above equation, and then substituting the result into (51), we obtain (52).

(ii) Derivation of (58): long-run effect on the new wage

The steady-state value of x_t in the post-disinflation steady state, x, is readily found from (44) to be such that $x = \omega$. Since we also know that $\omega_t = e_t$ (see (43)), it follows that $x = \bar{e}$, i.e. x is equal to the exogenous exchange rate peg.

To determine x_{-1}, we refer to the solutions for variables in the initial CISS, in which inflation is μ_I. Since x_t is a nominal variable and is hence growing over time in a CISS, it is helpful to define a new variable $s_t \equiv x_t$ - e_t, which will be time-invariant in the CISS. The CISS value of s_t, s_I, depends on μ_I. So in t = -1, the last period before the unanticipated disinflation, we have:

$$\begin{aligned} x_{-1} &= e_{-1} + s_I \\ &= e_{-1} + [1/2 - (1-\beta)/(1+\beta)2\gamma]\mu_I\,. \end{aligned}$$

[26] In early work we permitted a non-zero trade balance by endogenising production in the tradeables sector, assuming that tradeables output also uses labour drawn from the economy-wide labour market. However, this particular generalisation turns out to generate a trade surplus following an ERB disinflation, and moreover adds greatly to the mathematical derivations required.

Here we have used the solution for s_I from the Technical Appendix (see footnote 9). Subtracting this from x, i.e. $\bar{e}$, gives (58).

(iii) Solution method under preannouncement

Under preannouncement, the time path of e_t is given by:

$$e_t = \begin{cases} e_{-1} + (t+1)\mu_I & \text{for } t = -1,...,T-1, \\ e_{-1} + T\mu_I \ (= e_{T-1}) & \text{for } t \geq T-1. \end{cases}$$

e_t (= ω_t, by (43)) is a forcing variable in the law of motion for x_t, (44). When e_t is substituted out of (44), we obtain two versions of this law of motion:

$$x_t = (1-\gamma)(1+\gamma)^{-1}[(1+\beta)^{-1}x_{t-1} + \beta(1+\beta)^{-1}x_{t+1}]$$
$$+ \begin{cases} 2\gamma(1+\gamma)^{-1}[e_{-1} + (1+2\beta)(1+\beta)^{-1}\mu_I + \mu_I t] & \text{for} \quad t = 0,...,T-2, \quad \text{(A1)} \\ 2\gamma(1+\gamma)^{-1}e_{T-1} & \text{for} \quad t \geq T-1. \quad \text{(A2)} \end{cases}$$

The indefinite solutions of the second-order difference equations (A1) and (A2), respectively, are:

$$x_t = A\lambda^t + A'(\lambda')^t + e_{-1} + [2+\beta-(1-\beta)(1+\gamma)/2\gamma](1+\beta)^{-1}\mu_I + \mu_I t,$$

$$\text{for } t = \text{-1},...T\text{-1}, \qquad \text{(A3)}$$

$$x_t = B\lambda^t + B'(\lambda')^t + e_{T-1}, \qquad \text{for } t \geq T\text{-2}, \qquad \text{(A4)}$$

where λ,λ' are the eigenvalues, and A,A',B,B' constants of integration to be determined below. Note that (A3) and (A4) apply for ranges of t which extend one period before, and one period after, the ranges of t for which (A1) and (A2) apply. This is because the solutions to (A1) and (A2) must be valid for all instances of x_t to which (A1) and (A2) apply.

We now want to solve for A,A',B,B' using the known boundary conditions on the perfect-foresight solution. First, since $\lambda' > 1$, convergence from period T onwards requires that $B' = 0$: this is the usual saddlepath condition. Next, an expression for the initial predetermined value of x_t, x_{-1}, may be derived by using the assumption that the economy is in a CISS: see part (ii) of this Appendix, above. For present purposes, we treat x_{-1} as known. Applying (A3) for t = -1 then gives us a first equation linking the two unknowns A,A'. To complete the solution, notice that both (A3) and (A4) hold in periods T-2 and T-1. Writing these out for t = T-2 and t = T-1 then gives four further equations, containing the unknowns

(A,A',B, x_{T-2},x_{T-1}). We hence have a determinate system of five simultaneous equations in five unknowns. Since this system is linear, it is straightforward to solve it. Doing so, we obtain:

$$A \;=\; \lambda(x_{-1}-e_{-1}) \;+\; \lambda\Big\{[(\lambda'-\lambda)^{-1}(\lambda')^{1-T}(1-\lambda)-1]H \;+\; (\lambda'-\lambda)^{-1}(\lambda')^{1-T}\lambda\Big\}\mu_I\,,$$

$$A' \;=\; -(\lambda'-\lambda)^{-1}(\lambda')^{2-T}\,\{(1-\lambda)H+\lambda\}\,\mu_I\,,$$

$$B \;=\; \lambda(x_{-1}-e_{-1})$$

$$-\;\lambda\Big\{[(\lambda'-\lambda)^{-1}\lambda'(1-\lambda)(\lambda^{-T}-(\lambda')^{-T})-\lambda^{-T}+1]H \;+\; (\lambda'-\lambda)^{-1}\lambda'\lambda(\lambda^{-T}-(\lambda')^{-T})\Big\}\mu_I\,,$$

$$\text{where } H \;\equiv\; [1-(1-\beta)(1+\gamma)/2\gamma](1+\beta)^{-1}.$$

Having solved for the complete time path of x_t, it is straightforward to use it to recover the impact value x_0 - x_{-1}. We can then employ this in (51) to obtain wage inflation in t = 0, and hence the counterpart of (52) for the case of preannouncement.

(iv) Proof that (61) is positive for all β.

The condition that the term in braces in (61) be positive can be rewritten as the condition:

$$\lambda \;>\; (\phi-\beta)/(1-\beta\phi)\;\; [\equiv\theta]\,,$$

where we define $\phi \equiv (1-\gamma)/(1+\gamma)$. Note that $0 < \gamma < 1$ under our parameter assumptions, so that $0 < \phi < 1$. Hence also $\theta < 1$. To show that this condition holds for all β, we use the characteristic equation of the difference equation (44), which is the following quadratic:

$$\beta\phi\nu^2 \;-\; (1+\beta)\nu \;+\; \phi\;\; [\equiv F(\nu)] \;=\; 0\,.$$

Its solutions are the eigenvalues λ, λ'. The graph of $F(\nu)$ is a parabola, and since we know that $0 < \lambda < 1$ and $\lambda' > 1$ (proved in the Technical Appendix), it must be downward sloping in the neighbourhood of λ, one of the two points at which it cuts the horizontal axis. To show that $\theta < \lambda$, it therefore suffices to show that $F(\theta) > 0$. (Since $\theta < 1$, $F(\theta) > 0$ cannot imply that θ instead lies above λ'.) Evaluating $F(\nu)$ at $\nu = \theta$, after some manipulation we obtain:

$$F(\theta) \;=\; (1-\beta\phi)^{-2}\beta(1+\beta)(\phi-1)^2(\phi+1)\,.$$

This is unambiguously positive, which proves the desired result.

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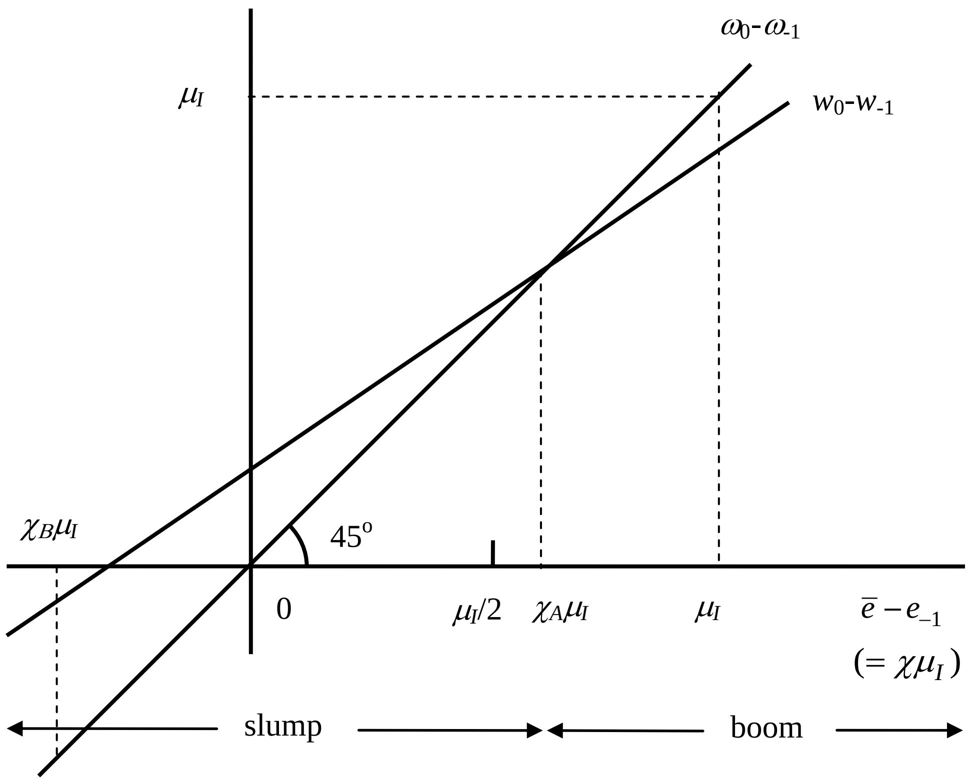

Figure 1. Impact effect of an unanticipated ERB disinflation on output as a function of the value of the exchange rate peg.

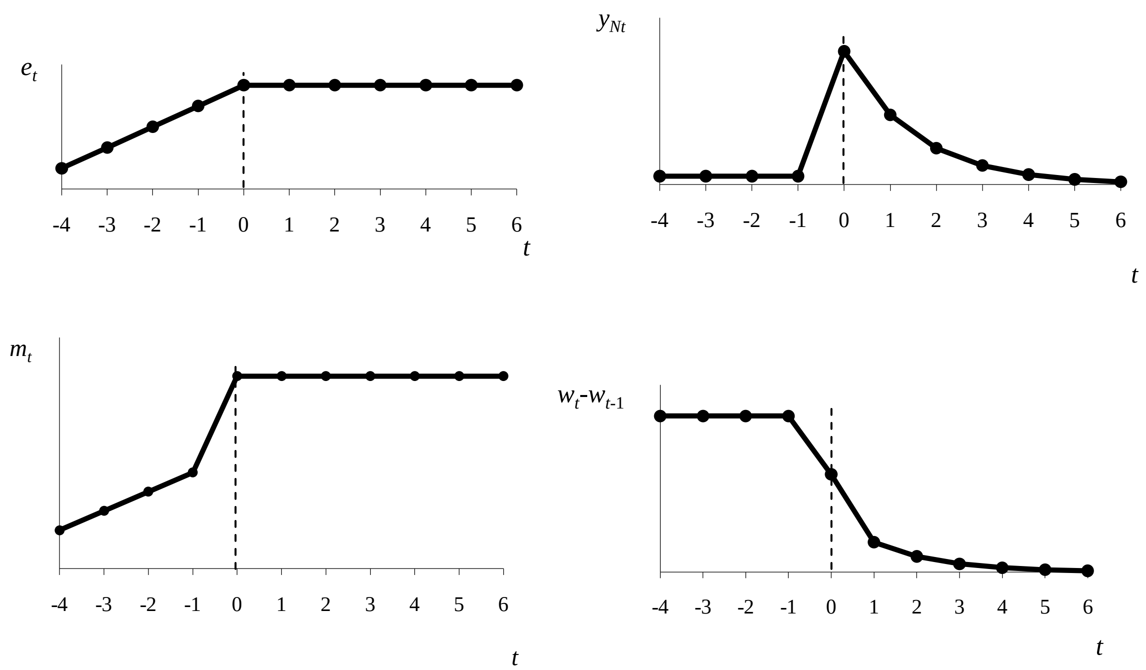

Figure 2 Unanticipated ERB disinflation (χ = 1) in t=0

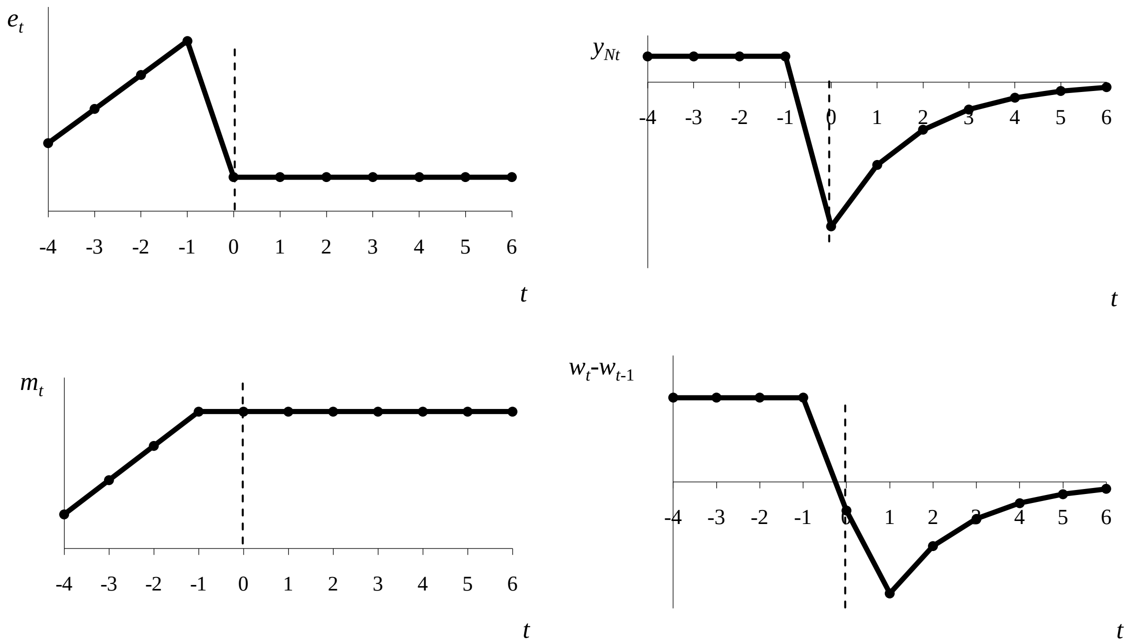

Figure 3 Unanticipated MB disinflation in *t*=0

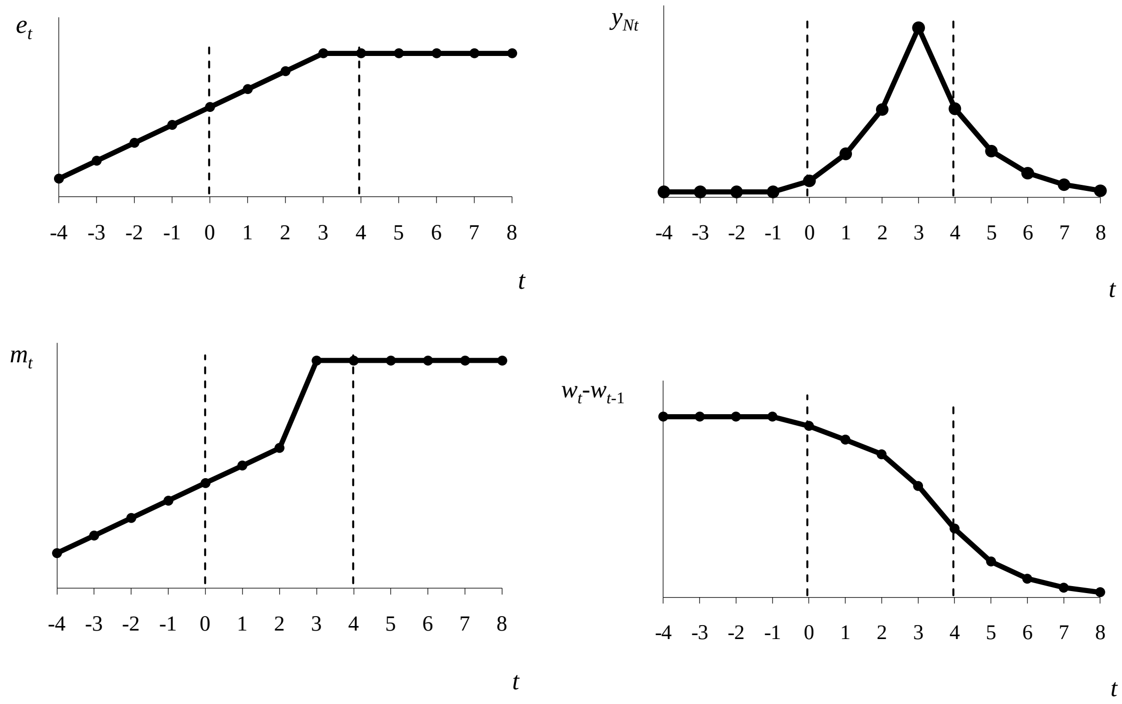

Figure 4 ERB disinflation announced in *t*= 0, implemented in *t*=4

	% change in nontradeable output (relative to pre-disinflation value)		
	on impact/ announcement ($t = 0$)	in period prior to implementation ($t = T$-1)	in long run ($t \rightarrow \infty$)
unanticipated ERB disinflation ($\chi = 0$)	-3.87 %	n/a	-0.25 %
unanticipated ERB disinflation ($\chi = 1$)	3.75 %	n/a	-0.25 %
preannounced ERB disinflation ($T = 2$)	1.94 %	6.69 %	-0.25 %
preannounced ERB disinflation ($T = 4$)	0.52 %	7.70 %	-0.25 %

Table 1 The change in nontradeable output resulting from a reduction in the inflation rate from 10% per period to zero. (Parameter values: $\sigma = 1$, $\beta = 0.99$, $\varepsilon = 13$, $\zeta = 4$.)