Firm Entry and Exit and the Cost of Disinflations

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Abstract

The log-linearized version of the basic New Keynesian model with real wage rigidity generates a recession in response to a credible and permanent disinflation by the central bank. However, its nonlinear version implies that permanent disinflation actually leads to a boom (except when the initial steady state inflation rate is close to zero), and under real wage rigidity output increases during the adjustment to the new steady state. This paper shows that the presence of firm entry and exit may help reconcile the log-linear and non-linear properties of the model with respect to the output cost of disinflations. In this regard, the degree of price flexibility of incumbents versus new entrants plays a role in determining the transitional dynamics following the disinflation policy.

JEL Classification: E31, E50.

Keywords: firm entry and exit, real wage rigidity, disinflation

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1 Introduction

Using the standard New Keynesian model, Blanchard and Gali (2007) invoke real wage rigidity as a mechanism to generate a recession following a permanent disinflation by the central bank.[1] Blanchard and Gali (2007) consider a disinflation experiment which lowers steady state inflation rate from 4 percent to zero percent (both annualized). They show that real wage rigidity implies slow adjustment of inflation to its new steady state, which in turn leads to a recession. However, their result is based on a log-linearize version of the model (in particular, the model is log-linearized around a zero steady state inflation rate) and Ascari and Merkl (2009) show that the original nonlinear version has starkly different implications about the effects of permanent disinflation on output.[2] In particular, the non-linear version implies that the disinflation policy actually leads to a boom, not a recession, and real wage rigidity increases output during the adjustment to the new steady state. While Ascari and Merkl (2009) consider a disinflation experiment with 4 percent initial inflation rate, as in Blanchard and Gali (2007), in the basic New Keynesian model, non-linearities matter even for a disinflation policy with initial inflation rate as low as 0.5 percent. The reason is that the steady state Phillips curve is downward sloping except for steady state inflation rates very close to zero.

This paper attempts to reconcile the linear and non-linear properties of the Blanchard and Gali (2007) model with respect to the effects of disinflation by allowing for firm entry and exit.[3] It shows that such a reconciliation depends on the degree of price flexibility of new entrants and incumbents. We identify three channels whereby

[1]Ball and Romer (1990) emphasize the role of real rigidities in generating non-neutrality of monetary policy and amplifying the effects of small nominal rigidities.

[2]Ascari and Merkl (2009) show that the difference between the log-linear and the nonlinear model is only quantitative under a temporary shock, which, by definition, does not change the initial steady state. We thus focus on the issue of permanent disinflation.

[3]There is an expanding literature on the role of firm entry and exit for business cycle outcomes; see, e.g., Bilbiie, Ghironi and Melitz (2007).

firm entry and exit affects the inflation-output tradeoff. First, firm entry and exit affects the sensitivity of aggregate price to changes in optimized prices as long as the degree of price flexibility of incumbents and new entrants are different. We call this the *price sensitivity channel.* Second, firm entry and exit lowers price dispersion as new entrants who can not set an optimal price take the average price level as a reference point. We call this *price dispersion channel.* Third, the presence of firm entry and exit makes reset prices less forward-looking, as firms discount expected future payoffs more strongly because of the risk of exit in the future. We call this the *discounting channel.* While the wage dispersion channel improves the inflation-output tradeoff, the price sensitivity channel is a priori ambiguous. It improves (worsens) the tradeoff if prices of new entrants are less (more) flexible than those of incumbents. The discounting channel improves the inflation-output tradeoff for a given degree of price rigidity, thus reinforcing the price dispersion channel, but we do not stress this mechanism because the degree of price rigidity may depend on firm turnover such that the discounting channel becomes weak or irrelevant (see section 2).

Section 2 presents a New Keynesian model that incorporates exogenous firm entry and exit and derives the key equations characterizing aggregate behavior. Then Section 3 presents the main results for alternative assumptions about the price flexibility of new entrants versus incumbents. Here we show results pertaining to steady states as well as transitional dynamics. Section 4 gives concluding remarks.

2 A New Keynesian model with firm entry and exit

The model is basically an extension of Blanchard and Gali (2007), in which price rigidity is of the Calvo-type, where in any given period a fraction of firms cannot reset their prices optimally, the labor market is perfectly competitive and there is real wage rigidity. Moreover, monetary policy is implemented using a standard Taylor rule. We incorporate exogenous entry and exit of firms.[4]

Household utility depends on consumption C_t and hours worked N_t

$$U(C_t, N_t) = \log C_t - \frac{N_t^{1+\eta}}{1+\eta},$$

where $\eta > 0$. The household consumes a continuum of differentiated goods, indexed by k, which are transformed into a Dixit-Stiglitz composite good C_t as follows

$$C_t = \left(\int_0^1 C_{k,t}^{1/\mu} dk\right)^{\mu}, \tag{1}$$

where $\mu = \frac{\theta}{\theta-1}$ and θ is the elasticity of substitution between any two differentiated goods. We first solve for the household's consumption allocation across all goods for a given level of C_t. Minimizing total expenditure $\int_0^1 P_{k,t} C_{k,t} dk$ subject to (1) gives the consumption demand for each good k

$$C_{k,t} = \left(\frac{P_{k,t}}{P_t}\right)^{-\theta} C_t, \tag{2}$$

where P_t is the aggregate price index (or the price level), which is defined as

$$P_t = \left(\int_0^1 P_{k,t}^{1-\theta} dk\right)^{\frac{1}{1-\theta}}. \tag{3}$$

[4]To make our point more clearly, we make the simplifying assumption of exogenous entry. For a model with endogenous entry see for instance Bilbiie, Ghironi and Melitz (2007).

Next, we derive the optimal decisions regarding the paths of C_t and N_t. The household maximizes its lifetime utility

$$E_t \sum_{i=0}^{\infty} \beta^i U(C_{t+i}, N_{t+i})$$

subject to the budget constraint

$$C_t + \frac{B_t}{P_t} = \frac{W_t}{P_t} N_t + R_{t-1} \frac{B_{t-1}}{P_t} + \frac{D_t}{P_t}.$$

Here, β is the discount factor, R_t is the gross nominal interest rate on bond holdings B_t, W_t is the market wage level, D_t is the aggregate nominal profit income.

Finally, the first-order conditions for consumption and bond holdings imply the following consumption Euler equation

$$1 \quad = \quad \beta R_t E_t \left(\frac{C_t P_t}{C_{t+1} P_{t+1}} \right).$$

Optimal labor supply under real wage rigidity takes the same form as in Blanchard and Gali (2007) and Ascari and Merkl (2009),

$$\frac{W_t}{P_t} \quad = \quad \left(\frac{W_{t-1}}{P_{t-1}} \right)^{\gamma} (C_t N_t^{\eta})^{1-\gamma},$$

where γ controls the degree of real wage rigidity ($0 \leq \gamma \leq 1$ such that $\gamma = 0$ represent the absence of real wage rigidity).

2.1 Pricing under firm entry and exit

At the beginning of period t, there is a continuum of monopolistically competitive firms of measure 1. At the end of the period, a fraction $1-\rho$ of firms, randomly chosen, exit the goods market while at the beginning of $t+1$, new firms of measure $1-\rho$ enter the market. Let firm k has a production function of the form $Y_{k,t} = N_{k,t}$ where $N_{k,t}$ is labor input, so that aggregate labor demand is given by $N_t^d = \int_0^1 N_{k,t} dk$.

While firms choose prices, output is demand determined, which in turn pins down labor demand. Nominal prices of incumbent firms are sticky, as in the basic New Keynesian model, so that in any given period a fraction $1-\omega$ are allowed to reset their prices. It follows that for each incumbent firm k in period t, its nominal price $P_{k,t}$ is set such that $P_{k,t} = P_t^*$ if set optimally and $P_{k,t} = P_{k,t-1}$ otherwise. From the set of new entrants a fraction $1-\omega^n$ set their prices optimally while the rest set prices equal to the market price in the previous period, P_{t-1}; the idea is that, since the non-optimizing new entrants have technology that is identical to other firms, they adopt the pre-existing market price as a benchmark in posting their own prices.

When firm k (an incumbent or a new entrant) is allowed to (re)set its price optimally, it chooses a price which maximizes the expected lifetime profit

$$E_t \sum_{i=0}^{\infty} (\rho\omega)^i Q_{t,t+i} \left(\frac{P_t^*}{P_{t+i}} - \phi_{t+i} \right) C_{k,t+i}, \tag{4}$$

where in any given period $\rho\omega$ is the probability that current price remains fixed in the following period conditional on the event that the firm does not exit the market, $Q_{t,t+i} = \beta^i \frac{C_t}{C_{t+i}}$ is the stochastic discount factor and $\phi_t = \phi_{k,t} = \frac{W_t}{P_t}$ is the real marginal cost. The stochastic discount factor depends on the ratio of future to current marginal utility of income, reflecting the fact that households own all firms in the economy. Let $z_t = P_t^*/P_t$ denote the optimal relative price, identical for all firms optimizing in period t.

Differentiating (4) with respect P_t^*, while taking account of the demand function (2), leads to the first-order condition, expressed in terms of P_t^*/P_t,

$$z_t = \mu \frac{E_t \sum_{i=0}^{\infty} (\rho\beta\omega)^i \phi_{t+i} \left(\frac{P_{t+i}}{P_t}\right)^{\theta}}{E_t \sum_{i=0}^{\infty} (\rho\beta\omega)^i \left(\frac{P_{t+i}}{P_t}\right)^{\theta-1}}.$$

Note that entry and exit affects pricing decision of a firm by reducing the effective discount factor, $\rho\beta\omega$, pushing newly set price down. We call this channel the *discounting effect*. However, as we remarked in the introduction section, we do not emphasize the discounting channel for an empirical reason, which is that the product $\rho\omega$ is the theoretical counterpart of the average price duration observed in the data. This means that the Calvo parameter ω (the probability that an incumbent's price is not reset in a given period) is not identified independently of a firm's surviving probability ρ. Following Blanchard and Gali (2007) the model is calibrated using an average price duration of 4 quarters, so that $\rho\omega = 0.75$ implying $\omega = 0.75/\rho$. In this case, we calibrate ρ using data on product turnover (Broda and Weinstein (2010)).

2.2 Aggregation and market clearing

Let $\omega^* = \rho\omega + (1-\rho)\omega^n$ and $\Pi_t = P_t/P_{t-1}$ where Π_t denotes gross price inflation. Then from (3) P_t can be rewritten as a weighted average of optimized and non-optimized prices

$$\begin{aligned} P_t^{1-\theta} &= \int_0^1 P_{k,t}^{1-\theta} dj \\ &= (1-\omega^*) P_t^{*(1-\theta)} + \rho\omega \int_0^1 P_{k,t-1}^{1-\theta} dj + (1-\rho)\omega^n P_{t-1}^{1-\theta} \\ &= (1-\omega^*) P_t^{*(1-\theta)} + \omega^* P_{t-1}^{1-\theta} \end{aligned}$$

implying

$$\Pi_t^{\theta-1} = \frac{1-(1-\omega^*)z_t^{1-\theta}}{\omega^*}. \tag{5}$$

Equation (5) captures the *price sensitivity channel*: the smaller is ρ the smaller is $\partial\Pi_t/\partial z_t$ if $\omega^n > \omega$ and vice versa. Thus the price sensitivity channel is a priori ambiguous. Next, imposing goods and labor market clearing, we get a relationship between aggregate employment and aggregate output. Aggregating labor demand across firms leads to

$$\begin{aligned} N_t^d &= \int_0^1 N_{k,t} dk \\ &= Y_t \int_0^1 \left(\frac{P_{k,t}}{P_t}\right)^{-\theta} dk \\ &= \Delta_t Y_t, \end{aligned}$$

where $\Delta_t = \int_0^1 \left(\frac{P_{k,t}}{P_t}\right)^{-\theta} dk$ measures price dispersion. Using backward recursion, the price dispersion equation can be rewritten as

$$\Delta_t = (1-\omega^*)z_t^{-\theta} + \rho\omega\Pi_t^\theta\Delta_{t-1} + (1-\rho)\omega^n\Pi_t^\theta. \tag{6}$$

Equation (6) captures the *price dispersion channel*: the smaller is ρ the smaller is Δ_t, as new entrants that are subject to the Calvo constraint and can not set prices optimally adopt the average price in the previous period as a reference in posting their prices.

In the baseline case, incumbents and entrants are assumed to be symmetric as far the same degree of price rigidity is concerned (i.e., $\omega^n = \omega$).[5] Then

$$\Pi_t^{\theta-1} = \frac{1-(1-\omega)z_t^{1-\theta}}{\omega}$$

and

$$\Delta_t = (1-\omega)z_t^{-\theta} + \rho\omega\Pi_t^{\theta}\Delta_{t-1} + (1-\rho)\omega\Pi_t^{\theta},$$

so that the price sensitivity channel is shut down while the price dispersion channel is operative.

We close the model with the setting of monetary policy, which is implemented via a Taylor rule

$$\frac{R_t}{R} = \left(\frac{\Pi_t}{\Pi}\right)^{\varphi_\pi}\left(\frac{Y_t}{Y}\right)^{\varphi_y},$$

where the variables without subscripts are steady state levels. Here we follow Blanchard and Gali (2007) and assume that $\Pi = 1+\pi$ coincides with the central bank's inflation target, $\Pi^* = 1+\pi^*$.

[5] Our assumption of symmetry is analogous to those in models of firm entry and exit with Rotemberg-type price adjustment cost, where it is common to assume symmetry in price adjustment costs between new entrants and incumbents (see, e.g., Bilbiie, Ghironi and Melitz (2007)). We assume Calvo-type price staggering so as to stay close to the framework of Blanchard and Gali (2007).

3 The effects of disinflation

Having derived the key aggregate equations, we are now in a position to analyze the steady state effects of firm entry and exit. We calibrate the most of the parameters as in Blanchard and Gali (2007) and Ascari and Merkl (2009). The discount factor β is 0.99, the elasticity of substitution in goods θ is 10, the labor supply elasticity η is 1, the coefficients of the Taylor rule $\varphi_\pi = 1.5$ and $\varphi_y = 0.125$. A firm's survival probability ρ is set at 0.93, which is consistent with 25 percent annual product turnover reported in Broda and Weinstein (2010). Since our model features firm entry and exit, we set the parameter ω (fraction of incumbent firms not resetting prices) such that $\rho\omega = 0.75$ so that prices are fixed on average for 4 quarters, as in Blanchard and Gali (2007) and Ascari and Merkl (2009).

3.1 Steady state

We first show the steady state effect of firm entry and exit in the non-linear model. Figure 1 shows two curves—the dashed line corresponds to the case with no firm entry and exit and the solid line to the case with firm entry and exit—for the baseline calibration where entrants and incumbents are symmetric, that is, both groups have the same degree of price flexibility ($\omega^n = \omega$). In the vertical axis is the percentage deviation of steady state output from its level at zero steady state rate of inflation, denoted by y, against the trend rate of inflation π (annualized).

Note the different implications of the two cases regarding the long-run effects of a disinflationary policy. In the case with no entry and exit, even a disinflation from 0.5 percent to zero percent would lead to a higher steady state output. By contrast, in the model with entry and exit a disinflation from as high as 3 percent to zero percent would lead to lower steady state output.[6]

[6]The nonlinear relationship between steady-state inflation and output is a result of two opposing

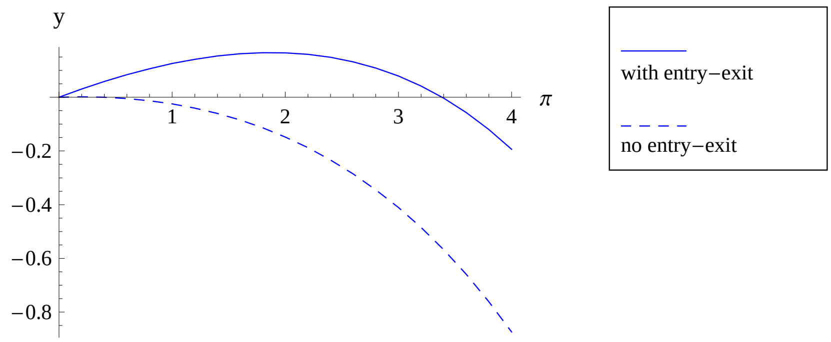

Figure 1: Steady state Phillips curve when new entrants and incumbents face the same degree of price rigidity (baseline case).

Figure 2 shows the effects of entry and exit under alternative assumptions on the relative degree of price flexibility of entrants and incumbents. The dashed line corresponds to the baseline case, (it replicates the solid line in Figure 1; i.e., the case where $\omega^n = \omega$). The dotted line corresponds to the case where entrants have a higher degree of relative price flexibility ($\omega^n = 0.75\omega$) while the solid line corresponds to the case where entrants have a lower degree of relative price flexibility ($\omega^n = 1$).

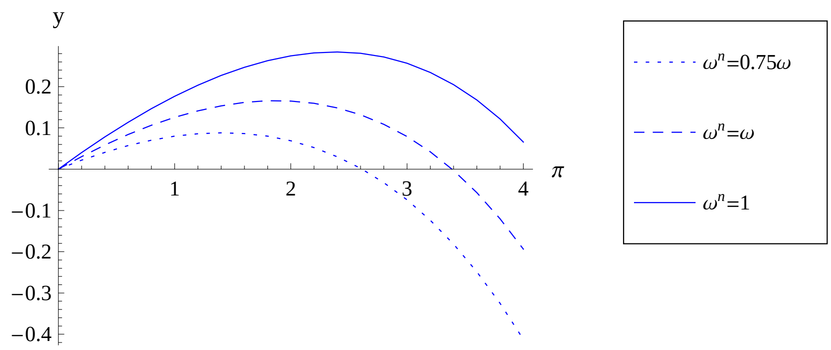

Figure 2: Steady state Phillips curve when new entrants and incumbents face different degrees of price rigidity.

effects of steady state inflation on the average markup, and hence aggregate demand and output. On the one hand, optimizing firms set higher prices relative to current marginal cost so as to offset the expected erosion of their relative prices by future inflation. On the other, steady state inflation mechanically erodes the relative prices that were set by firms in the past. The first effect dominates except for trend inflation rate which are close to zero.

3.2 Transitional dynamics under real wage rigidity

In this section, we make a disinflation experiment under alternative values for the degree of real wage rigidity—$\gamma \in \{0, 0.5, 0.9\}$, similar to Blanchard and Gali (2007) and Ascari and Merkl (2009). In particular, the central bank reduces its inflation target from 4 percent to zero percent, the reduction is permanent and unanticipated by the private sector. We focus on permanent shock because this is where the log-linear and the non-linear version differ (see also Ascari and Merkl (2009)).

Figure 3 shows the transitional dynamics for output, price inflation, real wages, and the nominal interest rate. Output and real wage are in percentage deviation from their respective new steady state while price inflation and interest rate are in percentage (annualized). First, note that consistent with Figure 1, the new steady state is associated with a higher steady state output. Moreover, in the absence of real wage rigidity ($\gamma = 0$) as well as in the case with a moderate degree of real wage rigidity ($\gamma = 0.5$), output increases initially and then slowly decreases to the new steady state. These adjustment paths are thus counterfactual, as is also shown in Ascari and Merkl (2009) for a model without firm entry and exit.

However, results differ somewhat when the degree of real wage rigidity is very high ($\gamma = 0.9$). Initially output increases but the economy experiences a recession along the adjustment path before reaching its higher steady state value. The reason is that a high degree of real wage rigidity leads to a slow adjustment of inflation towards the new steady state (the central banks's target), which in turn causes output to drop sharply after the initial increase. In this case, the non-linear model and its log-linear version differ as to the short-run effect of disinflation, as well as the adjustment path.

Figure 4 shows the transitional dynamics for output, price inflation, real wages, and the nominal interest rate but for a disinflation from 3 percent to zero percent. Again, note that consistent with Figure 1, the new steady state is associated with

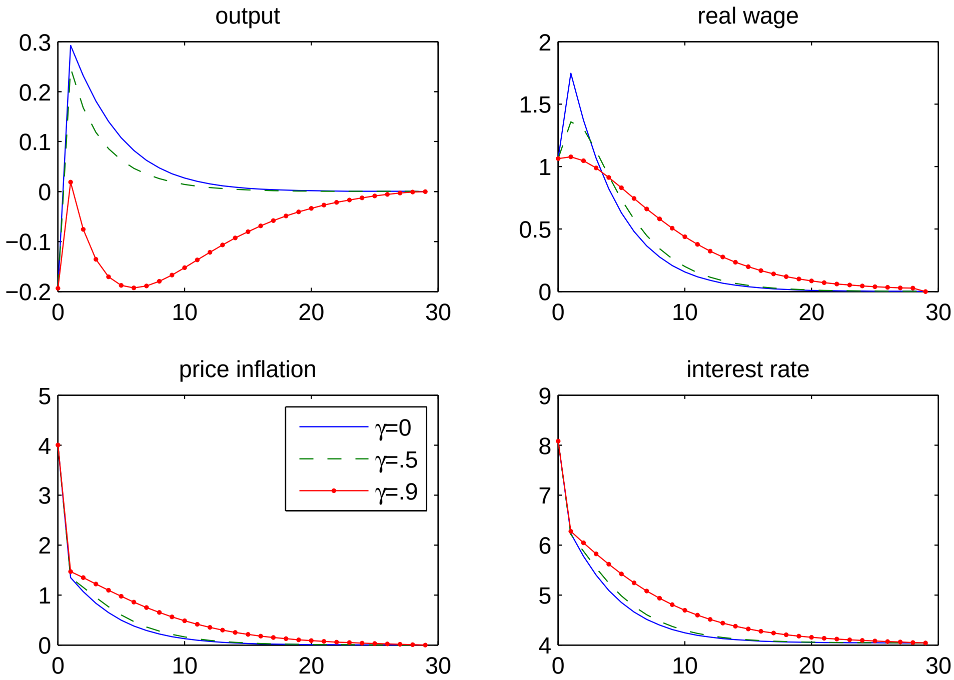

Figure 3: Transitional dynamics for a disinflation from 4 percent to zero percent (baseline case). Output and real wage are in percentage deviation from their respective new steady state while price inflation and interest rate are in percentage term (annualized).

a lower steady state output. The transitional dynamics in the absence of real wage rigidity ($\gamma = 0$) as well as in the case with a moderate degree of real wage rigidity ($\gamma = 0.5$), are similar to the 4 percent disinfation experiment (Figure 3): output increases initially and then slowly decreases to the new steady state.

However, the case with the high degree of real wage rigidity ($\gamma = 0.9$) gives realistic transitional dynamics: disinflation leads to a recession along the adjustment path of the economy to the new steady state. Here the high degree of real wage rigidity leads to a smaller initial drop in inflation as well as to a slow adjustment of inflation towards the new steady state, which in turn causes output to drop below its long-run level along the adjustment path. In this case, the non-linear model and its log-linear version have similar implications in the sense that both models imply that disinflation is costly.

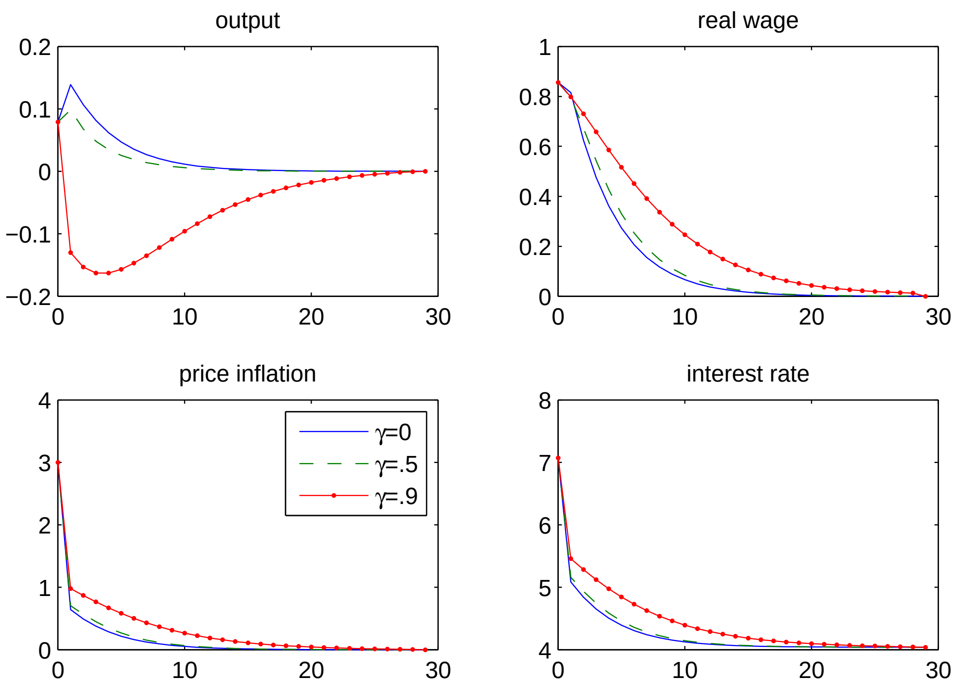

Figure 4: Transitional dynamics for a disinflation from 3 percent to zero percent (baseline case). Output and real wage are in percentage deviation from their respective new steady state while price inflation and interest rate are in percentage term (annualized).

As we have shown above (see also Figure 2), the degree of relative price flexibility of entrants versus incumbents determines the slope of the long-run Phillips curve. One can also show that this parameter is key for the transitional dynamics following a disinflation policy. For example, in the case where entrants have a lower degree of relative price flexibility ($\omega^n = 1$) the steady state output at 4 percent steady state inflation is higher than the corresponding value at 0 percent inflation. Figure 5 shows the transitional dynamics for a disinflation from 4 percent to zero percent. Qualitatively the transitional dynamics look similar to those in Figure 4 and thus the non-linear model has transitional dynamics that are similar to the log-linear version.

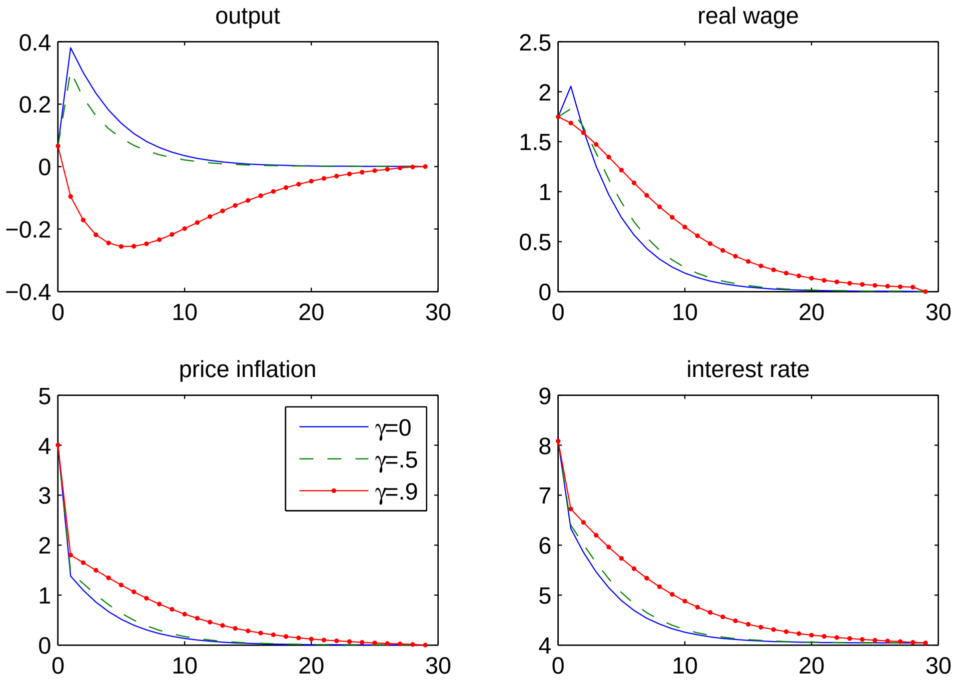

Figure 5: Transitional dynamics for a disinflation from 4 percent to zero percent. Prices of entrants are less flexible than those of incumbents. Output and real wage are in percentage deviation from their respective new steady state while price inflation and interest rate are in percentage term (annualized).

This result suggests that in the case where entrants have a higher degree of relative price flexibility the non-linear model has transitional dynamics that are similar to the log-linear version only for moderate disinflation, less than 3 percent. say from 2 percent to zero percent. For example, in our calibration where $\omega^n = .75\omega$, we find that the transitional dynamics for linear and non-linear models are similar for a disinflation from 2 percent to zero percent, but dissimilar for a disinflation from 3 or 4 percent.[7]

[7]Result are available upon request.

4 Concluding remarks

The log-linearized version of the basic New Keynesian model with real wage rigidity has been shown to generate a recession in response to a credible and permanent disinflationary policy towards price stability. However, its nonlinear version implies that permanent disinflation actually leads to a boom, not a recession, and real wage rigidity increases output during the adjustment to the new steady state. this paper attempts to reconcile the log-linear and non-linear properties of the model with respect to the output costs of disinflation by appealing to the presence of firm entry and exit. In this regard, a key determinant is the degree of price flexibility of new entrants versus incumbents. It would be useful to calibrate the price flexibility of new entrants in order for the analysis to yield concrete results regarding the role of firm entry and exit. Moreover, there is room for model extensions, for example by having endogenous entry of firms. We see our analysis as a first step towards a better understanding of the role of firm entry and exit in determining the output costs of disinflation.

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