Information–Price Updating and Inertia[*]

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Abstract

The random duration scheme à la Calvo represents the most common specification of price resetting or information updating in macroeconomic models. We show that the use of a random rather than a fixed duration scheme has important implications for the dynamics of the model. Under fixed duration à la Taylor, the sticky information model (Mankiw and Reis [2002]) fails to generate inertia in inflation and output. And this remains the case even in the presence of the various real rigidities that are commonly used to help the sticky *price* model generate inertia. The sticky price model also benefits from the random duration assumption as it allows it to produce inertia in output without an excessive degree of price stickiness.

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Introduction

In spite of its great popularity, the standard New Keynesian (NK) model has many important empirical flaws. The list of weaknesses is long with the most important one concerning inflation and output dynamics (Mankiw and Reis [2002]).

This failure has motivated work to find specifications that fare better empirically. A popular remedy that has proved successful empirically uses backward looking agents (Christiano, Eichenbaum and Evans [2005] , Smets and Wouters [2003]). The assumption of backward price indexation schemes in combination with real rigidities can produce inertia in inflation and output[1]. Another, theoretically more compelling approach (because it adheres to full rationality) involves the replacement of sticky prices with sticky information (Mankiw and Reis [2002]), an approach reminiscent of the original, Lucas rational expectations, imperfect information model.

The main idea in this approach is that if information disseminates slowly throughout the population then different agents' expectations may end being based on different information sets. The resulting Phillips curve contains past expectations of current economic conditions giving rise to inertial inflation behavior. Mankiw and Reis [2002] demonstrate that such a model has good empirical properties. In particular, it gives rise to empirically realistic, hump shaped responses of inflation and output following a monetary shock.

Collard and Dellas [2003] and Dupor and Tsuruga [2005] show that the alleged good performance of the sticky information model hinges critically on its assumption that the arrival of information follows the random scheme suggested by Calvo [1983]. An important implication of this assumption is that there exist some agents who do not update their information sets for extremely long periods of time (they are trapped in a time warp). Using instead an updating scheme that does not have such an extreme implication, for instance the one suggested by Taylor where all agents–firms regularly, even if infrequently, update their information set, eliminates the good properties of the sticky information model. This happens even when informational lags are relatively long. Hence, the use of the Calvo scheme in the sticky information problem is not "innocuous".

One could argue that it may be unreasonable to expect that a modest amount of sticky information would suffice to solve the inertia problem by itself. And that the model would require the help of the various real rigidities that are commonly employed in the NK models in order to amplify and propagate the effects of nominal frictions (Christiano et al. [2005], Collard and Dellas [2005]). We examine this possibility by incorporating the various real rigidities (habit per-

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[1]The main flaw of this scheme is that it is at variance with observed pricing patterns as it implies that nearly all price changes at the firm level are equal to the aggregate inflation rate.

sistence, variable capital utilization, capital or investment adjustment costs[2]) that have proved useful in other related contexts. We find that, under the fixed duration updating scheme, the presence of real rigidities is not of much help to the sticky information model.

Hence, the assumption of random duration plays a critical role in the model of sticky information. Does it play a similar role in sticky *price* models (such as in Christiano et al. [2005])? It is commonly thought that the two updating schemes have roughly equivalent properties in the NK model and that the widespread use of the Calvo scheme owes to its greater tractability. Our analysis suggests that this may not be the case. Random duration is not important for the model's ability to generate inflation dynamics, as long as there exists backward price indexation. But it matters for getting inertia in output, at least for empirically plausible levels of price stickiness.

The rest of the paper is organized as follows. Section 1 describes the sticky information and the sticky price model under the Taylor and Calvo updating (or price revision) schemes. Section 2 presents the main results. Section 3 concludes.

1   The Model

The economy is populated by a large number of identical infinitely–lived households and consists of two sectors: one producing intermediate goods and the other a final good. The intermediate good is produced with capital and labor and the final good with intermediate goods. The final good is homogeneous and can be used for consumption (private and public) and investment purposes.

1.1   The Household

Household preferences are characterized by the lifetime utility function:[3]

$$\mathbb{E}_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left[\log(c_{t+\tau} - \vartheta c_{t+\tau-1}) + \frac{\nu^m}{1-\sigma_m} \left(\frac{M_{t+\tau}}{P_{t+\tau}} \right)^{1-\sigma_m} - \frac{\nu^h}{1+\sigma_h} h_{t+\tau}^{1+\sigma_h} \right] \tag{1}$$

where $0 < \beta < 1$ is a constant discount factor, c denotes consumption , M/P is real balances and h is the quantity of work supplied by the representative household. ϑ is the habit persistence parameter.

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[2]These are the three real rigidities that Christiano et al. [2005] identify as the key ingredients for their model's ability to generate inertial behavior of output and inflation following a monetary policy shock. We too find that adding more features is of no consequence.

[3]$E_t(.)$ denotes mathematical conditional expectations. Expectations are conditional on information available at the beginning of period t.

The budget constraint is

$$E_t B_{t+1} Q_t + M_t + P_t(c_t + i_t + z(u_t)k_t) = B_t + M_{t-1} + P_t v_t u_t k_t + W_t h_t + \Omega_t + \Pi_t \tag{2}$$

where W_t is the real wage; P_t is the nominal price of the domestic final good; c_t is consumption and i is investment expenditure; k_t is the amount of physical capital owned by the household and leased to the firms at the real rental rate v_t. Only a fraction u_t of the capital stock is utilized in any period. M_{t-1} is the amount of money that the household brings into period t, and M_t is the end of period t money holdings. N_t is a nominal lump–sum transfer received from the monetary authority; T_t is the lump–sum taxes paid to the government and used to finance government consumption. The capital stock evolves according to

$$k_{t+1} = \left(1 - \Phi\left(\frac{i_t}{i_{t-1}}\right)\right) i_t + (1 - \delta)k_t \tag{3}$$

where $\delta \in [0, 1]$ denotes the rate of depreciation. We assume that $\Phi(\cdot)$ satisfies $\Phi(1) = \Phi'(1) = 0$ and $\varphi = \Phi''(1) > 0$. This investment adjustment cost specification is the one used by Christiano et al. [2005].

The household determines consumption/savings, money holdings and leisure plans by maximizing utility (1) subject to the budget constraint (2) and the evolution of physical capital (3).

1.2 Final sector

The final good is produced by combining intermediate goods. This process is described by the following CES function

$$y_t = \left(\int_0^1 y_t(i)^\theta \mathrm{d}i\right)^{\frac{1}{\theta}} \tag{4}$$

where $\theta \in (-\infty, 1)$. θ determines the elasticity of substitution between the various inputs. The producers in this sector are assumed to behave competitively and to determine their demand for each good, $y_t(i)$, $i \in (0, 1)$ by maximizing the static profit equation

$$\max_{\{y_t(i)\}_{i \in (0,1)}} P_t y_t - \int_0^1 P_t(i) y_t(i) \mathrm{d}i \tag{5}$$

subject to (4), where $P_t(i)$ denotes the price of intermediate good i. This yields demand functions of the form:

$$y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{\frac{1}{\theta-1}} y_t \text{ for } i \in (0, 1) \tag{6}$$

and the following general price index

$$P_t = \left(\int_0^1 P_t(i)^{\frac{\theta}{\theta-1}} \mathrm{d}i\right)^{\frac{\theta-1}{\theta}} \tag{7}$$

The final good may be used for consumption — private or public — and investment purposes.

1.3 Intermediate goods producers

Each firm i, $i \in (0,1)$, produces an intermediate good by means of capital and labor according to a constant returns–to–scale technology, represented by the production function

$$y_t(i) = \begin{cases} A_t(u_t(i)k_t(i))^\alpha h_t(i)^{1-\alpha} - \Psi & \text{if } A_t(u_t(i)k_t(i))^\alpha h_t(i)^{1-\alpha} \geqslant \Psi \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where $\alpha \in (0,1)$. $u_t(i)k_t(i)$ and $h_t(i)$ respectively denote the capital services and the labor input used by firm i in the production process. A_t is an exogenous stationary stochastic technology shock, whose properties will be defined later. $\Psi > 0$ denotes the fixed cost of production. Assuming that each firm i operates under perfect competition in the input markets, the firm determines its production plan so as to minimize its total cost

$$\min_{\{K_t(i), h_t(i)\}} P_t w_t h_t(i) + P_t z_t u_t(i) k_t(i)$$

subject to (8). This leads to the following expression for the marginal cost:

$$P_t s_t y_t(i)$$

where the real marginal cost, s, is given by $\frac{w_t^{1-\alpha} z_t^\alpha}{A_t \alpha^\alpha (1-\alpha)^{1-\alpha}}$

Intermediate goods producers are monopolistically competitive and therefore set prices for the good they produce. We consider two alternatives: Sticky prices and flexible prices. In the sticky price specification, there are two cases. Prices are set according to the random duration scheme á la Calvo. Or, prices are set according to the fixed duration scheme á la Taylor. That is, a fraction of the firms set their prices for a *fixed* number of periods (as in Chari, Kehoe and McGrattan [2000]). Under flexible prices we assume, following Mankiw and Reis [2002], that the pricing decision at any point in time may or may not reflect information that is up-to-date. In a fashion analogous to that described above for the updating of prices, the updating of information may follow either the Calvo scheme (as in Mankiw and Reis [2002]) or the Taylor scheme (as in Collard and Dellas [2003] and Dupor and Tsuruga [2005]).

We now describe the pricing decisions under the random and fixed duration schemes (á la Calvo and Taylor respectively).

1.3.1 Random Duration

Sticky Prices: Following Calvo, we assume that in each and every period, a firm either gets the chance to adjust its price (with probability γ) or it does not. If it does not get the chance, then it sets its price according to

$$P_{it} = \xi_t P_{it-1} \tag{9}$$

We consider two scenarios concerning ξ_t. Under the first one, the price grows at the steady state rate of inflation ($\xi_t = \overline{\pi}$). This guarantees a vertical, long term Phillips curve[4]. Under the second scenario –popularized by Christiano et al. [2005]– the non-optimizing firms index their prices to the lagged, aggregate rate of inflation ($\xi_t = \pi_{t-1}$).

A firm i that sets its price optimally in period t, chooses $P_t^\star$

$$P_t^\star = \frac{1}{\theta} \frac{\mathbb{E}_t \sum_{\tau=0}^{\infty} (1-\gamma)^\tau \Phi_{t+\tau} P_{t+\tau}^{\frac{2-\theta}{1-\theta}} \Xi_{t,\tau}^{\frac{1}{\theta-1}} \psi_{t+\tau} y_{t+\tau}}{\mathbb{E}_t \sum_{\tau=0}^{\infty} (1-\gamma)^\tau \Phi_{t+\tau} \Xi_{t,\tau}^{\frac{\theta}{\theta-1}} P_{t+\tau}^{\frac{1}{\theta-1}} y_{t+\tau}} \tag{10}$$

where ψ is real marginal cost, P is the aggregate price index, $\Phi_{t+\tau}$ is an appropriate discount factor derived from the household's optimality conditions and

$$\Xi_{t+\tau} = \begin{cases} \prod_{\ell=0}^{\tau-1} \xi_{t+\ell} & \text{for } \tau \geqslant 1 \\ 1 & \tau = 0 \end{cases}$$

In each period, a fraction γ of contracts ends and $(1-\gamma)$ survives. Hence, the aggregate price level is

$$P_t = \left(\gamma P_t^{\star \frac{\theta}{\theta-1}} + (1-\gamma)(\xi_t P_{t-1})^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \tag{11}$$

Sticky Information: We follow Mankiw and Reis [2002] in assuming that all firms set a price every period, but the information set available differs across firms. In particular, in each period, only a fraction γ of firms is able to update its information about the state of the economy. The remaining firms set their prices based on information collected earlier. We follow Mankiw and Reis [2002] and assume that information arrival is similar to the adjustment assumption in the Calvo model: each firm has the same constant probability, γ, of updating its information when taking price decisions. Therefore a firm that had the opportunity to update its information set j periods ago will set its price as

$$P_t(j) = E_{t-j} P_t^\star$$

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[4]The model dynamics would not differ if we held non-optimizing prices completely fixed.

where, as before, $P_t^\star = P_t s_t / \theta$. Therefore, the aggregate price index is given by

$$P_t = \gamma \sum_{j=0}^{\infty} (1-\gamma)^j E_{t-j} \left(\frac{P_t s_t}{\theta} \right)$$

1.3.2 Fixed Duration

Sticky Prices: We follow Chari et al. [2000] and assume that intermediate producers set prices for N periods of time in a staggered fashion. In each and every period, a fraction $1/N$ of producers chooses a new optimal price $P_t^\star(i)$. During the following $N-1$ periods this price evolves according to

$$P_{it} = \xi_t P_{it-1} \tag{12}$$

with either $\xi_t = \bar{\pi}$ or $\xi_t = \pi_{t-1}$ as in the Calvo case above.

We assume that intermediate producers are indexed such that producers $i \in [0, 1/N]$ set new prices in $0, N, 2N, \ldots$, those indexed by $i \in [1/N, 2/N]$ set prices in $1, N+1, 2N+1, \ldots$ Prices are set so as to maximize the expected sum of discounted profits from period t to period $t+N-1$, that is

$$\mathbb{E}_t \sum_{\tau=0}^{N-1} \Phi_{t+\tau} \left(P_t^\star(i) \Xi_{t,\tau} - P_{t+\tau} s_{t+\tau} \right) y_{t+\tau}(i)$$

subject to the total demand it faces

$$y_{t+\tau}(i) = \left(\frac{\Xi_{t,\tau} P_t^\star(i)}{P_{t+\tau}} \right)^{\frac{1}{\theta-1}} y_{t+\tau}$$

where $\Phi_{t+\tau}$ is an appropriate discount factor related to the way the household values future as opposed to current consumption. This leads to the price setting equation

$$P_t^\star(i) = P_t^\star = \frac{1}{\theta} \frac{\mathbb{E}_t \sum_{\tau=0}^{N-1} \Phi_{t+\tau} \Xi_{t,\tau}^{\frac{1}{\theta-1}} P_{t+\tau}^{\frac{\theta-2}{\theta-1}} s_{t+\tau} y_{t+\tau}}{\mathbb{E}_t \sum_{\tau=0}^{N-1} \Phi_{t+\tau} \Xi_{t,\tau}^{\frac{\theta}{\theta-1}} P_{t+\tau}^{\frac{-1}{\theta-1}} y_{t+\tau}} \tag{13}$$

Since the price setting scheme is independent of any firm specific characteristic, all firms that reset their prices will choose the same price.

Hence, from (7), the aggregate intermediate price index is given by

$$P_t = \left(\frac{1}{N} \sum_{\tau=0}^{N-1} (\Xi_{t-\tau,\tau} P_{t-\tau}^\star)^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \tag{14}$$

Sticky Information: We follow Mankiw and Reis [2002] and assume information diffuses slowly through the population of price setters. More specifically, we assume that in each an every period, all intermediate good producers reset their price, but using only a restricted piece of information. More specifically, we assume that the population of firms can be split into N parts, each of them indexed by $i \in [0, N-1]$. Then each fraction of firm i/N is able to use information available in period $t - i$. This implies that a firm i sets its price maximizing its profit

$$E_{t-i} \left((P_t^{\star}(i) - P_t s_t) y_t(i) \right)$$

subject to the total demand it faces

$$y_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{\frac{1}{\theta-1}} y_t$$

which leads to the price setting behavior for firm i

$$P_t^{\star}(i) = E_{t-i} \left(\frac{P_t s_t}{\theta} \right) \tag{15}$$

Hence, from (7), the aggregate intermediate price index is given by

$$P_t = \left(\frac{1}{N} \sum_{\tau=0}^{N-1} \left(E_{t-\tau} \left(\frac{P_t s_t}{\theta} \right) \right)^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \tag{16}$$

1.4   The monetary authorities

Monetary policy are assumed to follow an exogenous money supply rule, such that

$$M_{t+1} = M_t + \Omega_t \tag{17}$$

where Ω_t is the lump sum money injection in the economy, which is assumed to be exogenously set according to

$$\Omega_t = (\mu_t - 1)M_t$$

where the gross growth rate of the money supply, μ_t, is assumed to follow an exogenous stochastic process whose properties will be defined later.

1.5   The government

The government finances government expenditure on the domestic final good, $P_t G_t$, using lump sum taxes, T_t. The stationary component of government expenditures is assumed to follow an exogenous stochastic process, whose properties will be defined later.

2 Parametrization

The model is parameterized on US quarterly data for the post WWII period. The data are taken from the Federal Reserve Database.[5] The parameters are reported in table 1.

The parametrization of preferences follows Christiano et al. [2005]. More precisely, we set $\vartheta = 0.65$, $\sigma_h = 1$ and $\sigma_m = 10.62$. ν_h is set such that the model generates a total fraction of time devoted to market activities of 31%. The value of ν_m is selected such that the model reproduces the average ratio of M1 money to nominal consumption expenditures. The nominal growth of the economy, $\overline{\mu}$, is set such that the average quarterly rate of inflation over the period is $\overline{\pi} = 1.2\%$ per quarter.

The capital utilization function $z(u_t)$ satisfies $z(1) = 0$, $z''(1)/z'(1) = \sigma_z$. We use the value $\sigma_z = 0.01$.

The parametrization of the investment adjustment costs function follows closely Christiano et al. [2005]. We therefore set $\varphi = 2.5$.

Table 1: Calibration: Benchmark case

Discount factor	β	0.988
Inverse labor supply elasticity	σ_h	1.00
Habit persistence	ϑ	0.65
Elasticity of money in the utility function	σ_m	10.62
Capital elasticity of intermediate output	α	0.232
Adjustment costs parameter	φ	2.500
Depreciation rate	δ	0.025
Capital utilization	σ_z	0.01
Parameter of markup	θ	0.833
Length of contracts/information stickiness	N	2 to 8
Probability of updating	γ	0.5 to 0.125
Shocks and policy parameters		
Persistence of technology shock	ρ_a	0.950
Standard deviation of technology shock	σ_a	0.008
Persistence of government spending shock	ρ_g	0.970
Volatility of government spending shock	σ_g	0.010
Persistence of money growth	ρ_m	0.500
Volatility of money shock	σ_m	0.009
Steady state money supply growth (gross)	μ	1.012
Share of government spending	g/y	0.200

θ is set such that the level of markup in the steady state is 20%. α, the elasticity of the production

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[5]URL: `http://research.stlouisfed.org/fred/`

function to physical capital, is set such that the model reproduces the US labor share — defined as the ratio of labor compensation to GDP — during the sample period (0.64).

The technology shock, $a_t = \log(A_t/\overline{A})$ follows

$$a_t = \rho_a a_{t-1} + \varepsilon_{a,t}$$

with $|\rho_a| < 1$ and $\varepsilon_{a,t} \rightsquigarrow \mathcal{N}(0, \sigma_a^2)$. We set $\rho_a = 0.95$ and $\sigma_a = 0.008$.

The government spending shock[6] is assumed to follow an AR(1) process

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1 - \rho_g) \log(\overline{g}) + \varepsilon_{g,t}$$

with $|\rho_g| < 1$ and $\varepsilon_{g,t} \sim \mathcal{N}(0, \sigma_g^2)$ with ρ_g, of 0.97 and $\sigma_g = 0.02$. The government spending to output ratio is set to 0.20.

Gross money growth takes the form

$$\mu_t = (1 - \rho_m)\overline{\mu} + \rho_m \mu_{t-1} + \epsilon_{mt}$$

where $|\rho_m| < 1$, $\overline{\mu} = E(\mu_t)$ and ϵ_{mt} is a gaussian white noise process. We use the same parametrization as Mankiw and Reis [2002].

3   Results

We focus on the most important stylized facts that have been singled out by Mankiw and Reis [2002] in their attempt to establish the good performance of the sticky information model. Mankiw and Reis study the IRFs of output and inflation to three shocks: *i)* To a sudden and permanent drop in the level of aggregate demand ; *ii)* To a sudden disinflation ; *iii)* To an anticipated disinflation ; and *iv)* to a one–standard-deviation monetary policy shock. We will focus on *iv)* as all four specifications share the same dynamic mechanism and the first three experiments can be obtained as special cases of *iv)* with the appropriate specification of the money growth equation.

In order to be able to identify the contribution of information stickiness relative to that of the various real rigidities, we first examine the performance of the model without *any* real rigidities. Figure 1 reports the impulse response functions of output and inflation to a money supply shock in the case of a fixed –Taylor– duration scheme. For comparison purposes, in addition to the sticky information case, the graph also includes IRFs from two models with *sticky prices*: One

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[6]The –log– of the government expenditure series was detrended using a linear trend.

with full backward price indexation ($\xi = 1$), TFI. And one without any price indexation ($\xi = 0$), TNI. The duration of price or informational stickiness is set to $N = 2, 4, 6, 8$ periods.

This figure demonstrates that, in the absence of real rigidities, sticky information cannot on its own generate inertia in inflation and output (as Collard and Dellas [2003] and Dupor and Tsuruga [2005] have already established). And it also shows that the same is true for sticky prices. Furthermore, figure 2 shows that this weakness is shared by the random duration specifications. Hence, without real rigidities, neither the Taylor nor the Calvo specification is capable of generating inertia.

We then incorporate the "standard" real rigidities that have proved successful in generating inertial behavior in sticky price models. We include those identified by Christiano et al. [2005] as being the most important for generating realistic inflation and output dynamics. Namely, habit persistence, variable capital utilization and investment adjustment costs.[7] In theory, their inclusion should help the sticky information model too because, by making nominal cost more sluggish, they make the firms' desired prices depend largely on the prices set by other firms and less so on tracking the exogenous monetary shock. In other words, receiving information on a recent monetary shock does not necessarily make the firm revise its plan accordingly because some of its competitors may have set the wrong prices and the firm knows it will take them some time to revise them.

Figure 3 reports the corresponding IRFs under the fixed duration scheme. As can be seen, inclusion of real rigidities does not help the sticky information model much. First, the model cannot generate any humps unless the degree of information stickiness is high (6 periods or more). And second, even in the case of long updating lags, the model gives rise to a hump in output but not in inflation.

The sticky price model, on the other hand, fares somewhat better. The model can generate inflation inertia even with not too much stickiness ($N = 4$) but the hump is driven solely by the assumption of full backward indexation (compare the IRFs with and without indexation –TFI vs TNI– for $N = 4$). Moreover, there is no hump in output, unless price stickiness is quite high ($N \geq 6$).

Comparing Figure 3 to Figure 4 (or to those reported by Mankiw and Reis) reveals the crucial role played by the form of the updating mechanism for the sticky information model. Namely, the model has nice dynamic properties under the random but not under the fixed duration assumption. It seems that the model needs agents who almost never update in order to get sufficient inertia in inflation.

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[7]The picture does not change when additional features from the Christiano et al. [2005] model are included.

The same graphs can be used to assess the role played by the type of the resetting mechanism in the sticky price model's ability to generate inertia. The comparison of figures 3 and 4 indicates that random duration helps the sticky price model with regard to output inertia in the sense that it makes it possible to produce a hump with a lower degree of nominal rigidity (four quarters vs six for the fixed duration). While this improvement may appear small it is quite critical because an average, aggregate price stickiness of four quarters represents an upper limit of acceptable values that can be supported by the existing micro evidence.

4 Conclusions

Sticky information models have been introduced as a means of tackling the issue of inertia in inflation and economic activity. Collard and Dellas [2003] and Dupor and Tsuruga [2005]) show that the good dynamic properties of the sticky information model owe much to the Calvo random duration assumption, which leaves some firms with outdated information for extremely long periods of time. And that these properties would be absent if the model used the Taylor fixed duration assumption instead. In this paper we have extended these two papers by including the real rigidities that have proved useful for generating inertia in the sticky price version model. We have found that the sticky information model with fixed duration is not helped much by the presence of real rigidities.

Motivated by this finding we then examined whether the assumption of random duration plays an equally critical role in the model of sticky *prices*. The answer is rather yes. The model of sticky prices has no difficulty generating a hump in inflation under fixed duration pricing, as long as the model also includes backward price indexation. But in order to produce a hump in output, it requires *more* price rigidity than its corresponding random duration version. For the commonly used value of four quarters, the Taylor scheme fails to generate sufficient inertia, in spite of the inclusion of several real rigidities (while the Calvo scheme *does*). Hence, the use of random duration pricing does not seem innocuous, whether in the context of sticky prices or, even more, in the context of sticky information.

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Figure 1: Fixed duration (Taylor), N periods: No real rigidities
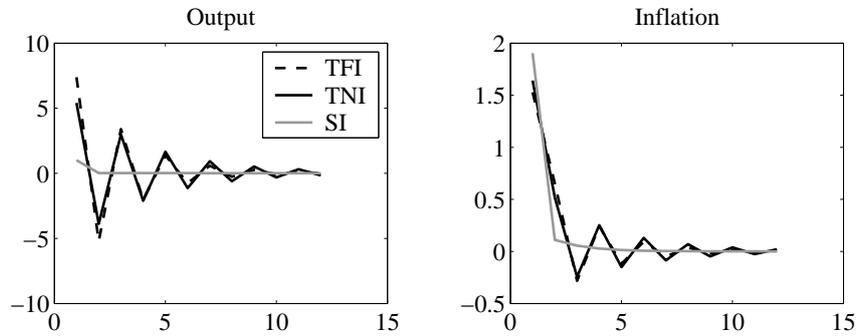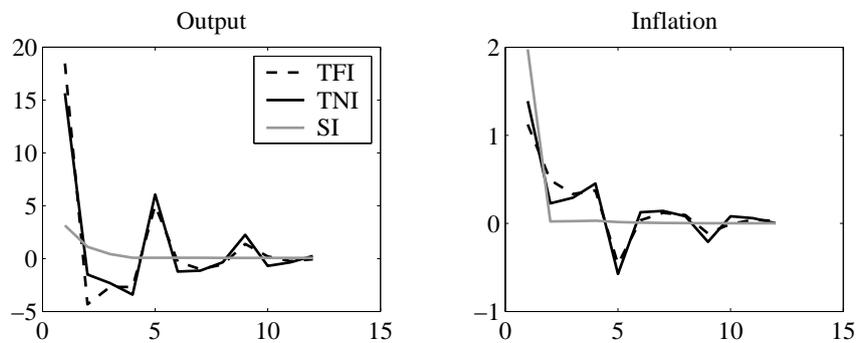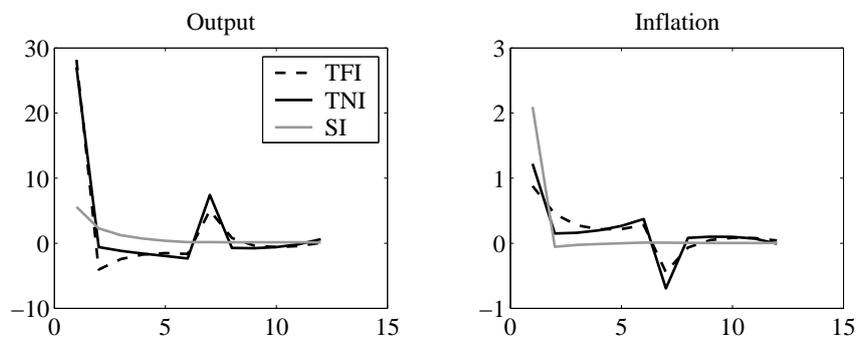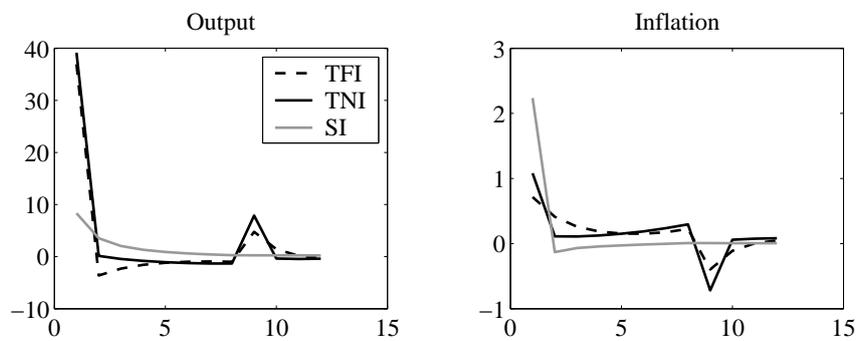
(a) 2 periods

(b) 4 periods

(c) 6 periods

(d) 8 periods

<u>Note:</u> TFI: Taylor updating, backward indexation ($\xi_t = \pi_{t-1}$), TNI: Taylor updating, no backward indexation ($\xi_t = \overline{\pi}$), SI: Sticky information.

Figure 2: Random duration (Calvo) scheme: No real rigidities
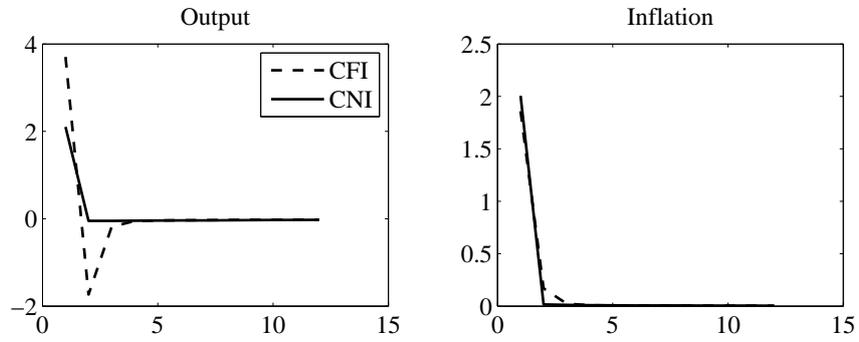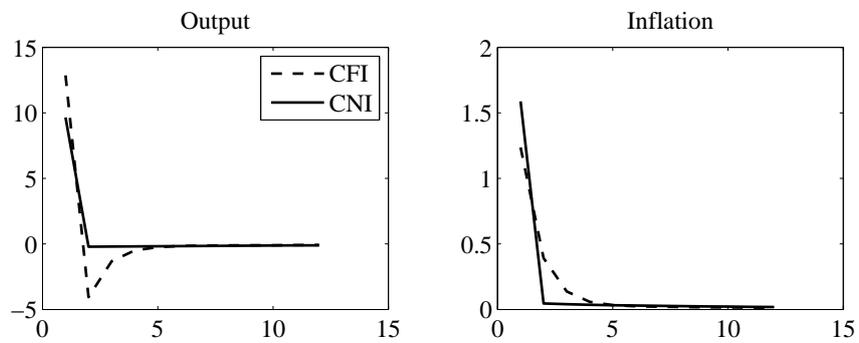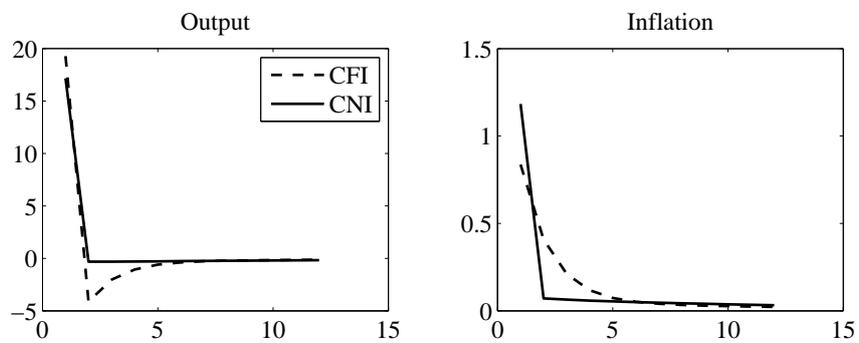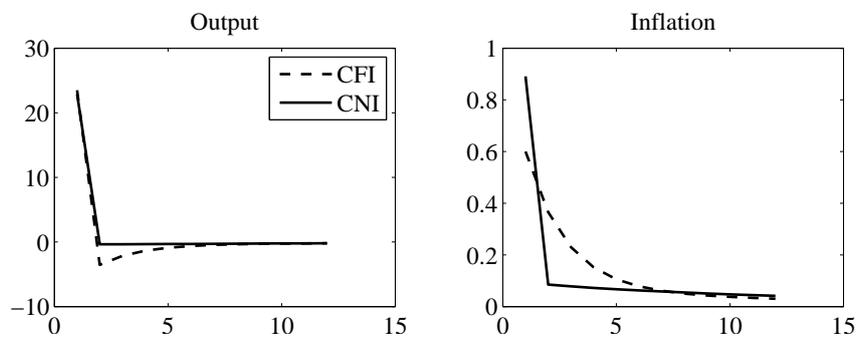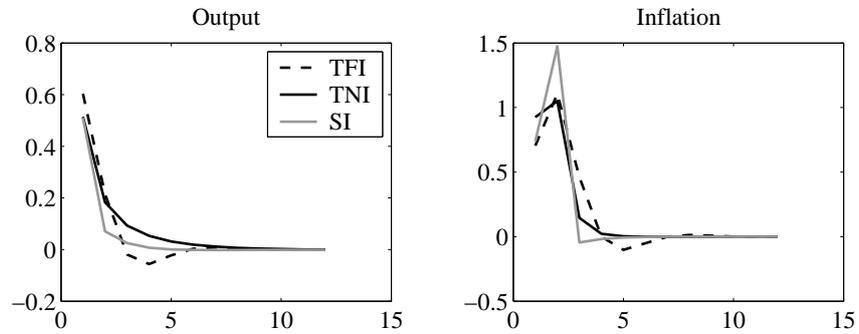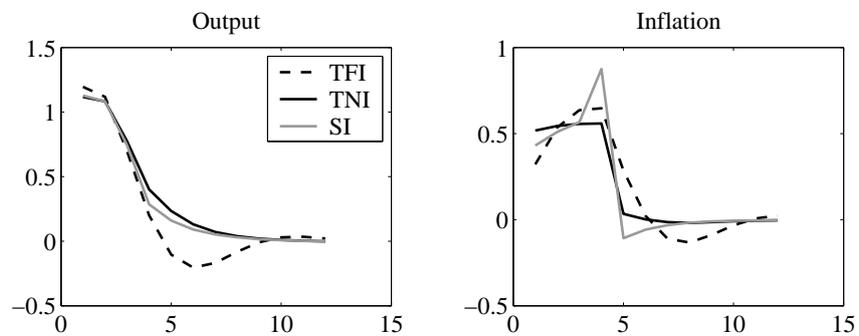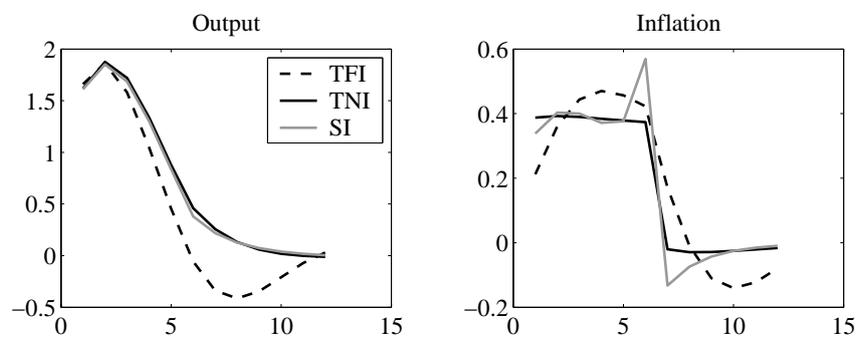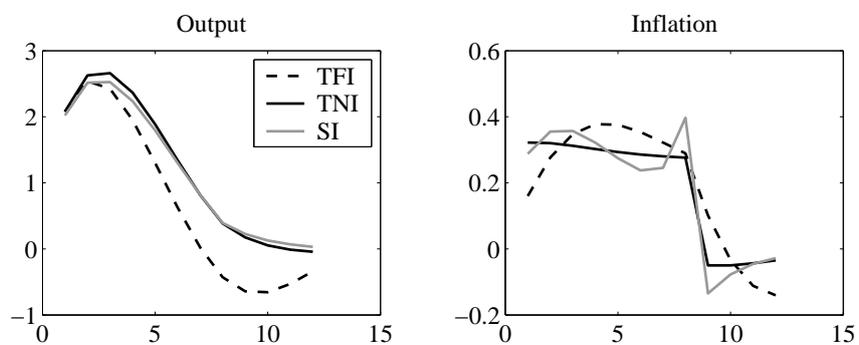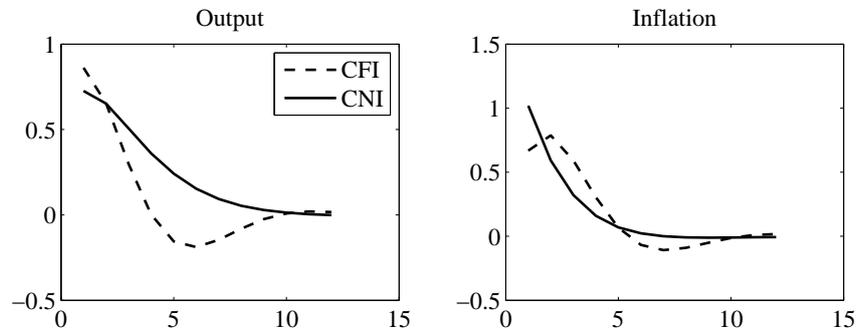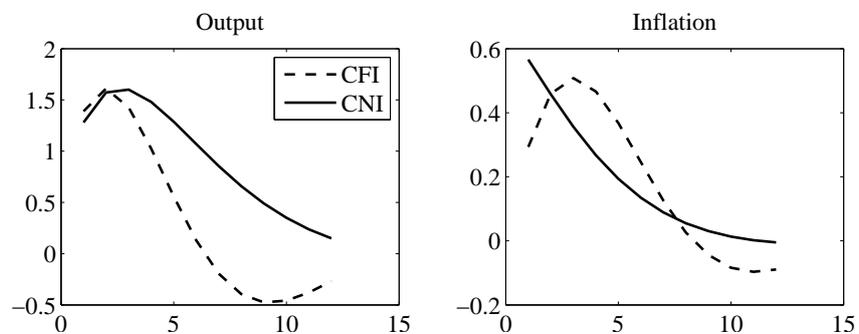
(a) 2 periods

(b) 4 periods

(c) 6 periods

(d) 8 periods

<u>Note:</u> CFI: Calvo updating, backward indexation ($\xi_t = \pi_{t-1}$), CNI: Calvo updating, no backward indexation ($\xi_t = \overline{\pi}$), SI: Sticky information.

Figure 3: Fixed duration (Taylor), N periods: Real rigidities

(a) 2 periods

(b) 4 periods

(c) 6 periods

(d) 8 periods

Note: TFI: Taylor updating, backward indexation ($\xi_t = \pi_{t-1}$), TNI: Taylor updating, no backward indexation ($\xi_t = \bar{\pi}$), SI: Sticky information.
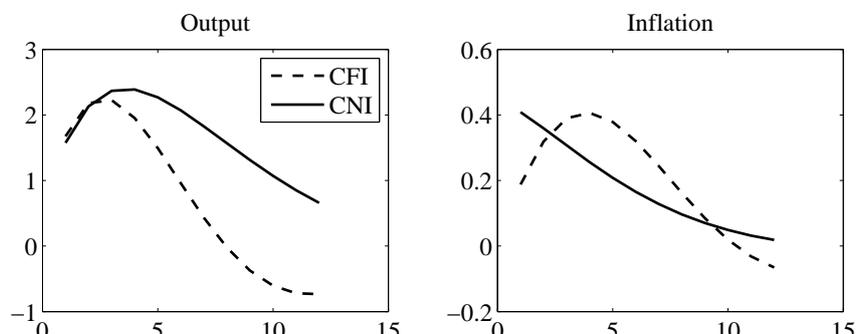
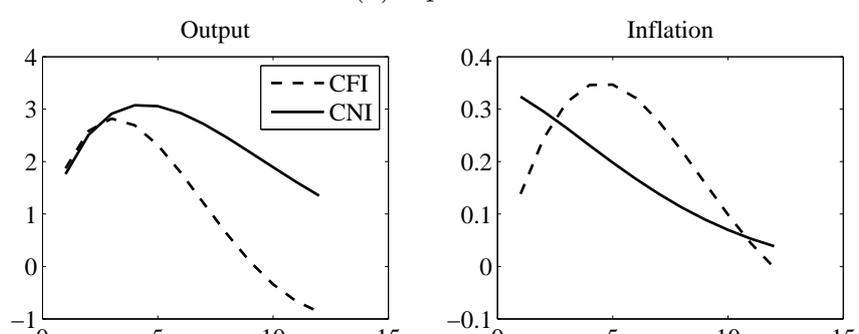Figure 4: Random duration (Calvo) scheme: Real rigidities

(a) 2 periods

(b) 4 periods

(c) 6 periods

(d) 8 periods

Note: CFI: Calvo updating, backward indexation ($\xi_t = \pi_{t-1}$), CNI: Calvo updating, no backward indexation ($\xi_t = \bar{\pi}$), SI: Sticky information.