Inflation persistence and costly market share adjustment: a preliminary analysis

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Abstract

In this paper we develop a dynamic general-equilibrium model to explore the role, if any, that market share may play in inducing inflation persistence. We extend a standard sticky-price model by including a form of market share discussed in Rotemberg and Woodford (1995). In particular, a firm that raises its price relative to competing firms will not only sell less to its existing customers but also lose future market share; and as market share is costly to regain, firms attempt to minimise price movements that erode their market share. It is the latter feature that we believe may offer insights on the observed inertial behaviour of inflation.

1. Introduction

The inability of standard macroeconomic models to deliver degrees of inflation persistence found in the data has led many researchers to suggest alternative explanations for the observed inertial behaviour of inflation. Dittmar et al (2001), for instance, argue that it is possible to account for inflation persistence in a flexible-price, general-equilibrium business-cycle model if the monetary authority follows an interest rate rule. The policy rule transforms output persistence induced by a persistent technology shock into inflation persistence. Other authors have focused on different forms of contracting. Fuhrer and Moore (1995) propose relative-wage contracting while Jadresic (2000) proposes a staggered price-setting model with a flexible distribution of price duration to explain inflation persistence. Roberts (1998) and Ball (2000) apply different forms of near-rational expectations in otherwise standard staggered wage setting models to examine the inertial behaviour of inflation. Along a similar margin, Andolfatto and Gomme (2002), Andolfatto et al (2002) and Erceg and Levin (2001) each suggest a model in which households and firms use optimal filtering to disentangle long-lasting and transitory shifts in the monetary policy rule to account for the observed dynamics of inflation. Finally, Mankiw and Reis (2001) argue that inflation persistence is caused by the slow diffusion of information about macroeconomic conditions.

In this paper, we offer an alternative explanation for inflation persistence: costly market share. We are not arguing that costly market share is the only explanation but that it may be an additional factor that helps us to understand inflation dynamics. This paper examines the implications of introducing market share into an otherwise standard sticky-price model. To this end, we construct and analyse a dynamic, general-equilibrium model that incorporates Taylor-style price contracts and a market share concept similar to that discussed in Rotemberg and Woodford (1992). We then examine the implications of the interaction between price contracts and market share for price adjustment. As Ball and Romer (1990) argue, both a real rigidity and nominal price rigidity are required to explain sluggish price adjustment. In the type of market share model we consider, demand has a dynamic pattern; a firm that increases its current price not only sells less to its existing customers but also erodes its market share in the next period. Having a smaller market share decreases future sales for any given future price and, thus,

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lowers the present value of expected future profits. This feature, we believe, will induce firms to slow the rate of introduction of price increases.

The idea that market share may influence pricing decisions is not new. Froot and Klemperer (1989) study exchange rate pass-through when firms' future demand depends on current market shares. Expected future exchange rates in their framework affect the value of current market share and so affect current pricing strategies. They show that this type of intertemporal dependence implies that the magnitude of the pass-through will depend on whether exchange rate movements are thought to be temporary or permanent.

Stiglitz (1979) and Ball and Romer (1990) argue that imperfect information induces existing customers to be more responsive to price increases than prospective new customers to price decreases (making the marginal revenue curve steeper). In particular, Ball and Romer introduce market share into a menu-cost model where sellers base their pricing decisions on maximising the current period profit. In this environment, the presence of market share increases the degree of real rigidity measured by the insensitivity of real price to changes in aggregate demand so that the real output effect of exogenous changes in the money supply becomes more palpable.

Rotemberg and Woodford (1995, 1999) examine the implications of introducing market share, inter alia, into an otherwise standard neoclassical growth model. The type of market share model is based on Phelps and Winter (1970). Under this specification firms incorporate, into their decision-making process, the effect of today's pricing decision on future market share. Rotemberg and Woodford argue that this type of structure can capture the idea that consumers have switching costs (see Beggs and Klemperer (1992)) when changing from one producer to another. These papers demonstrate that market share considerations of this form can introduce real rigidity into the model as well as generate a countercyclical markup. They do not, however, examine the implications for the degree of nominal price rigidity in the model. Finally, Yun (1998) examines the consequences for government budget deficits of introducing market share into a sticky-price model. Yun finds that including market share tends to not only reduce the size but also the sign of output's response to an exogenous increase in the government budget deficit.

On the empirical side, if one believes that the importance of market share is inversely related to the degree of competition, then there is much empirical evidence supporting a negative relationship between market share and the frequency of price changes. In addition, models of price adjustment predict greater frequency of price changes in markets with more competition because firms face more elastic demand (eg Barro (1972)). In the empirical literature the firm concentration ratio is often used as an inverse measure of market competition, with a higher value expected to be correlated with less elastic demand. Several papers find an inverse relationship between the concentration ratio and the frequency of price changes for US data (Carlton (1986) and Caucutt et al (1999)). Encaoua and Geroski (1986) use data for five Organisation for Economic Co-operation and Development countries to estimate the relationship between price, cost and concentration. They find, in general, that higher degrees of concentration are associated with slower price adjustments to cost changes. Bils and Klenow (2002) examine the frequency of price changes for 350 categories of goods and services using unpublished data from the BLS from 1995 to 1997. They also find evidence of a positive empirical relationship between market competitiveness and price flexibility.

As Rotemberg and Woodford (1995) argue, one reason for the importance of market share may be switching costs. Switching costs also appear empirically important for pricing decisions. Carlton (1979) and Hubbard and Weiner (1992) find systematic differences between prices when buyers and sellers meet randomly and when buyers and sellers establish an ongoing relationship. During booms, prices associated with random meetings increase substantially relative to prices determined by an ongoing relationship, even for what appear to be homogeneous goods.

The remainder of this paper is organised as follows. Section 2 describes the structure of the economic model and Section 3 details its calibration. In Section 4 we discuss our findings, while concluding remarks are contained in Section 5.

2. The model

Much of the model structure and calibration comes from Dib (2001), who in turn borrows from Rotemberg and Woodford (1995, 1997) and others. The economy consists of households, final-good-producing firms, intermediate-good-producing firms, and a central bank. The intermediate-good-producing firm combines labour and capital in the production of a differentiated good that it sells in a monopolistically competitive market to the final-good producer. This final-good producer combines the continuum of intermediate goods into a single final good that it sells in a perfectly competitive market to households for consumption and investment.

As in Taylor (1980), we assume that intermediate firms hold their prices fixed for two periods. The firms are evenly distributed across the two periods so that half the firms can reset their price in odd-numbered periods and half in even-numbered periods. Calvo-style pricing is used more commonly in recent literature but, for the purposes of this paper, Taylor contracting provides a simpler base case upon which to build. The main innovation of the paper will be the addition of market share considerations to the problem of the intermediate-good producer. In particular, if an intermediate producer increases its price relative to the general price level, then it will not only decrease the demand for its product this period but will also lose market share in the following period.

2.1 The household

The representative household derives utility from consumption of the final good, c_t, from holding real money balances, M_t/P_t, and from leisure, $(1-h_t)$. Household preferences are described by the following expected utility function:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, \frac{M_t}{P_t}, h_t\right) \tag{1}$$

where $\beta \in (0,1)$ is the discount rate.

The period utility function, u, is given by:

$$u(\bullet) = \frac{\gamma}{\gamma-1} \log\left[c_t^{\frac{\gamma-1}{\gamma}} + b^{\frac{1}{\gamma}}\left(\frac{M_t}{P_t}\right)^{\frac{\gamma-1}{\gamma}}\right] + \eta \log(1-h_t) \tag{2}$$

where b, γ and η are positive parameters.

Investment, i_t, is done by the household and increases the capital stock according to the standard equation:

$$k_{t+1} = (1-\delta)k_t + i_t \tag{3}$$

where δ represents a constant depreciation rate.

The household's budget constraint is given by the following equation:

$$c_t + i_t + \frac{M_t}{P_t} \le r_t k_t + w_t h_t + \frac{M_{t-1} + T_t + D_t}{P_t} \tag{4}$$

Let r_t and w_t denote the real capital rental rate and real wage rate, respectively. Households receive a monetary transfer, T_t, directly from the central bank and a dividend payment, D_t, from the intermediate-good producers.

The household's maximisation problem is to choose $\{c_t, M_t, h_t, k_{t+1}\}$ in order to maximise its expected utility function in equation (1). The Bellman equation for this dynamic programming problem can be written as follows:

$$V(k_t, M_{t-1}, \Omega_t) = \max_{\{c_t, M_t, h_t, k_{t+1}, i_t\}} \left[u\left(c_t, \frac{M_t}{P_t}, h_t\right) + \beta E_t V(k_{t+1}, M_t, \Omega_{t+1})\right] \tag{5}$$

subject to the constraints in equations (3) and (4). The variable Ω_t represents the information set available to households at time t upon which their decisions are based. The first-order conditions for this problem are given by:

$$\frac{c_t^{-\frac{1}{\gamma}}}{c_t^{\frac{\gamma-1}{\gamma}} + b^{\frac{1}{\gamma}}\left(\frac{M_t}{P_t}\right)^{\frac{\gamma-1}{\gamma}}} - \lambda_t = 0 \tag{6}$$

$$\frac{b^{\frac{1}{\gamma}}\left(\frac{M_t}{P_t}\right)^{-\frac{1}{\gamma}}}{c_t^{\frac{\gamma-1}{\gamma}} + b^{\frac{1}{\gamma}}\left(\frac{M_t}{P_t}\right)^{\frac{\gamma-1}{\gamma}}} - \lambda_t + \beta E_t\left(\frac{P_t\lambda_{t+1}}{P_{t+1}}\right) = 0 \tag{7}$$

$$\frac{\eta}{1-h_t} - \lambda_t w_t = 0 \tag{8}$$

$$\beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\left(r_{t+1} + (1-\delta)\right)\right] - 1 = 0 \tag{9}$$

$$k_{t+1} - (1-\delta)k_t - i_t = 0 \tag{10}$$

2.2 The final-good-producing firm

The consumption and investment good purchased by households is produced by a Dixit and Stiglitz (1977) aggregator. This final good, y_t, is produced from a continuum of imperfectly substitutable intermediate goods, y_{jt}, according to the following CES production function:

$$y_t \le \left(\int_0^1 s_{jt}^{\frac{1}{\theta}} y_{jt}^{\frac{\theta}{\theta-1}} dj\right)^{\frac{\theta}{\theta-1}}, \qquad \theta > 1 \tag{11}$$

The parameter θ represents the degree of substitutability between intermediate inputs and the degree of monopoly power of the firms producing these inputs. The variable s_{jt} represents the market share of firm j that is assumed to evolve according to the following expression:

$$s_{jt} = \left(\frac{P_{jt-1}}{P_{t-1}}\right)^{-\chi} s_{jt-1}, \qquad \chi > 0 \tag{12}$$

Market share follows a random walk process such that a firm's share at time t depends on its share at $t-1$ as well as its price relative to the aggregate price level at $t-1$. When a firm's price increases relative to the market price at t, its market share at $t-1$ will decrease. As long as this price differential persists, firm j's market share will continue to fall. Firm j will need to undercut the market price in order to rebuild its market share back up to its original level. As discussed above, the introduction of market share can be motivated by the customer market model of Phelps and Winter (1970). The firm that lowers its price today not only expands the demand for its product in the current period but also increases its customer base in subsequent periods.

The final good is sold at price P_t in a perfectly competitive market while input y_{jt} is purchased at price P_{jt} from a monopolistically competitive supplier. The final-good producer maximises its profits given in the following expression:

$$\max_{y_{jt}}\left[P_t\left(\int_0^1 s_t^{\frac{1}{\theta}}\, y_{jt}^{\frac{\theta-1}{\theta}} dj\right)^{\frac{\theta}{\theta-1}} - \int_0^1 P_{jt} y_{jt} dj\right] \tag{13}$$

The resulting first-order condition for input y_{jt} yields the following demand function for intermediate goods:

$$y_{jt} = y_t \left(\frac{P_{jt}}{P_t} \right)^{-\theta} s_t \tag{14}$$

Similar input demand functions have also been used in Rotemberg and Woodford (1995) and Yun (1998). The underlying motivation for this specification is that consumers face costs of switching from one product to another. As such, there is inertia in their buying patterns and hence the market share of the firms. See Klemperer (1995) and Beggs and Klemperer (1992) for examples of switching cost models.

The demand for input y_{jt} increases with aggregate output, y_t, and price, P_t, but decreases with input price P_{jt}. Since the final-good producer sells its output in a perfectly competitive market, it earns zero profits in each period. The resulting zero profit condition yields a definition for the aggregate price level given in equation (15):

$$P_t = \left(\int_0^1 s_{jt} P_{jt}^{1-\theta} dj \right)^{\frac{1}{1-\theta}} \tag{15}$$

2.3 The intermediate-good-producing firm

The intermediate good is produced using capital, k_{jt}, and labour, h_{jt}, according to the following decreasing returns to scale production function:

$$y_{jt} \le A_t k_{jt}^{\alpha_1} h_{jt}^{\alpha_2}, \qquad \alpha_1, \alpha_2 \in (0,1),\ \alpha_1 + \alpha_2 < 1 \tag{16}$$

Decreasing returns to scale are assumed since, under the standard constant returns to scale assumption, firms do not care about the scale of their operations. With decreasing returns there is an optimal size for the firm and producers will try to offset the effects of shocks that reduce their market share and keep them away from their preferred scale of production. The producers' desire to maintain a desired level of production will ensure that the random walk specification of market share in (12) will actually have a steady state.

A standard technology shock, A_t, affects all firms symmetrically and evolves according to the following AR(1) equation:

$$A_t = (1 - \rho_A) A + \rho_A A_{t-1} + \varepsilon_{At} \tag{17}$$

where $\rho_A \in (-1,1)$ and ε_{At} is a normally distributed iid shock.

The intermediate-good producer is assumed to be only able to change its price once every two periods. In other words, prices evolve according to two-period staggered Taylor contracting. Half the firms will change their prices in even-numbered periods while the remainder of the firms will change their prices only in odd-numbered periods. In support of assuming two-period contracting, Christiano et al (2001) find that prices are fixed for approximately two quarters in their estimated model. The firm selects capital, labour, and the price of its output to maximise the discounted stream of future profits given by:

$$\max_{\{k_{jt}, h_{jt}, p_{jt}\}} E_0 \left[\lambda_t \frac{D_{1jt}}{P_t} + \beta \lambda_{t+1} \frac{D_{2jt+1}}{P_{t+1}} + \beta^2 \lambda_{t+2} \frac{D_{1jt+2}}{P_{t+2}} + \beta^3 \lambda_{t+3} \frac{D_{2jt+3}}{P_{t+3}} + \cdots \right] \tag{18}$$

where

$$D_{1jt} = P_{jt} y_{jt} - P_t r_t k_{jt} - P_t w_t h_{jt} \tag{19}$$

and

$$D_{2jt+1} = P_{jt} y_{jt+1} - P_{t+1} r_{t+1} k_{jt+1} - P_{t+1} w_{t+1} h_{jt+1} \tag{20}$$

The intermediate firm's problem is to maximise discounted profits in (18) subject to:

$$A_t k_{jt}^{\alpha_1} h_{jt}^{\alpha_2} \ge y_t \left(\frac{P_{jt}}{P_t} \right)^{-\theta} s_t \tag{21}$$

The first-order conditions are given by:

$$\alpha_1 \frac{y_{jt}}{k_{jt}} \frac{\xi_t}{\lambda_t} - r_t = 0 \tag{22}$$

$$\alpha_2 \frac{y_{jt}}{h_{jt}} \frac{\xi_t}{\lambda_t} - w_t \tag{23}$$

$$y_{jt} + \theta y_t \left(\frac{P_{jt}}{P_t}\right)^{-\theta-1} s_{jt} \left(\frac{\xi_t}{\lambda_t} - \frac{P_{jt}}{P_t}\right) + \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}} y_{jt+1}\right] \tag{24}$$

$$+ \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\frac{\xi_{t+1}}{\lambda_{t+1}} - \frac{P_{jt}}{P_{t+1}}\right) \left(\frac{P_t}{P_{t+1}} y_{t+1} \theta \left(\frac{P_{jt}}{P_{t+1}}\right)^{-\theta-1} s_{jt+1} + \chi y_{t+1} \left(\frac{P_{jt}}{P_{t+1}}\right)^{-\theta} \left(\frac{P_{jt}}{P_t}\right)^{-\chi-1} s_{jt+1}\right)\right]$$

$$+ \beta^2 E_t \left[\frac{\lambda_{t+2}}{\lambda_t} \chi y_{t+2} \left(\frac{P_{jt+2}}{P_{t+2}}\right)^{-\theta} \left(\frac{P_{jt}}{P_{t+1}}\right)^{-\chi-1} s_{jt+2} \left(\frac{\xi_{t+2}}{\lambda_{t+2}} - \frac{P_{jt+2}}{P_{t+2}}\right)\right] = 0$$

$$A_t k_{jt}^{\alpha_1} h_{jt}^{\alpha_2} - y_t \left(\frac{P_{jt}}{P_t}\right)^{-\theta} s_{jt} = 0 \tag{25}$$

The Lagrangian multiplier for equation (21) is given by ξ_t. Equation (22) equates the marginal rate of substitution for capital to the real interest rate and equation (23) that for labour to the real wage. These equations imply that the price markup over costs is given by $q_t = \lambda_t / \xi_t$. Equation (24) governs the price setting behaviour of the monopolistically competitive intermediate-good producer.[2]

2.4 The monetary authority

The monetary authority adjusts the money supply each period by making equal lump sum transfers to all households. Therefore, we have $M_t - M_{t-1} = T_t$. Assume that the monetary authority follows the policy rule for the money growth rate given by:

$$\mu_t = (1 - \rho_\mu)\mu + \rho_\mu \mu_{t-1} + \varepsilon_{\mu t} \tag{26}$$

where μ_t denotes the growth rate of money in period t ($M_t / M_{t-1} = \mu_t$) and $\rho_\mu \in (-1,1)$ is its persistence parameter. The money supply growth rate shock is an iid random variable given by $\varepsilon_{\mu t}$. The steady state money growth rate and inflation rate is given by μ.

2.5 Market clearing conditions

The market clearing conditions for this economy are given by:

labour: $h_t = h_{1t} + h_{2t}$ (27)

capital: $k_t = k_{1t} + k_{2t}$ (28)

final goods: $y_t = c_t + i_t$ (29)

2.6 Symmetric equilibrium and solution

In a symmetric equilibrium, all intermediate-good-producing firms setting their price in a given period are identical. As such, all firms that can set their price in odd-numbered periods are identical. The same is true for firms setting their price in even periods. Let y_{1t} and y_{2t} represent the output of firms

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[2] We are investigating the feasibility of introducing a full oligopoly-pricing problem into this general equilibrium framework but have yet to work out the details.

setting their price in odd-numbered and even-numbered periods, respectively. All other intermediate-good-producers' variables are similarly labelled.

There is no real growth in the model but there can be nominal growth. Therefore, real variables do not need to be rescaled but all nominal variables need to be deflated by the money stock in order to be able to solve for a symmetric stationary equilibrium. The following normalisations are necessary:

$$m_t = \frac{M_t}{P_t} \quad \text{or} \quad p_t = \frac{P_t}{M_t}, \quad p_{jt} = \frac{P_{jt}}{M_t} \quad \forall\, j \tag{30}$$

A symmetric equilibrium is composed of an allocation set, $\{y_t, y_{1t}, y_{2t}, c_t, m_t, h_t, h_{1t}, h_{2t}, k_t, k_{1t}, k_{2t}, i_t\}$, and a sequence of prices and costate variables, $\{p_t, p_{1t}, p_{2t}, w_t, r_t, q_{1t}, q_{2t}, \lambda_t\}$, that satisfy the household's first-order conditions in equations (6)-(10), the intermediate-good-producer's first-order conditions in equations (22)-(25), the production function in equation (11), the demand functions in equation (14), the aggregate price definition in equation (15) and the market clearing conditions in equations (27)-(29). This represents a system of 20 equations with 20 unknowns.

The solution technique used to solve this model was a stacked-time method described in Armstrong et al (1998).

3. Calibration

The calibration of the model follows closely the results in Dib (2001). In that study, roughly one third of the structural parameters were fixed whereas the remainder were estimated on Canadian data using the approach described in Hansen and Sargent (1998). The parameters are reported in Table 1.

Table 1

Calibrated parameters

Parameters	β	η	α_1	α_2	δ	θ	b	μ	ρ_μ	γ	A	ρ_A
Values	0.992	1.42	0.33	0.6	0.025	10.0	0.535	1.0	0.0	0.4366	220.67	0.9471

The major exception to following Dib is the parameter θ, which represents the elasticity of substitution between different inputs and the degree of monopoly power. We calibrated θ to equal 10 since this represents a middle ground between the value calibrated in Dib ($\theta = 6$) and that estimated by Kim (2000) ($\theta = 12.4$), albeit with US data. Sensitivity analysis with different values of θ showed that the results pertaining to the importance of market share did not substantially change. In the experiments below we consider two values of χ, 5 and 15, to examine their implications for inflation persistence. Capital's share in production, α_1, is set at 0.33 while labour's share, α_2, is assumed to be 0.6. This introduces a relatively minor degree of decreasing returns to scale.

Other minor deviations from the estimated parameters in Dib (2001) include assuming that monetary policy shocks are not persistent ($\rho_\mu = 0$) and that the steady state inflation rate is zero ($\mu = 1.0$). These modifications helped to simplify the solution of the model and should not have significantly affected the results.

4. Results

In this section we compare the predictions of the standard sticky-price model to the model augmented by market share. We focus the analysis on inflation for two reasons: (i) we conjecture that the presence of market share will help induce inflation persistence; and (ii) there is a large empirical literature demonstrating that the response of inflation to a shock should be gradual and hump-shaped (see, for example, Christiano et al (1999)).

Graphs 1 and 3 present the response of inflation to a technology and a money supply shock, respectively.[3] Graphs 2 and 4 contain the responses of output to the same two shocks. The solid line represents the response of inflation (or output) in the standard sticky-price model whereas the dashed and dotted lines are inflation responses from the models with greater degrees of market share. To be precise, $\chi = 5$ for the dashed line and $\chi = 15$ for the dotted line. For both types of shocks, the standard sticky-price model admits an inflation response that peaks in the first period and then decays very quickly to steady state. This result offers prima facie evidence supporting the conclusions in Christiano et al (2001) that the critical nominal friction in their model is staggered wage contracts, not price contracts.

Looking across the two figures for inflation, it is readily apparent that, for the chosen calibration, the presence of market share in our model does not significantly prolong the reaction of inflation to either shock. The presence of market share, however, can substantially diminish the first-period response of inflation, with greater values of χ leading to greater dampening of the inflation response. Given the current calibration of the model, $\chi = 15$ was the largest market share parameter that could be assumed. Above that level, the model exhibited evidence of instability that we do not yet fully understand.

One possible reason for the lack of a significant increase in inflation persistence may be that wages, which are completely flexible, are moving in a manner to unwind any effect arising from market share concerns. In preliminary work, we investigated a version of the model that also included wage contracts but found that their interaction with market share did little to change the response of inflation. Even in the extreme case of virtually no wage response to the shock, the effect of market share was about the same.

The main reason we believe market share is not playing a large role is that the intermediate-good producers are not playing an oligopoly pricing game. So far, each intermediate producer has assumed that the price and output levels of his competitors do not respond to changes in his price. If a more sophisticated pricing game was being played in which the reaction of the competitors was taken into account, then it is possible that market share would become a more significant variable in the decision-making process.

Another factor that may be playing a role is that entry and exit are not permitted in this version of the model. As such, even when a firm earns negative profits because it moved its price too much or too little, it will not be forced out of the industry. This could also be described as there being no punishment for earning losses. It could therefore be interesting to investigate market share in a financial accelerator model (see Bernanke et al (1999)) in which the net worth of the firm was an important determinate of the equilibrium outcome. Firms may then be more interested in protecting their market share if it also implies they are protecting their net worth and future borrowing ability.

We also tried different methods of incorporating market share into the model but the effects on the inflation response were not substantially changed.[4] In one model, however, which assumed that deviations of a firm's price from the market price imposed a direct real cost on the firm, inflation responses to shocks were small and very persistent. This version of the model was unsatisfactory and ad hoc. But it does indicate that market share could be important for inflation persistence.

A sensitivity analysis revealed some interesting results. First, the degree of persistence of inflation is not particularly sensitive to the level of steady state inflation. Inflation was marginally less persistent at lower rates of average inflation but the difference was too small to be of note. Somewhat more interesting, however, is the fact that the model exhibits an asymmetry between the effects of a positive and a negative shock.[5] The inflation response is larger for a positive money growth rate shock than for a negative shock of equal magnitude (see Graph 5). There is a very small asymmetry apparent in the base case model without market share but it is strongly accentuated by the presence of market share effects. The demand function in equation (14) naturally implies greater increases in demand for a price decline than decreases following a price increase. The presence of market share in equation (14) strongly

[3] We also considered impulse responses for money demand and labour supply shocks. However, these results were quite similar to the technology shock shown.

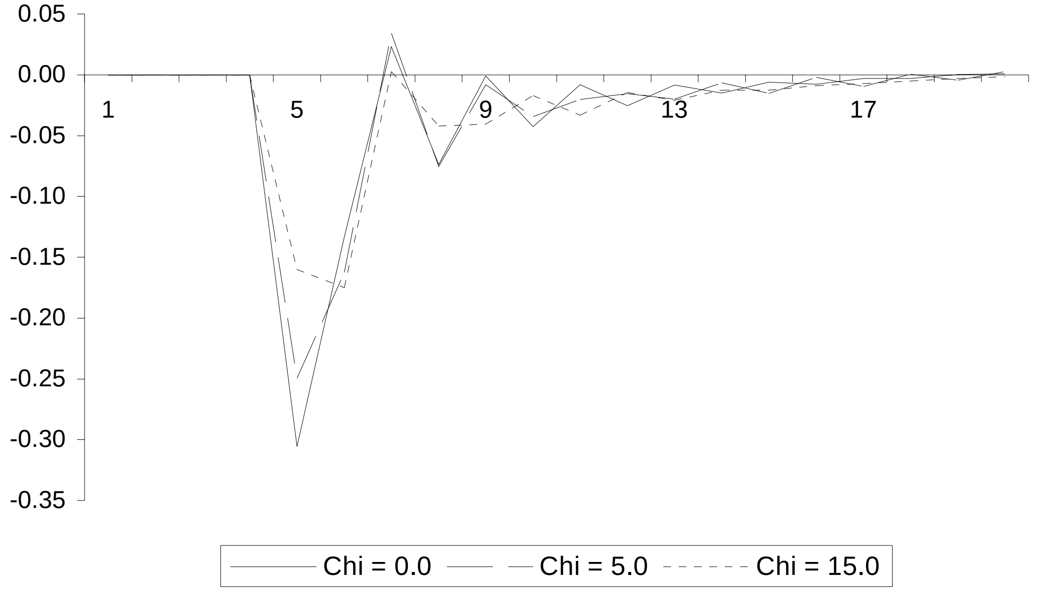
[4] We also examined the implications of three-period contracts but found that the results were quite similar.

[5] The stacked-time solution technique used in this paper yields a non-linear solution to the model.

Graph 1

Inflation response to a technology shock

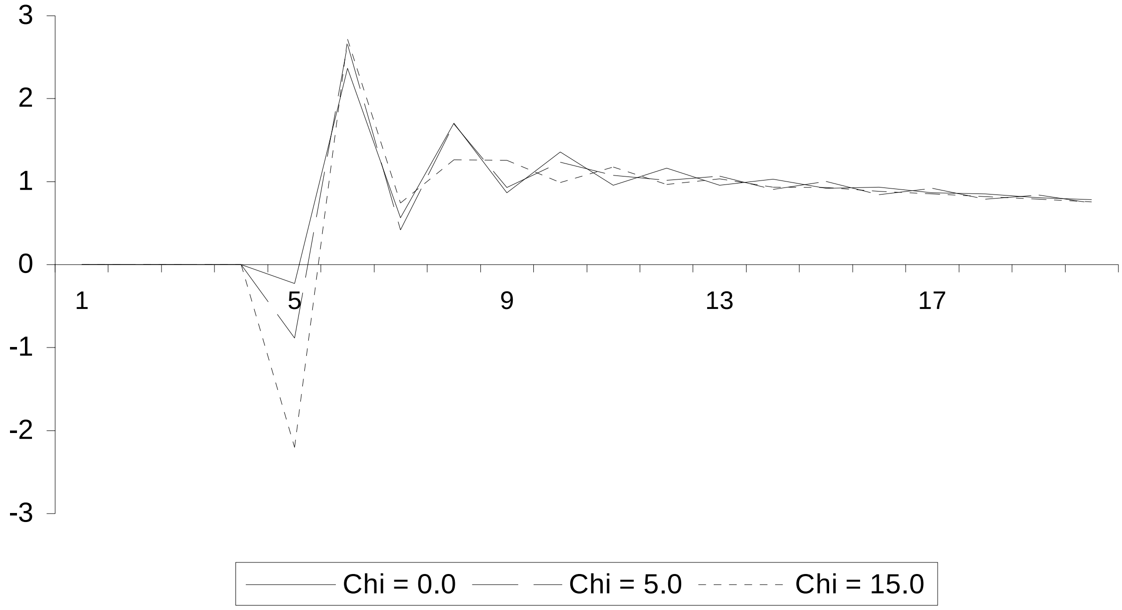
Percentage point deviation



Graph 2

Output response to a technology shock

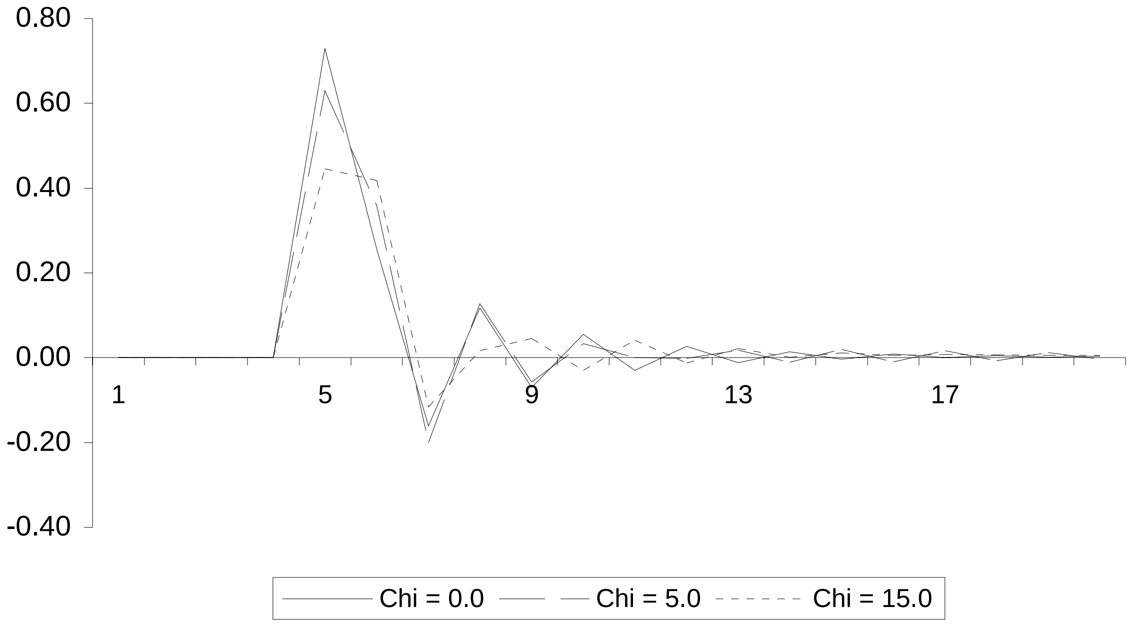
Percentage deviation



Graph 3

Inflation response to a money supply shock

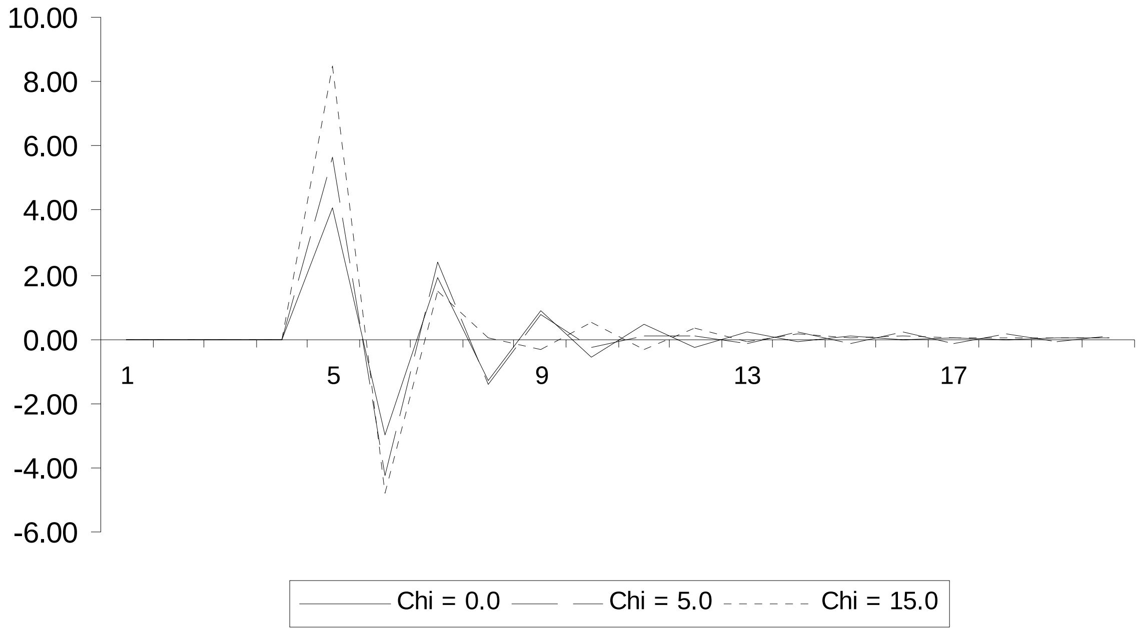
Percentage point deviation



Graph 4

Output response to a money supply shock

Percentage deviation

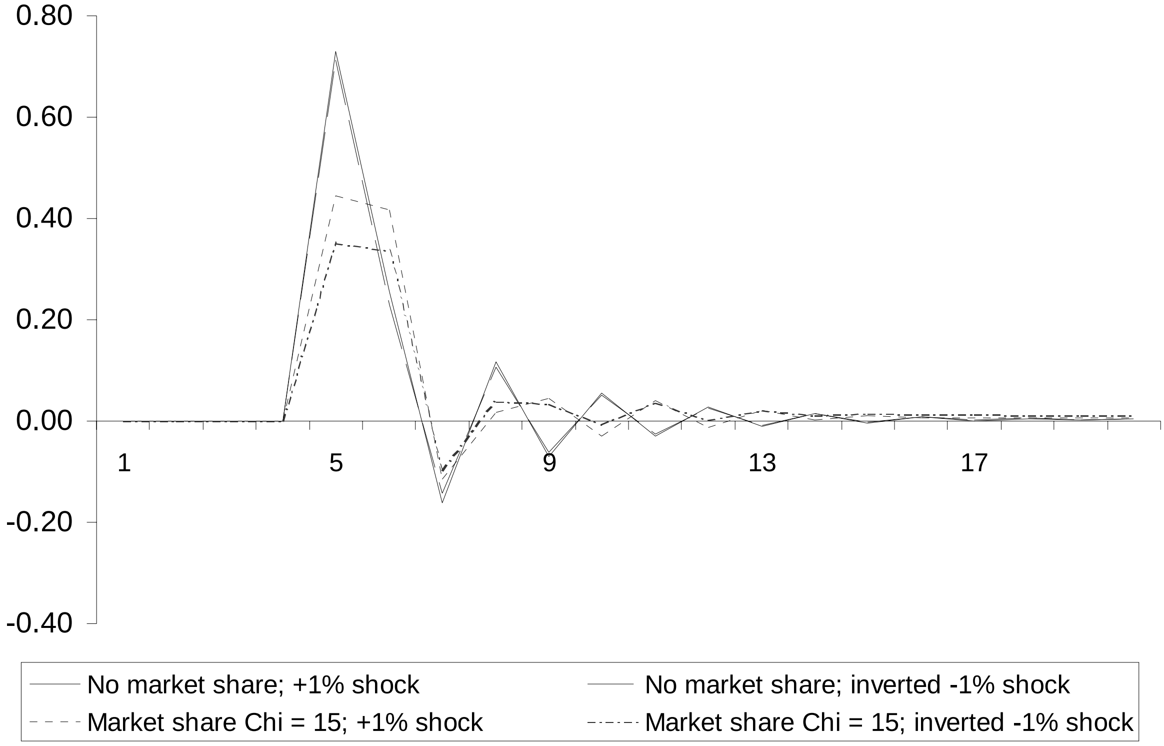


enhances this natural asymmetry. In addition, some of the asymmetry seems to be coming from the inflation tax on money holdings. Unfortunately, one would have expected that, following a negative money shock, the initial price mover would decrease his price by even more (than for a positive money shock) given that this would persistently improve his market share. The initial price mover does not take advantage of this opportunity to steal market share from his competitors. This is another indication that the firms in this model are not playing a pricing game that is as sophisticated as occurs in reality.

Graph 5

Inflation response to a money supply shock

Percentage point deviation



Turning to the output responses in Graphs 2 and 4, we see that market share increased the size of the response following both technology and money shocks. This is unsurprising given that the inflation responses were dampened. However, it is interesting that, despite significant and persistent deviations of the market shares and outputs of the two types of firms, there is no increased persistence of the deviation of aggregate output. The movements of market share of each firm type are offsetting, implying that the shape of the aggregate output response is basically as in the base case without market share. Longer Taylor contracts or Calvo-style pricing would probably yield more persistent output movements since market share changes would not cancel out as easily upon aggregation.

5. Conclusions

In this paper, we examine whether market share is able to improve our understanding of inflation persistence. To this end, we develop a dynamic, general-equilibrium model that features sticky prices and market share, and study the implications of their interaction using a series of standard shocks. Sticky prices are incorporated via Taylor-style contracts and concern over market share is added using a form of the "customer market" model described in Phelps and Winter (1970). Unfortunately, the form of market share considered in this paper did little to prolong the response of inflation to a shock, although it did reduce the first-period response.

However, the analysis has revealed a number of interesting alternative specifications of the model that should be fruitful to pursue. Further research is, therefore, key to determining the true role of market share in the persistence of inflation. In particular, empirical estimation of this or similar models is necessary to better determine the empirical importance of market share considerations as a contributor to inflation persistence.

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