External MPC Unit

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The Pricing Behaviour of UK Firms

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Abstract

Industrial prices of goods and services are a function of costs of production and of the mark-up that firms apply on those costs. If these prices relate to goods that are traded internationally, they will also be influenced by the price at which those goods are exchanged in international markets. In this paper we present two models of industry pricing behaviour and confront them with UK sectoral data, by estimating the theoretically derived pricing equations using an input-output table at basic prices prepared by Cambridge Econometrics and employment and wage data from the New Earnings Survey. The model based on Bils (1987) and Hall (1988) and which was originally devised for industries within the US manufacturing sector appears to fit the data only marginally better than the one which is based on a structural dynamic pricing equation from Batini, Jackson and Nickell (2000). In both models, sectoral domestic prices depend on marginal costs and sectoral world prices in domestic currency. We find that, in this respect, the weight attached to world prices is significantly correlated with the degree of openness of the industry.

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Abstract

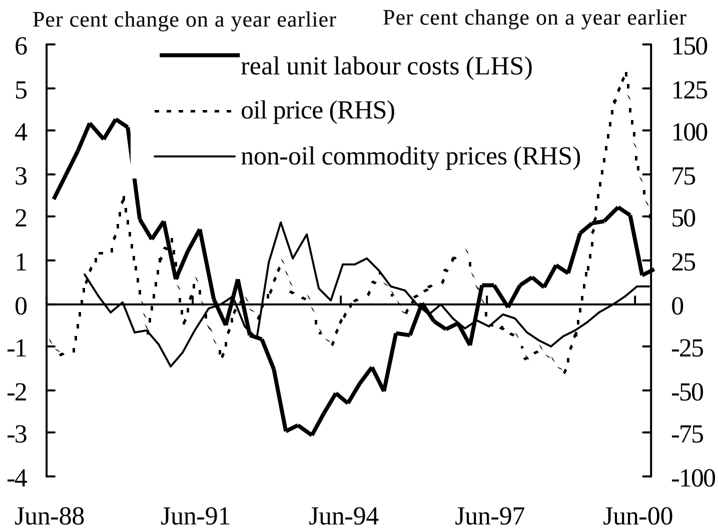
Industrial prices of goods and services are a function of costs of production and of the mark-up that firms apply on those costs. If these prices relate to goods that are traded internationally, they will also be influenced by the price at which those goods are exchanged in international markets. In this paper we present two models of industry pricing behaviour and confront them with UK sectoral data, by estimating the theoretically derived pricing equations using an input-output table at basic prices prepared by Cambridge Econometrics and employment and wage data from the New Earnings Survey. The model based on Bils (1987) and Hall (1988) and which was originally devised for industries within the US manufacturing sector appears to fit the data only marginally better than the one which is based on a structural dynamic pricing equation from Batini, Jackson and Nickell (2000). In both models, sectoral domestic prices depend on marginal costs and sectoral world prices in domestic currency. We find that, in this respect, the weight attached to world prices is significantly correlated with the degree of openness of the industry.

1. Introduction

Industrial prices of goods and services are influenced by labour costs, the cost of capital and by the costs of intermediate goods used in production. If these prices relate to goods that are traded internationally, they will also be influenced by the price at which those goods are exchanged in international markets.

Typically, all these costs fluctuate considerably. Chart 1 below emphasises this point by showing, for the UK case, the volatile pattern of changes in oil prices over the past decade; and the oscillatory behaviour of non-oil commodity prices and of unit labour costs over that same period.

Chart 1



In effect, the ultimate impact of changes in costs on the prices of goods produced domestically depends on the pricing behaviour of firms in the various industries, i.e. on the way in which firms maximise profits and thereby pass on costs. This in turn is a function of the degree of competition in each market — affected in the long run by secular factors like market reforms and deregulation, technological advance as well as markets' globalisation.

Our purpose in this paper is to examine the pricing behaviour of UK firms at the industry level and investigate the impact of factor costs and world prices of tradables on domestic prices in the UK.

Perhaps the most prominent contributions to the literature that analyses the link between output prices, mark-ups and marginal cost at the industrial level are Bils (1987) and Hall (1988), both using US data. Other contributions in this area that also focus on US data include Domowitz, Hubbard and Petersen (1988), Shapiro (1987), Waldmann (1991), Roberts and Supina (1996), Kollmann (1997) and Ghosal (2000). For the UK, Geroski (1992) and Geroski and Hall (1995) both look at the responses of prices and quantities to cost and demand shocks in the manufacturing sector, whereas Haskel, Martin and Small (1995), and Small (1997) also use manufacturing data to estimate the mark-up of price over marginal cost. Using a calibrated optimising model, Britton, Larsen and Small (1999) investigate the behaviour of the mark-up over marginal cost for the UK at an aggregate level, comparing the ability to explain UK data of a customer market model with that of a model assuming implicit market collusion**.**

In contrast to existing work on the UK, here we concentrate specifically on firms' determination of output prices, which we model at the industry level. This approach is preferable to one based on a structural decomposition analysis because the latter relies on a mere breakdown of identities to draw out statistical associations and is not properly grounded in economic theory.[1] To capture the specific effect of world prices on domestic prices we follow the analysis of Froot and Klemperer (1989) (see also, among others, Dornbusch (1987), Bulow et al (1985), Layard et al (1991)). Drawing on models of industrial organisation, this shows how price adjustments are a function of the degree of market concentration, the extent of product homogeneity and substitutability, and the relative market shares of domestic and foreign firms. Using an input-output table at basic prices prepared by Cambridge Econometrics and employment and wage data from the New Earnings Survey, we then estimate the theoretically derived pricing equations for all industries in the economy, including the public sector. We include the public sector despite the fact that public sector prices are not determined by profit maximising behaviour. We do this so that we have an empirical model that covers more or less all the economy. In addition, our data set covers the period 1969-1998. Thus, in contrast to previous studies, which analysed explicitly pricing behaviour but focused primarily on the 1980s, our empirical analysis also encompasses the more recent past.

The wealth of results associated with a sector-specific analysis enables us to examine several important issues related to the determinants of UK industrial prices, and more broadly of producer prices and consumer prices inflation in the UK. For instance, we are able to

[1] See Rose and Casler (1996) for a criticism of input-output structural decomposition analysis.

investigate the relationship between prices and marginal cost in each UK industry. We can also examine whether international prices of tradables influence domestic sectoral prices; whether these influences differ across industries, in particular, whether international price effects are systematically related to the openness of each sector.

The paper is divided into four sections. Following the Introduction (Section 1), Section 2 lays out two models that stylise the microeconomic theory of pricing behavior at the industry level. The first is in line with Bils (1987) and Hall (1988) (henceforth 'BH'), which was originally devised to model industry pricing behavior in the US manufacturing sector, and assumes imperfect competition and *ad hoc* adjustment costs. The second, based on a structural dynamic pricing model for the UK, follows Batini, Jackson and Nickell (2000) ('BJN' hereafter), and assumes monopolistic competition and quadratic adjustment costs. Section 3 then describes the data that we use to estimate the model of Section 2. Part of these data is derived from the UK Office of National Statistics' Input-Output tables, so we begin by describing an open input-output model. This illustrates the relationship between various costs of production, net taxes, and industry prices in an open economy that uses imported inputs together with domestically produced inputs for production. This section also presents the empirical results obtained by estimating the pricing equation (in levels and growth rates) derived in Section 2 for each industry. Section 4 concludes.

At the end of the paper we include a Data Appendix describing the data that we have used in the empirical analysis.

2. Microeconomic Theory of Pricing Behaviour

We consider two models of industry pricing behaviour. Both assume that technology is Cobb-Douglas and that firms use as inputs to production labour, domestically produced goods, and imported intermediate goods. For analytical convenience, throughout the analysis we assume that capital is fixed (predetermined).

Sub-section 2.1 presents the first model. This is similar in spirit to Bils (1987) and Hall (1988), and lays out the microeconomic principles that underlie pricing decisions at the industry level, when competition in the market of the industry's product is imperfect. Sub-section 2.2 then presents an alternative model of industry pricing behaviour based on the structural dynamic pricing model in BJN (2000). The main difference between these two models relates to their dynamic properties. Whereas the first is inherently a static model, so that dynamics have to be introduced *ad hoc* at a later stage, the second model is intrinsically dynamic because, from the start, it assumes that firms maximise a real profit objective subject to price and employment adjustment costs. Sub-section 2.1.1 and 2.2.1, respectively, show how the structural pricing models that we obtain can be made operational for estimation.

2.1 Bils - Hall model of *i*-th industry pricing behaviour

One way to derive structural pricing models for a paradigmatic industry, in line with Bils (1987) and Hall (1988), is to start by considering a representative firm, labelled j, operating in a non-competitive industry where all firms are assumed to be identical. For simplicity, in what follows we omit the subscript i which indexes the industry. Suppose the costs facing firm j are:

$$\text{Cost} = C_t\left(Y_{jt}\right) = q_{jt}\overline{C}\left(Y_{jt}\right)$$

where q_{jt} is a random productivity shock and Y_{jt} is the value added of j-th firm. Next assume that demand facing firm j is:

$$Y_{jt} = \left(\frac{P_{jt}}{P_t}\right)^{-h_{jt}} Y_{djt}$$

where P_{jt} is j-th firm's value added price, P_t is the aggregate price, and Y_{djt} is a demand index.

Supposing also that firm j sets its price prior to the productivity shock being revealed, profit maximisation for firm j implies:

$$P_{jt}^{*} = \left(\frac{q_{jt}^{e}}{q_{jt}}\right) m_{jt}^{*} MC_{jt}$$

where $MC = \frac{\partial C}{\partial Y}$ = marginal cost, m^*_{jt} is the equilibrium mark-up (discussed further in Section 2.2 below) and is equal to $\left(1 - \frac{1}{h_{jt}}\right)^{-1}$, $\left(\frac{q}{q^e}\right)$ is a productivity innovation, and P^* is the equilibrium price. Given our initial assumption that firms within the industry are identical, we can aggregate this to the industry level to get:

$$P^*_{it} = \left(\frac{q^e_{it}}{q_{it}}\right) m^*_{it} MC_{it} \qquad \textbf{(1)}$$

The above equation gives the static equilibrium level of (value added) prices for industry i, that is, the price that would prevail if prices were fully flexible. In reality, prices are sticky because of adjustment costs of various kinds. Adding arbitrary price adjustment to reflect price stickiness, gives, in logs:

$$p_{it} = l_i p^*_{it} + (1 - l_i)\, p_{it-1}$$

or

$$p_{it} = l_i \left(p^*_{it} - p_{it-1} \right)$$

where $p_{it} = \Delta p_{it}$ represents inflation in industry i. Substituting for p^* using **(1)** yields:

$$p_{it} = l_i \left(mc_{it} - p_{it-1} \right) + l_i \ln m^*_{it} - l_i \ln\left(q_{it} / q^e_{it} \right) \qquad \textbf{(1a)}$$

This equation says that price inflation in industry i depends on the industry's marginal cost relative to last period's price, the industry's equilibrium mark-up, and the industry's productivity shock. In order to estimate it, though, we must first specify an expression for marginal cost. For that purpose, we assume that production has the form:

$$Y = A\left(NH \right)^a e^{tt} \qquad \textbf{(2)}$$

where N is employment, H indicates hours, and t is the rate of technical change. We then suppose that variable cost is given by:

$$C = W(H)HN + \frac{1}{2}b\bar{W}\frac{\left(N-(1-d)N_{-1}\right)^2}{(1-d)N_{-1}} \qquad \textbf{(3)}$$

where $W(H)$ represents the average hourly wage, d is the (exogenous) quit rate, and $\bar{W}$ represents the average weekly wage rate (that is, the weekly wage computed at some average level of hours). The second term reflects quadratic adjustment costs. Then, if wages are paid at a premium rate when hours exceed H_N, standard hours, we have:

$$W(H) = W_0\frac{\left[H^N + (1-r)(H-H^N)\right]}{H} \qquad (H \geq H^N)$$

or

$$W(H) = W_0\left[1 + r\left(1 - \frac{H^N}{H}\right)\right] \qquad \textbf{(4)}$$

where r is the overtime premium, H^N is standard hours, and W_0 is the basic hourly wage rate.

Noting that $W'(H) = W_0 r\frac{H^N}{H^2}$, we observe that:

$$\frac{HW'(H)}{W(H)} = \frac{r\frac{H^N}{H}}{\left(1 + r\left(1 - \frac{H^N}{H}\right)\right)} \simeq r \qquad \textbf{(5)}$$

since $H \simeq H^N$.

To generate marginal cost, we compute the change in cost divided by the change in output, again in line with Bils (1987) and Hall (1988), starting from a baseline of $\bar{W},\ (1-d)N_{-1},\ H^N$. From **(3)**, the deviation in costs from this baseline is given by:

$$\Delta C = \bar{W}\left(N-(1-d)N_{-1}\right)+\bar{W}(1-d)N_{-1}\frac{\left(H-H^N\right)}{H^N}+\bar{W}'(H)H(1-d)N_{-1}\left(H-H^N\right)$$
$$+b\bar{W}\frac{\left(N-(1-d)N_{-1}\right)}{(1-d)N_{-1}}\left(N-(1-d)N_{-1}\right)$$

Noting that $W'(H)H \simeq rW(H)$ [from **(5)**]$\simeq r\dfrac{\bar{W}}{H^N}$, at the baseline, we have:

$$\Delta C = \bar{W}(1-d)N_{-1}\left[\Delta\tilde{n}+\frac{OT}{H^N}(1+r)+b(\Delta\tilde{n})^2\right] \qquad \textbf{(6)}$$

where $\Delta\tilde{n}=\dfrac{N-(1-d)N_{-1}}{(1-d)N_{-1}}$, $OT = H - H^N =$ overtime hours. Equation **(6)** says that a change in costs in this model will depend on changes in employment plus the change in overtime hours adjusted for the overtime premium, all computed relative to the baseline. In line with Bils (1987) and Hall (1988), marginal cost will then be given by the ratio of **(6)** to the change in output from the same baseline, where we remove that part of the change corresponding to technical progress as opposed to increased inputs. That is:

$$MC = \frac{\Delta C}{(\Delta Y - tY)}$$

Since at the baseline, average cost is equal to $AC = \bar{W}(1-d)N_{-1}/Y$, the ratio of marginal to average costs will be:

$$\frac{MC}{AC} = \frac{\Delta C}{\bar{W}(1-d)N_{-1}(\Delta y - t)}$$

where $\Delta y = \dfrac{\Delta Y}{Y} = \Delta\ln Y$. Substituting from **(6)** and **(7)** we have:

$$\frac{MC}{AC} = \frac{\Delta\tilde{n}+(1+r)\frac{OT}{H^N}+b(\Delta\tilde{n})^2}{(\Delta y - t)} \qquad \textbf{(8)}$$

In addition, from the production function **(2)** we have:

$$y = \ln A + a \ln N + a \ln H + t\, t$$

Taking deviations from the same baseline ($\overline{W},\ \left(1-d\right)N_{-1},\ H^N$), we obtain:

$$\Delta y = a\Delta\tilde{n} + a\,\frac{OT}{H^N} + t \tag{9}$$

So in the end, from **(8)** and **(9)** we get an expression for the ratio of marginal to average cost as a function of overtime hours and changes in employment. The ratio will also depend on four parameters; the overtime premium (r), the labour factor share (a), the adjustment cost parameter (b), and the quit rate (d). It is given by:

$$\frac{MC}{AC} = \frac{1}{a}\left[1 + \frac{r\,\frac{OT}{H^N} + b\,\frac{\left(\Delta\tilde{n}\right)^2}{\overline{\left(\Delta\tilde{n}\right)}}}{\frac{OT}{H^N} + \Delta\tilde{n}}\right] \tag{10}$$

This derivation of marginal cost leaves us with two alternative options for estimating our pricing BH equation [**(1a)**].

First, we can replace mc_{it} by $\ln AC$ (natural log of unit labour costs), OT/H^N, $\Delta\tilde{n}$, and $\left(\Delta\tilde{n}\right)^2$ in the regression for value added price inflation based on **(1a)**. This is effectively using a linear approximation of **(10)**. Below we refer to the model associated with this first option as model **I(a)**.

Second, we can use estimates of the parameters a, r, b, and d to compute MC/AC, and have this in **(1a)** instead, alongside $\ln AC$. Below we refer to the model associated with this alternative option as model **I(b)**. Plausible parameters in this respect could be, for instance, r = 0.4 (range 0.25 to 0.5); d = 0.1 (range 0.05 to 0.15); a = 0.7.[2] Moreover, supposing that

[2] Alternatively, we could compute the average a for each industry, although the difference between these two methods would anyway be irrelevant since, in a log formulation, it will merge with the constant term.

adjustment costs per employee hired are approximately equal to two months pay,[3] then average adjustment cost per employee hired is:

$$\frac{1}{2}b\left(52\bar{W}\right)\overline{\frac{\left(N-\left(1-d\right)N_{-1}\right)}{\left(1-d\right)N_{-1}}}$$

where two months pay is equal to $\frac{52\bar{W}}{6}$. So $\frac{1}{2}b\overline{\left(\Delta\tilde{n}\right)}=\frac{1}{6}$, and $b=\frac{0.33}{\overline{\left(\Delta\tilde{n}\right)}}$, where $\overline{\Delta\tilde{n}}$ is the average of $\Delta\tilde{n}$ over the sample period. Thus we have:

$$\frac{MC}{AC}=\frac{1}{0.7}\left[1+\frac{0.4\frac{OT}{H^N}+0.33\frac{\left(\Delta\tilde{n}\right)^2}{\overline{\left(\Delta\tilde{n}\right)}}}{\frac{OT}{H^N}+\Delta\tilde{n}}\right] \quad \textbf{(11)}$$

where $\Delta\tilde{n}=\frac{N-0.9N_{-1}}{0.9N_{-1}}$.

Finally, let the cost shock be proportional to $tfp_{it}-tfp_{it-1}-t_i$, where t_i is the average rate of total factor productivity (*tfp*) growth (Δtfp_{it} is the rate of total factor productivity growth).

Given that average cost at time *t* is $\frac{W\left(H_t\right)H_tN_t}{Y_t}=\frac{W_tN_t}{Y_t}$, so that $ac_t=w_t+n_t-y_t$, model **I(a)** will include $\left(w_t+n_t-y_t\right),\left(OT/H^N\right)_t,\Delta\tilde{n}_t,$ and $\left(\Delta\tilde{n}\right)_t^2$. Model **I(b)** will include $\left[\left(w_t+n_t-y_t\right)+\ln\left(MC/AC\right)_t\right]$, based on **(11)**. Both regressions will include Δtfp_{it} to reflect the impact of the cost shock.

[3] Measures of adjustment costs per employee hired vary in the literature. Most of the analysis in this area is based on US data. Relative to that data, Oi (1962) estimated that hiring costs for unskilled workers are approximately equal to 22 hours pay. Baron et al (1983) estimated hiring costs for unskilled/semi-skilled to be around 42 employee hours. Rees (1973) estimated hiring costs pay for managerial/technical employees as twelve times those for unskilled workers and for skilled manual employees as five times those for the unskilled. Overall we propose 2 months pay, as UK labour markets are somewhat less flexible than US labour markets.

2.2 Batini, Jackson and Nickell model of *i*-th industry pricing behaviour

The aggregate version of **(1)** gives the static equilibrium level of prices, that is, the price that would prevail in the absence of adjustment costs. This equation is equivalent to equation **(6)** in BJN (2000). So as an alternative to equation **(1a)**, we can model pricing behaviour at the industry level using directly the disaggregated price-setting equation from BJN (2000). In contrast to the Bils-Hall specification, which, as we showed, introduces adjustment costs arbitrarily and at a later stage (see Sub-Section 2.1), the BJN (2000) model is intrinsically dynamic because it postulates that firms aim to maximise real profits *subject* to (price and employment) adjustment costs.

As in the BH model, the BJN (2000) model assumes that firms in industry i are identical, so we can start once more by considering the representative firm with production function $Y_{it} = A_{it} N_{it}^{a}$ and demand $Y_{it} = \left(P_{it}/P_t\right)^{-h_{it}} Y_{dit}$. We then follow the derivations in BJN (2000) up to equation **(15)**, with equations **(11)** and **(9)** in BJN (2000) dated $s = 0$.[4] This gives us a pricing equation for industry i as a function of (lagged expectations of) past, present and future deviations of i-th industry prices from aggregate prices and as a function of $\hat{p}_{it}$:

$$p_{it} - E_{t-1}p_t = f\,l\,E_{t-1}\left(p_{it+1} - p_{t+1}\right) - f\,l^{2}E_{t-1}\left(p_{it} - p_t\right) + l\left(p_{it-1} - p_{t-1}\right) + \left(1 - l\right)\left(1 - f\,l\right)E_{t-1}\hat{p}_{it} \quad \textbf{(12)}$$

where $\hat{p}_{it}$ is equal to:

$$\hat{p}_{it} = p_{it}^{*} - E_{t-1}p_t + \frac{b_p}{q}E_{t-1}\left(f\Delta p_{t+1} - \Delta p_t\right) - \frac{b_n h}{q a^{2}}E_{t-1}\left[f\Delta\left(y_{dit+1} - a_{it+1}\right) - \Delta\left(y_{dit} - a_{it}\right)\right] \quad \textbf{(13)}$$

$$a_{it+s} + a\,n_{it+s} = -h\left(p_{it+s} - p_{t+s}\right) + y_{dit+s} \quad \textbf{(14)}$$

Setting s = 0,1 in **(14)** and substituting in **(13)** gives, after some rearrangement an expression of $\hat{p}_{it}$ as a function of the i-th industry static equilibrium price level, p_{it}^{*}, current aggregate prices, next period's changes in aggregate inflation, changes in i-th industry price inflation, and finally, changes in employment:

[4] Extracts from BJN(2000) presented in an appendix to this paper reproduce these equations.

$$\hat{p}_{it} = p^*_{it} - E_{t-1}p_t + \left[\frac{b_p}{q} + \frac{b_n h}{qa^2}\right](f E_{t-1}p_{t+1} - E_{t-1}p_t) - \frac{b_n h^2}{qa^2}(f E_{t-1}p_{it+1} - E_{t-1}p_{it})$$
$$- \frac{b_n h}{qa}(f E_{t-1}\Delta n_{it+1} - E_{t-1}\Delta n_{it}) \quad \textbf{(15)}$$

Furthermore, after some manipulation, **(12)**, **(15)** reduces to:

$$p_{it} = \frac{1}{1+m_{i1}}(p^*_{it} - p_{it-1}) + \frac{m_{i1}}{1+m_{i1}} E_{t-1}p_{it+1} + \frac{m_{i2}}{1+m_{i2}}(f E_{t-1}p_{t+1} - E_{t-1}p_t)$$
$$- \frac{m_{i3}}{1+m_{i1}}(f E_{t-1}\Delta n_{t+1} - E_{t-1}\Delta n_t) + n_{it} \quad \textbf{(16)}$$

where $n_{it} = k(p_{it} - E_{t-1}p_{it})$, $m_{i1} = \frac{l}{(1-l)(1-fl)} - \frac{b_n h^2}{qa^2}, m_{i2} = \frac{b_p}{q} - m_1, m_{i3} = \frac{b_n h}{qa}$ (note that all the parameters are *i*-specific), $p^*_{it} = \ln m^*_{it} + mc_{it}$, $mc_{it} = -\ln a_i + (w_{it} + n_{it} - y_{it})$, and where m^*_{it} is the equilibrium mark-up.

So we now have three alternative models: model **I(a)** (BH including average costs, overtime hours and changes in employment); model **I(b)** (BH including average costs and the ratio of marginal to average costs); and model **II** (a modification of BJN (2000) for the industry level). In all these models industry prices depend on m^*, that is, the industry equilibrium mark-up, the specification of which we now discuss.

2.3 The Equilibrium Mark-Up

In an open economy, the domestic market for the output of a typical industrial sector will consist of the sales of a large number of goods which are fairly close substitutes (e.g. different makes of cars). These will be produced by domestic firms, whose prices we are modelling, and foreign firms.[5]

[5] The impact of strategic interaction between domestic and foreign firms is discussed by Froot and Klemperer (1989). See also, among others, Dornbusch (1987), Bulow et al (1985), and Layard et al (1991).

The hypothesis we propose here is that the prices charged by the domestic firms will be influenced in the long run by the costs, in domestic currency, of the foreign firms. To see how this may happen, consider a simple two-firm oligopoly model. The domestic firm (D) sells its goods in the home country at price P and produces at constant marginal cost C. The foreign firm (F) sells its goods in both the home country, at price P_f (in domestic currency) and in the foreign country where it acts as a monopolist and sells at P_f'. These goods are imperfect substitutes for those produced by the domestic firm. It produces at constant marginal cost C_f (in foreign currency). Suppose $D(P,P_f)$ is the demand for the good produced by (D) and $D^f(P,P_f)$ is the demand for the good produced by (F) in the home country. The foreign firm sets a price P_f' in the foreign country, where $P_f' = mC_f$, m being some fixed mark-up.[6] In the home market the domestic producer solves:

$$\max_P PD(P,P_f) - CD(P,P_f)$$

taking P_f as given (we use price competition for ease of exposition). The first order condition is:

$$\left[1 - \frac{1}{h(P,P_f)}\right]P = C$$

where $h = -\dfrac{P\partial D/\partial P}{D}$

The solution is the structural equation:

$$P = f'(P_f, C) \qquad \textbf{(17)}$$

Analogously, the foreign producer solves:

$$\max_{P_f} P_f e D^f(P,P_f) - C_f D^f(P,P_f)$$

[6] It is straightforward to introduce transport costs so as to prevent arbitrage across countries in the foreign produced good.

taking P as given. e is the number of units of foreign currency which exchange for one unit of domestic currency, so that a fall in e is a domestic depreciation. The FOC is:

$$\left[1-\frac{1}{h^f(P,P_f)}\right]P_f = C_f \big/ e$$

where $h^f = -\dfrac{P_f\,\partial D^f \big/ \partial P_f}{D^f}$

The solution is the structural equation:

$$P_f = f^2(P, C_f \big/ e) \qquad \textbf{(18)}$$

Eliminating P_f between **(17)** and **(18)** gives the reduced form equation for P, namely:

$$P = f(C, C_f \big/ e)$$

where we would expect f to be increasing in both arguments. Then a ceteris paribus depreciation of the domestic currency tends to increase P.

Note that $C_f \big/ e$ is difficult to observe. Luckily, the price decision in the foreign country enables us to replace $C_f \big/ e$ with $P_f' \big/ me$ since $P_f' = mC_f$ the price equation can be written:

$$P = f'\left(C, P_f' / e\right).$$

If we write this in log-linear form, we have:

$$p = n_0 + n_1\left(p_f' - \ln e\right) + n_2 mc$$

where $mc = \ln C$. This suggests that we allow the equilibrium mark-up to depend on world prices in domestic currency. Furthermore, it seems plausible that the importance of world prices in determining domestic price setting will depend on the openness of the domestic market.

2.4 The Final Empirical Equations

In the light of the analysis in the previous section, we model the equilibrium mark-up as:

$$\ln m_{it}^{*} = m_{i0} + m_{i4}\left(p_{it}^{w} - p_{it-1}\right)$$

where p_{it}^{w} is the world price of i^{th} industry goods in domestic currency.

So model **I(a)** becomes:

$$p_{it} = const + l_i \Delta tfp_{it} + l_i m_{i4}\left(p_{it}^{w} - p_{it-1}\right) + l_i\left(w_{it} + n_{it} - y_{it} - p_{it-1}\right) + m_{i5}\left(\frac{OT}{H^N}\right)_{it} \quad \textbf{(19)}$$

$$+ m_{i6}\Delta \tilde{n}_{it} + m_{i7}\left(\Delta \tilde{n}_{it}\right)^2$$

Model **I(b)** becomes:

$$p_{it} = const + l_i \Delta tfp_{it} + l_i m_{i4}\left(p_{it}^{w} - p_{it-1}\right) + l_i\left[\ln\left(\frac{MC}{AC}\right)_{it} + w_{it} + n_{it} - y_{it} - p_{it-1}\right] \quad \textbf{(20)}$$

where:

$$\left(\frac{MC}{AC}\right)_{it} = \frac{1}{0.7}\left[1 + \frac{0.4\left(OT/H^N\right)_{it} + 0.33\left[\left(\Delta \tilde{n}_{it}\right)^2 / \overline{\left(\Delta \tilde{n}_{it}\right)}\right]}{\left(OT/H^N\right)_{it} + \left(\Delta \tilde{n}\right)_{it}}\right] \quad \textbf{(20a)}$$

And model **II** becomes:

$$p_{it} = const + \frac{m_{i4}}{1+m_{i1}}\left(p_{it}^{w} - p_{it-1}\right) + \frac{1}{1+m_{i1}}\left(w_{it} + n_{it} - y_{it} - p_{it-1}\right) + \frac{m_{i1}}{1+m_{i1}} E_{t-1} p_{it+1}$$

$$+ \frac{m_{i2}}{1+m_{i2}} E_{t-1}\left(fp_{t+1} - p_t\right) - \frac{m_{i3}}{1+m_{i1}} E_{t-1}\left(f\Delta n_{t+1} - \Delta n_t\right) + n_{it} \quad \textbf{(21)}$$

Hence in steady state, models **I(a)**, **I(b)** and **II** all imply:

$$p_i = \frac{m_{i4}}{1+m_{i4}} p_i^w + \frac{1}{1+m_{i4}} \left(w_i + n_i - y_i \right) + ... \qquad \textbf{(22)}$$

where we would like to investigate the hypothesis that the weight, $\frac{m_{i4}}{1+m_{i4}}$, is correlated with the openness of sector *i*.

3. Empirical Results: An Analysis of UK Firms' Pricing Behaviour

In this section we present results from the estimation of the structural equations **(19)**, **(20)** and **(21)** conducted using sectoral time series data for the UK. Before doing so, Sub-Section 3.1 below briefly describes the data that we used, much of which come from an elaboration of the ONS Input-Output Tables by Cambridge Econometrics. Sub-section 3.2 discusses the issue of 'openness' or 'tradability' of the various sectors, a concept that is useful when we analyse the results. The empirical results are presented in Sub-sections 3.3 and 3.4.

3.1 An Open Input-Output Model

A useful starting point to describe the data that we use is to analyse the set of the input-output relationships of the UK economy.

Table 1 below provides an illustration of an input-output table with *n* products and *n* industries.[7]

[7] The concept of input-output analysis was first introduced by Leontief (1951) to understand "what level of input should each of the *n*-th industries in an economy produce, in order that it will just be sufficient to satisfy the total demand for that product". In this sense, Leontief analysis applied more to *quantities*, whereas our analysis focuses on the *value* (price times quantity) of industry purchases of domestic and imported intermediate products.

Table 1: Input-Output table at basic prices

	Industry Outputs 1 ... i … n
Industry domestic inputs 1 . j . n	$p_j x_{ij}$
Industry imported inputs 1 . j . n	$p_j^M M_{ij}$
Net taxes	T_i
Compensation to employees	$W_i L_i$
Gross operating surplus	$p_i^K K_i$
Gross output at basic prices	$p_i x_i$

Table 1 says that gross output of industry i at basic prices in each year is equal to the sum of the value of the inputs used in production by this same industry once adjustments have been made for net taxes, employees' compensation and gross operating surplus. Note that since the UK is an open economy, besides the n industries, the model also contains a rest-of-the-world sector consisting of an additional group of n foreign industries, which determines the final supply of inputs used in the production. In this sense the input-output model on which we focus is an "open" input-output model.

Algebraically, the identity linking gross output at basic prices in a given year and the sum of all inputs used to produce that output can be written as:

$$p_i x_i = w_i L_i + p_i^K K_i + \sum_{j=1}^{n} p_j^M M_{ij} + \sum_{j=1}^{n} p_j x_{ij} + T_i \tag{23}$$

where p_i denotes the price of good i, x_i denotes the quantity of good i produced over the year, p_j^K is the price of capital services, K_j is capital input, p_j^M is the price of imported input j, M_{ij} is the quantity of imports of the j input, and T_i are taxes net of subsidies. Note that p_i^K is actually profit per unit of capital and serves as a "residual" which ensures that the equation balances. If we differentiate equation **(23)** and re-arrange terms, we can obtain an equation for price changes in industry *i* in a given year:

$$\dot{p}_i = s_{iL}\dot{w}_i + s_{ik}\dot{p}_i^K + \sum_{j=1}^{n} s_{ij}\dot{p}_j^M + \sum_{j=1}^{n} v_{ij}\dot{p}_j + s_{iT}\dot{T}_i - \left(\dot{x}_i - s_{iL}\dot{L}_i - s_{iK}\dot{K}_i - \sum_{j=1}^{n} s_{ij}\dot{M}_{ij} - \sum_{j=1}^{n} v_{ij}\dot{x}_{ij}\right) \quad \textbf{(24)}$$

where s and v denote shares of costs in outputs and a dot ($\dot{}$) indicates growth rates. The shares are assumed fixed over the year but vary across years.

Equation **(24)** can be put in matrix form once we consider the prices of outputs of all the industries:

$$\begin{aligned}\dot{p} &= (I-V)^{-1} * S_L .* \dot{w} + (I-V)^{-1} * S_K .* \dot{p}^K + (I-V)^{-1} * S_M .* \dot{p}^M \\ &\quad + (I-V)^{-1} * S_T .* \dot{T} - (I-V)^{-1} * \dot{TFP}\end{aligned} \quad \textbf{(25)}$$

where I is a 50×50 identity matrix, the symbol ‘*’ represents matrix multiplication, the symbol ‘.*’ indicates element by element multiplication, V = $[n_{ij}]$, and $\dot{TFP}$ denotes the growth in total factor productivity, that is, the equivalent of the term in parentheses in equation **(24)**.

The price series constructed for each industry following the above input-output method gives us the industries’ gross output deflators. To obtain value added industry-specific deflators, p_{vi}, for use in the empirical section of the paper below, we can manipulate equation **(24)** as follows:

$$\dot{p}_{vi} = \left(\dot{p}_i - \sum_{j=1}^{n} s_{ij}\dot{p}_j^M - \sum_{j=1}^{n} v_{ij}\dot{p}_j\right) \Bigg/ \left(1 - \sum_{j=1}^{n} s_{ij} - \sum_{j=1}^{n} v_{ij}\right) \quad \textbf{(26)}$$

We obtain 49 of these industry-specific value added deflators — one for each industry, leaving out the fiftieth industrial category, ‘others’ — and use them in our estimates of the pricing equations derived in Section 2. Note however, that because some sectors will either not follow profit maximising behavior or will produce goods/services quite different in kind, its is extremely difficult to measure output prices in these sectors. This is particularly true of sectors like ‘health and social work’, ‘distribution’, ‘education’, ‘public administration and defence’, ‘insurance’, ‘miscellaneous services’, ‘other business services’, ‘banking and finance', 'professional services', and 'computing services'. 'Agriculture' output prices are also hard to measure because of distortions arising from the European Union's Common Agricultural Policy of tariffs and subsidies. Consequently, we expect regressions using these output prices to produce particularly dubious results.

3.2 Estimates of the Bils–Hall and the Batini, Jackson and Nickell models

3.2.1 Data description

We now discuss estimates of equations **(19)**, **(20)**, and **(21)** (that is, models **I(a)**, **I(b)** and **II**). The first two equations are estimated using ordinary least squares. However, we estimate equation **(21)** using the generalised method of moments (GMM) to deal with the expectation terms in that model. We prefer this method to alternative instrumental variable regression methods because, by exploiting orthogonality conditions between some function of the parameters in the model and a set of instrumental variables, it is typically more efficient and robust.

We also present a variation of model **I(b),** denoted $\mathbf{I(b)}'$, which is similar in all respects to **I(b)** but includes extra dynamics. Also, in addition to the original specification of model **II**, we present a variation of it, denoted $\overline{\mathbf{II}}$. In contrast to all other models which are estimated using a world price series that is constructed using the spot exchange rate, $\overline{\mathbf{II}}$ uses a world price series constructed using a moving average of the exchange rate, which also appears to improve the ability of this model to fit the data.[8]

All data are annual time series over the period 1972 – 1998. The majority of the data we use are from a data set provided by Cambridge Econometrics or derived from these data, with other series based on data from the OECD, the UK Office of National Statistics, and the *Department of Employment Gazette*.[9]

Following **(26)**, prices, the dependent variable in equations **(19), (20)** and **(21)**, are measured by the first difference of the industry-specific value added deflators, which we denote as $\Delta p_{it} = p_{it}$.

[8] We do not report results of the other models estimated by using world prices constructed using smooth exchange rate because in this case the regression results are very similar to the case when we use spot exchange rates.
[9] The Data Appendix provides more details about the series we use.

We use two measures of the degree of foreign competition faced by each sector. In both cases, world prices are approximated by using United States data. For the first measure, $p_{it}^{w} - p_{it-1}$, the world price series, p_{it}^{w}, is constructed using the spot sterling-dollar exchange rate, while for the second measure, $\overline{p}_{it}^{w} - p_{it-1}$, the world price series, $\overline{p}_{it}^{w}$, is constructed using a four-year moving average of the exchange rate[10].

We use two measures of marginal cost; $mc_{it} = w_{it} - prod_{it}$, where w_{it} is industry wages, and an adjusted measure, $mc_{it}^{*} = w_{it} - prod_{it} + \ln(MC/AC)_{it}$. Productivity is given by $prod_{it} = (y_{it} - n_{it})$, where y_{it} and n_{it} are real industry value added and employment respectively. As shown in equation **(20a)** in Section 2, the variable $(MC/AC)_{it}$ is a function of the ratio of overtime hours to normal hours worked in each industry, $\left(OT/H^{N}\right)_{it}$, and of an adjusted measure of proportional changes in industry employment, $\Delta\tilde{n}_{it}$[11].

Total factor productivity growth is given by Δtfp_{it}, while the price of aggregate gross value added, p_t, is given by the log of the ratio of current and constant price gross value added measured at basic prices, excluding taxes less subsidies on products.

3.2.2 Tradability

Answers to the key questions addressed in this paper depend critically on how open each sector is to the rest of the world. The extent to which the price of each sector's product is influenced by competition in the international markets is directly strictly related to the extent to which the market for each sector's product is international.

So, before we present and discuss the results, it is useful to rank the sectors in our set on the basis of their degree of openness, which we interpret to be the degree of 'tradability' of their products.

[10] We have also estimated all models using an alternative method of deriving the world price series, namely by constructing the weighted average of the GDP deflators of UK major trading partners for each industry. However, there are substantial limitations in the availability and quality of data we use, and we consider it preferable to use the US data as a proxy for world prices.

[11] In the derivation of $(MC/AC)_{it}$ in Equation **(20a)**, $\Delta\tilde{n}_{it}$ appears squared. In response to a suggestion on an earlier draft, we experimented with using different powers (namely, ½ and 3), but this has little effect, and so we do not report the results.

From a theoretical point of view, it is assumed that it is possible to distinguish between 'tradable' and 'non-tradable' goods and services. In practice, only a small proportion of output falls neatly in these categories. Hence, when moving from theory to empirical analysis we need an operational definition of what is meant by 'tradable'. An intuitive measure of tradability is the extent to which a particular commodity or service is actually traded. This measure informs the practice embraced in most empirical studies of classifying manufactures as 'tradables' and services as 'non-tradables'. Although this simple dichotomy might have been acceptable historically, it is no longer adequate in the light of the globalisation of service markets. For this reason, we base our classification on the ratio of total exports plus total imports to total production in each sector.[12] More precisely, we class a sector as 'tradable' if this ratio is more than 10% (ie if the sum of total exports and imports is 10% or more of total production in each sector).[13] This classification is a function of the particular threshold that we choose, but its sensitivity to this particular choice can be easily checked because this measure is based on the sample data.

Table 2a, column 1, reports a list of the sectors in our sample ranked, in ascending order, according to the size of the ratio of the sum of total exports and total imports to total value of production. Looking at average ratios over the period 1969-1998 (second column, labelled 't'), among the various sectors, 'oil & gas' seems to be the most tradable sector, with exports plus imports surpassing total domestic production by a factor of seven, followed by 'computing services' in which export plus imports are about the same in the total value of the production of the domestic sector (101%), 'other mining' (95%), 'aerospace' (65%), 'electronics' (54%) and so on. On the non-tradables side of the spectrum, 'retailing' appears to be the most non-tradable sector (0.05%), followed by utilities ('water supply' and 'gas supply'), construction (0.18%), public sector services and other inland transport services such as 'rail transport'.

This ranking is largely unaltered if we focus on average export plus import to production ratios over a shorter sample (not shown in Table 2a).

[12] De Gregorio, Giovannini and Wolf (1994) use a similar classification of goods into the tradable and non-tradable categories, but theirs is based on the ratio of total exports (only) to total production in each sector.

[13] At the numerator the measure of imports we use includes both imports of intermediate goods and services used in domestic production and imports of final goods.

The remaining columns in the table show the long-run coefficient on relative world prices, $\frac{m_{i4}}{1+m_{i4}}$, for each model variant that we analyse. Finally, Table 2b summarises correlation results between this coefficient and degree of openness of each sector. We discuss these results in detail in Section 3.2 below.

Table 2a: Sectoral degree of tradability and estimated long-run coefficients of relative world prices Sample: 1969-98

		Estimated long-run coefficients of relative world prices [$m_{i4}/(1+m_{i4})$, see equation (22)]			
	t	**I(a)**	**I(b)′**	**II**	$\overline{\textbf{II}}$
Retailing	0.05	0.42	0.59	0.40	0.80
Gas Supply	0.12	0.33	0.46	0.72	0.22
Water Supply	0.13			1.00	1.00
Construction	0.18	0.23	0.00	0.40	0.26
Health & Social Work	0.34	0.22	0.03	0.03	0.07
Public Administration & Defence	0.69	0.02	0.02	0.13	0.11
Rail Transport	0.84	1.00	1.00	1.00	1.00
Education	0.86	0.15	0.17	0.25	0.04
Distribution nes	0.99	0.36	0.34	0.75	0.02
Electricity	1.02	0.00	0.00	0.00	1.00
Waste Treatment	1.23	0.66	1.00	0.81	1.00
Insurance	2.40			0.86	0.52
Other Land Transport	2.89	0.13		0.00	0.00
Banking & Finance	3.77				0.83
Communications	3.96	0.34	0.47	0.44	1.00
Miscellaneous Services	4.97	0.02	0.14	0.00	0.00
Coal	5.05	0.30	0.65	0.05	0.01
Other Business Services	5.38	0.15	0.98	0.31	0.20
Metal Goods	8.62	1.00	1.00	0.00	0.00
Other Transport Services	9.32				1.00
Professional Services	10.69	0.19	0.28		
Non-Metallic Mineral Products	11.04	0.18	0.29	0.47	0.00
Paper, Printing & Publishing	11.78	0.12	0.17	0.18	0.00
Tobacco	14.22	0.00	0.00	0.00	0.00
Agriculture	14.30	0.45	0.34	0.09	0.09
Food	14.90	0.01	0.14	0.00	0.00
Hotels & Catering	14.90	0.06	0.00	0.00	0.00
Other Transport Equipment	18.32	0.00	0.00	0.40	0.45
Rubbers & Plastics	20.60	0.02	0.16	0.06	0.00
Manufacturing nes & Recycling	23.85	0.21	0.19	1.00	0.00
Wood & Wood Products	24.97	0.27	0.33	1.00	0.31
Basic Metals	26.12	0.13	0.00	0.44	
Textiles	27.48	0.41	0.56	0.00	0.00
Manufactured Fuels	28.30	0.90	0.65	1.00	1.00
Pharmaceuticals	30.72	1.00	1.00	1.00	1.00
Electrical Engineering	31.26	0.49	0.81	1.00	0.46
Chemicals nes	34.21	0.00	0.00	0.03	0.00
Water Transport	35.86	0.00	0.22	0.00	0.00
Mechanical Engineering	37.26	0.19	0.91	0.29	1.00
Instruments	38.42	0.24	0.64	1.00	0.80
Motor Vehicles	38.76	0.00	0.00	0.59	
Air transport	40.28	0.00	0.00	0.00	0.00
Clothing & Leather	41.24	0.50	0.42	0.00	0.00
Drink	51.39	0.13	0.13	0.18	0.29
Electronics	54.27	0.23	0.00	0.00	0.21
Aerospace	65.30	0.27	0.41	0.62	0.56
Other Mining	95.29	0.93	1.00		
Computing Services	101.4	0.85	1.00		
Oil & Gas etc	706.4	0.99	0.98	0.98	0.97

Table 2b: Correlation between tradability and estimated long-run coefficients on relative world prices. Sample: 1969-98				
	I(a)	**I(b)′**	**II**	$\overline{\textbf{II}}$
Tradable sector				
Correlation coefficient	0.477	0.405	0.293	0.402
(standard error)	0.169	0.176	0.195	0.195
P = probability of null	0.007	0.030	0.177	0.045
All industries				
Correlation coefficient	0.370	0.282	0.224	0.214
(standard error)	0.142	0.148	0.150	0.151
P = probability of null	0.005	0.036	0.139	0.077

Note: The omitted coefficients are those where the long-run coefficients on both world prices and average costs are negative. If the coefficient on world prices is negative and that on average costs is positive, we set the long-run coefficient on world prices to zero. Conversely, if the coefficient on world prices is positive and that on average costs is negative, we set the long-run coefficient on world prices to unity.

3.2.3 Estimation results for Bils - Hall models

We now present results of the estimation of equations **(19)** and **(20)** (that is, models **I(a)** and **I(b)**).

Tables **I(a)** (i)-(v) and **I(b)′** (i)-(v) at the end of the paper present OLS estimates of equations **(19)** and **(20)** for all 49 industrial categories. The tables are organised so that each row lists all coefficients for the corresponding industry price level regression, with *t*-statistics shown in parentheses.

Let us start with Tables **I(a)** (i)-(v), which report estimates of model **I(a)**. From section 2, this is the variant of the BH model that expresses sectoral inflation as a function of sectoral productivity growth, the extent of foreign competition faced by that sector, sectoral average (real) costs,[14] sectoral overtime hours, sectoral productivity growth, and finally, sectoral changes in employment. The main difference between this model and the other BH variant is that here marginal costs are represented by including separately average costs, overtime hours and employment changes, whereas in the other variant they are represented by including directly the expression for *MC* that can be derived by rearranging equation **(20a)**. So in this sense this model is an approximation of model **I(b)**, which is more structural.

[14] Indicated with $mc_{it} - p_{it\text{-}1}$ in the row labelling the explanatory variables.

Three things emerge from looking at these tables. First these model of industry pricing behaviour seems to offer quite a good portrait of how some particular sectors set their prices in practice.

Second, average costs enter significantly in most sectoral inflation equations. However, the same is not true of the overtime hours term, meant to capture the difference between marginal and average costs.

Third, as expected, the variable p_w - p, that is the weight attached to sectoral world prices in domestic currency — a proxy of the strength/weakness of foreign competition for each sector — enters significantly in a number of sectoral inflation equations. Where significant, the sign and the size of the coefficient on this variable varies across sectors. For instance, in the case of the 'oil and gas' inflation equation, the sign is positive and the coefficient is quite large (0.79) compared with the 'tobacco' inflation equation, where the sign is negative and the size is rather small (-0.073). Interestingly, most of the equations in which this variable is significant are of sectors which we classify as 'tradable' in sub-section 3.2.2, including 'oil and gas', 'other mining', 'clothing and leather', 'manufactured fuels', 'pharmaceuticals', and 'professional services'. However, in some cases this variable is significant in equations of sector that are classified as 'non-tradables' (such as 'coal' and 'retailing').

One way to quantify the importance given to sectoral world prices in domestic currency in price-setting is to look at correlations between the long-run coefficient on relative world prices ($m_{i4}/(1+m_{i4})$ in equation (22)) and the degree of tradability that we express in terms of the ratio of exports plus imports to total output.[15] In line with our early intuition, we find that for inflation equations associated with sectors in the tradable category (at the 10% threshold), the correlation is significantly positive (0.51, S.E. = 0.17) (see Table 2b, column **I(a)**). Furthermore, the correlation remains significantly positive if we include all sectors (0.41, S.E. = 0.14).

We now turn to Tables $\mathbf{I(b)}'$ (i)-(v), which report estimates of model $\mathbf{I(b)}'$, a variant of **I(b)** where we introduce lags on p_w and mc.[16] From Section 2, this is the variant of the BH model

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[15] The expression for the long-run coefficient is obtained by deriving the long-run solution to equations **(19)**, **(20)** and **(21)**, respectively (see equation **(22)**).

[16] We have also estimated $\mathbf{I(b)}'$ using IV estimation, with the following variables used as instruments: $p^w_{it} - p_{it-1}$, $?n^*_{it}$, $?^2n^*_{it}$, $tfpg_{it}$, $(ot/h)_{it}$ and $\tilde{w}_{it} + n_{it} - y_{it}$, where $\tilde{w}_{it} = w_{it-1} + (w_{it-1} - w_{it-2})$. These results do not vary substantially from those obtained using OLS and so we do not report them.

that expresses sectoral inflation as a function of sectoral productivity growth, the extent of foreign competition faced by that sector, and marginal costs represented by including directly the expression for MC that can be derived by rearranging equation **(19)**. By and large, **I(b)′** seems to be a satisfactory representation of the data and the extra-flexibility in **I(a)** is not really necessary except, perhaps, for industries 6 ('tobacco'), 25 ('other transport equipment'), 37 ('air transport')(although on average this model gives a slightly worse fit than model **I(a)** (the cumulative adjusted R^2 for this model is 2 % lower than the cumulative adjusted R^2 for model **I(a)**). Moreover, we prefer this model to model **I(a)** because, as discussed above, it includes our structural specification of the marginal cost term, in contrast to model **I(a)**, which approximates that by including separate measures of average costs and overtime hours.

Similar points to the ones highlighted for the previous model emerge here as well. Firstly, regressions for the 'oil & gas', 'paper, printing and publishing', 'rubbers & plastics', 'aerospace', 'retailing', 'rail transport', 'computing services', and 'education' sectors exhibit a reasonably good fit.[17] Secondly, in the majority of cases, the real marginal cost variable ($mc^* - p$) is strongly significant and has a correct (positive) sign. Thirdly, the coefficient on the relative world prices variable is significant in many tradable sectors (namely 'oil and gas', 'textiles', 'clothing and leather', 'paper, printing and publishing', 'rubbers & plastics', and 'hotels and catering'). Encouragingly, also using this more structural model, we find that for inflation equations associated with sectors in the tradable category (at the 10 % threshold), the correlation between the long-run coefficient on relative world prices and the degree of tradability is strongly positive and significant (0.40, S.E. = 0.18) as, by and large, is the correlation when we include all industries (0.28, S.E. = 0.15).

3.2.4 Estimates of the Batini, Jackson and Nickell model

This sub-section presents results of the estimation of equation **(21)**. To obtain GMM estimates of these equations, we have re-expressed the moment conditions as orthogonality conditions relating the parameters in the equations and a set of instrumental variables z_t.

[17] In some cases $p^w_{it} - p_{it-1}$ is not significant, but this occurs mostly for sectors that classify as non-tradable at either the 10 or 20 % threshold according to our definition.

More specifically, under rational expectations, equation **(19)** defines the orthogonality condition:

$$E_t\left\{\left(p_{it}-\begin{bmatrix} b_0+b_1\left(p_{it}^w-p_{it}\right)+b_2\left(w_{it}+n_{it}-y_{it}-p_{it-1}\right)+b_3 p_{it+1}+ \\ b_4\left[fp_{it+1}-p_{it}\right]+b_5\left[fp_{t+1}-p_t\right]-b_6\left[f\Delta n_{t+1}-\Delta n_t\right]+e_{it}\end{bmatrix}\right)z_t\right\}=0$$

Throughout we use the same vector of instruments, z_t. This includes two lags of: changes in *i*-th industry inflation, changes in aggregate inflation, real average costs for industry i, the *i*-th industry output gap, changes in the *i*-th industry employment, our measure of the strength/weakness of foreign competition for the *i*-th industry, and the relative price of domestic and foreign inputs for production in the *i*-th industry, respectively.[18]

Tables **II** (i)-(v) below present estimates of equation **(21)** for all 49 industrial categories. The tables are organised as before, with *t*-statistics shown in parentheses.

In general, model **II** (the revised BJN model) appears to perform less satisfactorily than **I(b)′** (the Bils-Hall model).

Looking at the individual sectoral regressions, the tables reveal that this model fits nicely for some sectors. Specifically, we find good fits in the case of the 'coal','drink', 'tobacco', 'pharmaceuticals', 'motorvehicles', manufacturing nes & recycling', 'water supply', 'water transport', 'public administration and defence' and 'waste treatment' sectors. In most sectoral regressions either relative world prices or the relative price of foreign inputs are strongly significant and are often associated with sectors in the tradable category. Here we find that the correlations between the long-run coefficient on relative world prices and our measure of the degree of 'tradability' are 0.28 (S.E.=0.20) for the aggregate of tradable sectors. This has a *p*-value of 0.18. Overall, we feel that these equations are less successful than the more simple and robust specification exemplified by model **I(b)′**. The basic problem is that for many of the sectors, the data are too error ridden to allow us to generate sensible estimates of such a sophisticated dynamic model. This is particularly true in many of the service sectors, where the output prices are highly dubious and also in those sectors where our measures of world prices do not properly match the sector concerned.

[18] Note that $fp_{t+1}-p_t$ and $f\Delta n_{t+1}-\Delta n_t$ are replaced with Δp_{t+1} and $\Delta^2 n_{t+1}$ (that is, we assume here that $f\simeq 1$).

Tables $\overline{\mathbf{II}}$ (i)-(v) below present estimates of equation **(21)** for all 49 industrial categories when the world prices series is constructed by using a smooth measure of the exchange rate (see the Data Appendix for more details). Using a smooth exchange rate measure appears to improve the ability of this model to fit the data quite substantially across the board. In particular, the correlation between the long-run coefficient on relative world prices and our measure of the degree of 'tradability' is much stronger with this model that with model **II** at 0.40 (S.E.=0.19) for the aggregate of tradable sectors.

4. Conclusions

In this paper we presented two models of industry pricing behaviour and confronted them with UK sectoral data, by estimating the theoretically derived pricing equations using an input-output table at basic prices prepared by Cambridge Econometrics and employment and wage data from the New Earnings Survey. In doing so we departed from existing analyses of the determinants of UK prices, in that we concentrated specifically on firms' determination of output prices, which we modelled at the industry level. In addition, contrary to previous studies which focused primarily on the 1980s, our data set covers the period 1969-1998 and thereby encompassess the more recent past.

The models that we derived and estimated show comparable fits, although the model based on Bils (1987) and Hall (1988) (model **I(b)'** in the paper) which was originally devised for industries within the US manufacturing sector appears to fit the data marginally better than the one based on structural dynamic pricing equation from Batini, Jackson and Nickell (2000).

In particular, we found that:

- The models fit extremely well for many sectors, but not for all sectors. This is, at least partly, a consequence of the fact that the price data in many sectors subject to a great deal of error;
- In both models, sectoral domestic prices depend significantly on marginal costs and sectoral world prices in domestic currency;
- In line with our theory, the relative weight attached to world prices is significantly correlated with the degree of openness of the industry.

Given that production in the tradable sector (defined as above) has stabilised to a level of around 40%, these findings suggest that world prices in the tradable sector play an important role both in the short run and in the long run for aggregate inflation in the UK.

Table I(a) (i) — Bils-Hall model (a), OLS, Sample period: 1972-1998, Dependent variable: Δp_{it}

		constant	$p^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δn^{*}_{it}	$\Delta^{2} n^{*}_{it}$	$tfpg_{it}$	$(ot/h)_{it}$	$\bar{R}^2$	DW
01	Agriculture	0.243	0.085	0.105	0.700	-6.748	0.003	-0.825	0.319	1.318
		(1.12)	(2.03)	(0.87)	(0.31)	(0.59)	(0.49)	(1.54)		
02	Coal	0.122	0.089	0.210	0.028	-0.443	-0.042	-0.413	0.581	1.856
		(2.16)	(3.89)	(3.00)	(0.11)	(1.20)	(0.71)	(2.19)		
03	Oil & Gas etc	0.259	0.457	0.003	-0.216	0.857	-0.229	-3.884	0.676	2.355
		(1.91)	(5.17)	(0.06)	(0.33)	(0.94)	(3.41)	(3.61)		
04	Other Mining	0.003	0.044	0.003	0.716	-5.174	-0.633	0.028	0.769	2.521
		(0.05)	(1.98)	(0.15)	(1.91)	(2.72)	(8.12)	(0.10)		
05	Food	0.006	0.001	0.065	-0.788	4.921	-0.003	0.327	0.012	1.538
		(0.07)	(0.02)	(1.90)	(0.59)	(0.72)	(1.18)	(0.64)		
06	Drink	0.382	0.057	0.397	0.232	-0.611	0.011	-0.744	0.477	1.205
		(4.45)	(1.80)	(4.35)	(0.45)	(0.22)	(0.28)	(1.53)		
07	Tobacco	0.506	-0.073	0.390	0.739	-2.911	-0.216	-0.287	0.679	2.487
		(5.88)	(3.08)	(6.01)	(1.43)	(0.82)	(3.76)	(0.90)		
08	Textiles	-0.005	0.053	0.078	0.171	-1.021	-0.267	0.437	0.655	2.144
		(0.22)	(5.08)	(2.35)	(1.31)	(1.02)	(3.70)	(2.67)		
09	Clothing & Leather	0.026	0.064	0.064	0.032	0.652	-0.228	-0.223	0.213	1.623
		(1.35)	(2.45)	(1.09)	(0.17)	(0.49)	(2.57)	(0.67)		
10	Wood & Wood Products	0.037	0.041	0.109	0.094	-1.256	0.024	0.419	0.318	2.388
		(1.21)	(1.66)	(3.00)	(0.29)	(0.73)	(0.45)	(1.28)		

Table I(a) (ii) — Bils-Hall model (a), OLS, Sample period: 1972-1998, Dependent variable: Δp_{it}

		$constant$	$p^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δn^*_{it}	$\Delta^2 n^*_{it}$	$tfpg_{it}$	$(ot/h)_{it}$	$\bar{R}^2$	DW
11	Paper, Printing & Publishing	0.047	0.035	0.257	0.551	-4.032	-0.628	0.598	0.773	1.483
		(0.78)	(1.95)	(4.72)	(0.43)	(0.70)	(3.99)	(1.93)		
12	Manufactured Fuels	-0.006	0.085	0.010	-0.051	-3.636	-0.009	0.818	0.161	2.200
		(0.03)	(1.49)	(0.13)	(0.05)	(0.70)	(1.81)	(0.64)		
13	Pharmaceuticals	-0.070	0.034	-0.045	0.130	0.123	-0.468	0.863	0.608	1.728
		(2.63)	(1.19)	(1.31)	(0.37)	(0.08)	(4.17)	(2.22)		
14	Chemicals nes	-0.001	-0.033	0.096	-0.247	1.634	-0.004	0.939	0.423	1.846
		(0.03)	(1.11)	(2.33)	(0.59)	(0.64)	(0.41)	(2.65)		
15	Rubbers & Plastics	0.083	0.007	0.357	-0.207	0.253	-0.422	0.670	0.775	1.812
		(2.50)	(0.39)	(4.09)	(1.01)	(0.31)	(4.11)	(2.48)		
16	Non-Metallic Mineral Products	0.057	0.039	0.180	0.081	-0.627	-0.422	0.252	0.544	1.224
		(1.14)	(0.80)	(2.67)	(0.19)	(0.27)	(2.67)	(0.63)		
17	Basic Metals	0.019	0.019	0.124	0.606	-4.584	-0.852	0.015	0.737	2.125
		(0.39)	(0.52)	(2.83)	(1.50)	(2.03)	(6.36)	(0.03)		
18	Metal Goods	0.040	0.051	-0.030	0.424	-2.719	-0.762	-0.354	0.602	1.406
		(1.38)	(2.02)	(0.50)	(1.34)	(1.46)	(5.65)	(1.35)		
19	Mechanical Engineering	0.002	0.022	0.095	-0.128	0.783	-0.053	0.385	0.302	1.440
		(0.04)	(1.36)	(1.30)	(0.28)	(0.28)	(0.80)	(0.91)		
20	Electronics	-0.049	0.035	0.116	0.202	-1.277	-0.373	0.849	0.731	1.732
		(1.53)	(1.09)	(3.29)	(0.82)	(1.14)	(4.93)	(1.73)		

Table I(a) (iii) — Bils-Hall model (a), OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		$constant$	$p^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dn^{*}_{it}	$D^{2}n^{*}_{it}$	$tfpg_{it}$	$(ot/h)_{it}$	$\bar{R}^{2}$	DW
21	Electrical Engineering	0.101	0.101	0.105	0.529	-3.529	-0.392	-0.705	0.695	1.197
		(3.57)	(5.85)	(2.23)	(1.73)	(2.41)	(3.53)	(2.34)		
22	Instruments	0.103	0.020	0.063	-0.229	0.923	-0.474	-0.248	0.605	1.555
		(2.44)	(1.43)	(1.79)	(0.77)	(0.58)	(4.12)	(0.90)		
23	Motor Vehicles	0.057	-0.005	0.110	0.317	-0.854	-0.107	-0.119	0.081	1.329
		(1.76)	(0.15)	(2.07)	(1.31)	(1.12)	(1.46)	(0.42)		
24	Aerospace	-0.046	0.057	0.155	0.556	-3.476	-0.556	0.674	0.828	2.866
		(1.44)	(1.36)	(5.88)	(2.04)	(2.40)	(8.77)	(2.01)		
25	Other Transport Equipment	0.002	0.000	0.170	0.649	-5.024	-0.435	0.243	0.580	1.925
		(0.08)	(0.00)	(4.36)	(2.28)	(3.05)	(3.91)	(1.19)		
26	Manufacturing nes & Recycling	0.047	0.020	0.074	-0.088	0.117	-0.846	-0.002	0.795	1.801
		(1.77)	(0.59)	(2.04)	(0.27)	(0.09)	(9.67)	(0.01)		
27	Electricity	0.094	-0.015	0.046	-0.237	5.327	-0.030	-0.611	0.083	1.726
		(0.78)	(0.16)	(0.53)	(0.33)	(0.98)	(1.80)	(0.88)		
28	Gas Supply	0.565	0.218	0.441	-0.834	3.875	-0.010	-2.144	0.341	1.645
		(3.42)	(1.84)	(3.82)	(0.97)	(0.73)	(0.85)	(2.16)		
29	Water Supply	0.060	-0.003	-0.021	-0.517	3.340	-0.616	-0.150	0.821	1.539
		(0.81)	(0.21)	(0.39)	(1.71)	(2.36)	(5.18)	(0.30)		
30	Construction	0.024	0.040	0.133	0.176	-0.235	-0.361	0.674	0.878	1.567
		(0.47)	(1.18)	(3.44)	(0.83)	(0.28)	(4.26)	(2.98)		

Table I(a) (iv) — Bils-Hall model (a), OLS, Sample period: 1972-1998, Dependent variable: Δp_{it}

		constant	$p^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δn^*_{it}	$\Delta^2 n^*_{it}$	$tfpg_{it}$	$(ot/h)_{it}$	$\bar{R}^2$	*DW*
31	Retailing	-0.003	0.127	0.177	0.570	-1.726	-0.415	0.410	0.565	1.227
		(0.04)	(5.65)	(2.93)	(0.36)	(0.24)	(2.44)	(0.73)		
32	Distribution nes	0.034	0.049	0.087	0.284	-1.768	-0.072	0.506	0.291	2.105
		(0.38)	(1.93)	(1.24)	(0.26)	(0.35)	(1.32)	(0.95)		
33	Hotels & Catering	0.126	0.015	0.247	1.368	-4.471	-0.287	0.203	0.541	1.291
		(1.20)	(0.41)	(4.08)	(1.01)	(0.88)	(3.20)	(0.57)		
34	Rail Transport	-0.072	0.049	-0.061	0.008	-0.053	0.003	0.354	0.000	2.512
		(0.91)	(1.28)	(1.39)	(0.04)	(0.12)	(1.70)	(1.04)		
35	Other Land Transport	0.108	0.020	0.131	-0.151	0.736	-0.071	-0.220	0.186	2.469
		(0.82)	(0.31)	(1.35)	(0.11)	(0.15)	(1.69)	(0.36)		
36	Water Transport	0.083	-0.021	0.074	-0.176	-0.429	-0.045	0.144	0.083	2.041
		(0.99)	(0.32)	(0.79)	(0.63)	(0.38)	(0.58)	(0.75)		
37	Air transport	0.411	-0.057	0.325	-0.464	1.215	0.006	-1.042	0.380	1.679
		(4.12)	(1.58)	(2.59)	(1.32)	(1.04)	(0.56)	(2.69)		
38	Other Transport Services	0.016	-0.008	-0.103	-2.130	7.973	0.020	0.806	0.554	2.711
		(0.21)	(0.24)	(1.74)	(1.77)	(1.48)	(3.00)	(1.35)		
39	Communications	0.171	0.108	0.209	0.762	-3.922	-0.513	-0.659	0.795	1.650
		(1.48)	(2.54)	(2.01)	(0.51)	(0.55)	(4.42)	(1.45)		
40	Banking & Finance	0.041	-0.019	-0.008	0.218	0.330	0.022	-1.604	0.315	1.261
		(0.43)	(0.53)	(1.08)	(0.21)	(0.08)	(3.00)	(0.78)		

Table I(a) (v) — Bils-Hall model (a), OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	$p^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δn^*_{it}	$\Delta^2 n^*_{it}$	$tfpg_{it}$	$(ot/h)_{it}$	$\bar{R}^2$	DW
41	Insurance	0.086	-0.034	-0.023	-1.591	6.428	0.027	-0.032	0.366	1.978
		(1.01)	(1.01)	(0.41)	(1.53)	(1.53)	(3.85)	(0.02)		
42	Professional Services	0.130	0.035	0.151	-0.506	2.359	-0.019	0.344	0.076	1.934
		(0.89)	(0.40)	(2.21)	(0.22)	(0.27)	(1.64)	(0.14)		
43	Computing Services	0.013	0.084	0.015	0.339	-0.159	0.086	-0.845	0.247	1.677
		(0.31)	(0.78)	(1.54)	(1.77)	(0.97)	(1.12)	(1.03)		
44	Other Business Services	0.183	0.019	0.105	-1.594	3.757	-0.044	0.498	0.312	1.910
		(1.69)	(0.45)	(1.55)	(1.31)	(1.02)	(1.01)	(0.85)		
45	Public Administration & Defence	0.338	0.022	0.985	1.189	-6.921	0.000	-2.754	0.858	1.196
		(3.21)	(1.32)	(7.27)	(0.89)	(1.13)	(0.05)	(3.08)		
46	Education	-0.051	0.104	0.590	2.969	-10.444	-0.019	0.400	0.860	2.343
		(0.35)	(5.43)	(8.25)	(1.21)	(1.05)	(2.66)	(0.47)		
47	Health & Social Work	0.109	0.042	0.148	-1.974	8.590	-0.012	1.085	0.553	2.183
		(1.31)	(1.84)	(1.66)	(1.81)	(2.12)	(1.16)	(2.63)		
48	Waste Treatment	0.070	0.089	0.047	0.036	-0.272	-0.280	-0.163	0.360	1.255
		(0.60)	(1.69)	(0.88)	(0.16)	(0.62)	(1.79)	(0.21)		
49	Miscellaneous Services	0.237	0.006	0.237	-1.390	4.071	-0.008	1.250	0.431	1.199
		(2.13)	(0.16)	(2.16)	(1.31)	(1.22)	(1.21)	(1.37)		
	Sum of $\bar{R}^2$								23.834	

Table I(b)′ (i) — Bils-Hall model (b)′ , OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	$p^w_{it} - p_{it-1}$	$mc^*_{it} - p_{it-1}$	$tfpg_{it}$	$p^w_{it-1} - p_{it-1}$	$mc^*_{it-1} - p_{it-1}$	$\bar{R}^2$	DW
01	Agriculture	0.179	0.114	0.069	0.001	0.031	0.213	0.269	1.529
		(2.14)	(1.49)	(0.48)	(0.12)	(0.35)	(1.48)		
02	Coal	-0.040	0.276	0.121	-0.041	-0.192	-0.075	0.485	1.624
		(0.84)	(1.54)	(1.52)	(0.71)	(1.02)	(0.81)		
03	Oil & Gas etc	0.003	0.424	0.176	-0.158	-0.246	-0.172	0.634	2.276
		(0.02)	(2.48)	(2.91)	(2.35)	(1.23)	(2.91)		
04	Other Mining	0.000	0.037	0.005	-0.495	0.035	-0.027	0.707	2.380
		(0.03)	(0.56)	(0.21)	(7.53)	(0.53)	(1.13)		
05	Food	-0.024	0.068	0.057	-0.005	-0.051	0.048	0.091	1.699
		(1.41)	(1.16)	(1.92)	(2.07)	(0.84)	(1.43)		
06	Drink	0.088	0.048	0.276	-0.008	0.001	0.062	0.355	1.426
		(3.38)	(0.42)	(2.09)	(0.18)	(0.01)	(0.35)		
07	Tobacco	0.281	-0.105	0.355	-0.187	0.048	0.033	0.483	1.802
		(4.03)	(1.51)	(4.29)	(2.67)	(0.70)	(0.31)		
08	Textiles	0.011	0.068	0.024	-0.317	-0.028	0.007	0.365	1.827
		(2.03)	(2.24)	(0.65)	(3.34)	(0.94)	(0.19)		
09	Clothing & Leather	-0.007	0.129	-0.029	-0.144	-0.092	0.081	0.253	1.464
		(0.34)	(3.25)	(0.65)	(1.62)	(2.33)	(1.69)		
10	Wood & Wood Products	0.020	0.076	0.006	0.054	-0.035	0.075	0.241	1.915
		(1.87)	(1.65)	(0.11)	(1.03)	(0.73)	(1.53)		

Table I(b)′ (ii)— Bils-Hall model (b)′ , OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	$p^w_{it} - p_{it-1}$	$mc^*_{it} - p_{it-1}$	$tfpg_{it}$	$p^w_{it-1} - p_{it-1}$	$mc^*_{it-1} - p_{it-1}$	$\bar{R}^2$	DW
11	Paper, Printing & Publishing	-0.032	0.067	0.226	-0.487	-0.007	0.077	0.705	1.253
		(2.13)	(2.40)	(2.66)	(3.29)	(0.25)	(0.63)		
12	Manufactured Fuels	0.036	0.147	0.074	-0.009	-0.061	-0.028	0.051	1.841
		(0.43)	(1.59)	(0.57)	(1.42)	(0.67)	(0.21)		
13	Pharmaceuticals	0.014	0.033	0.074	-0.495	-0.025	-0.157	0.717	1.944
		(2.81)	(0.89)	(1.85)	(6.69)	(0.68)	(4.37)		
14	Chemicals nes	0.010	0.023	0.111	-0.009	-0.111	-0.010	0.343	2.001
		(1.15)	(0.44)	(2.36)	(0.93)	(2.28)	(0.16)		
15	Rubbers & Plastics	-0.026	0.120	0.196	-0.513	-0.088	-0.026	0.669	1.618
		(1.55)	(2.50)	(3.08)	(4.53)	(1.60)	(0.33)		
16	Non-Metallic Mineral Products	-0.012	0.101	0.189	-0.415	-0.045	-0.049	0.554	1.127
		(0.90)	(1.67)	(2.35)	(2.86)	(0.68)	(0.59)		
17	Basic Metals	-0.036	0.036	0.138	-0.845	-0.045	-0.034	0.697	1.783
		(1.59)	(0.61)	(2.92)	(6.90)	(0.91)	(0.63)		
18	Metal Goods	0.033	-0.004	0.079	-0.669	0.016	-0.157	0.624	1.528
		(2.69)	(0.09)	(1.38)	(4.82)	(0.42)	(2.21)		
19	Mechanical Engineering	0.014	0.075	0.018	-0.068	-0.051	-0.016	0.275	1.328
		(0.94)	(1.81)	(0.22)	(1.04)	(1.08)	(0.23)		
20	Electronics	-0.025	0.022	0.127	-0.431	-0.071	-0.109	0.714	1.867
		(3.22)	(0.96)	(0.75)	(0.64)	(1.72)	(0.56)		

Table I(b)′ (iii)— Bils-Hall model (b)′ , OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	$p^w_{it} - p_{it-1}$	$mc^*_{it} - p_{it-1}$	$tfpg_{it}$	$p^w_{it-1} - p_{it-1}$	$mc^*_{it-1} - p_{it-1}$	$\bar{R}^2$	*DW*
21	Electrical Engineering	0.002	0.079	0.128	-0.348	0.023	-0.104	0.554	1.194
		(0.12)	(1.77)	(2.14)	(2.55)	(0.47)	(1.56)		
22	Instruments	0.016	0.023	0.056	-0.546	0.003	-0.041	0.569	1.805
		(0.77)	(0.57)	(1.38)	(4.46)	(0.08)	(1.00)		
23	Motor Vehicles	0.011	0.052	0.084	-0.087	-0.080	-0.057	0.162	1.275
		(0.85)	(0.91)	(1.60)	(1.25)	(1.63)	(1.02)		
24	Aerospace	-0.050	0.108	0.141	-0.510	-0.013	-0.008	0.754	2.319
		(1.87)	(1.70)	(3.10)	(6.94)	(0.22)	(0.15)		
25	Other Transport Equipment	-0.057	0.043	0.090	-0.316	-0.066	0.060	0.324	1.721
		(1.96)	(0.51)	(1.53)	(2.55)	(0.93)	(1.13)		
26	Manufacturing nes & Recycling	0.001	0.022	0.169	-0.785	-0.007	-0.107	0.866	1.839
		(0.10)	(0.78)	(4.26)	(10.41)	(0.24)	(2.68)		
27	Electricity	0.046	0.032	0.034	-0.023	-0.132	0.028	0.014	1.480
		(0.90)	(0.28)	(0.35)	(1.59)	(1.25)	(0.31)		
28	Gas Supply	0.052	-0.032	0.614	-0.003	0.130	-0.499	0.406	1.715
		(1.72)	(0.14)	(4.50)	(0.30)	(0.74)	(2.99)		
29	Water Supply	-0.001	0.053	0.050	-0.853	-0.063	-0.133	0.798	1.761
		(0.03)	(0.83)	(0.83)	(7.62)	(0.93)	(2.29)		
30	Construction	0.018	0.015	0.248	-0.528	-0.028	-0.166	0.792	1.305
		(1.31)	(0.28)	(4.12)	(5.89)	(0.57)	(2.18)		

Table I(b)′ (iv)— Bils-Hall model (b)′ , OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	$p^{w}_{it} - p_{it-1}$	$mc^{*}_{it} - p_{it-1}$	$tfpg_{it}$	$p^{w}_{it-1} - p_{it-1}$	$mc^{*}_{it-1} - p_{it-1}$	$\bar{R}^2$	*DW*
31	Retailing	0.006	0.086	0.276	-0.488	-0.009	-0.221	0.608	1.379
		(0.29)	(1.71)	(3.26)	(2.93)	(0.19)	(2.01)		
32	Distribution nes	0.031	0.058	0.151	-0.049	-0.018	-0.077	0.352	1.710
		(1.91)	(1.41)	(2.08)	(1.01)	(0.39)	(1.17)		
33	Hotels & Catering	0.117	0.112	0.309	-0.255	-0.128	-0.026	0.652	1.166
		(6.42)	(2.35)	(3.23)	(3.14)	(3.07)	(0.22)		
34	Rail Transport	0.017	0.205	-0.155	0.004	-0.162	0.129	0.323	2.056
		(0.64)	(2.42)	(2.95)	(2.54)	(1.74)	(2.95)		
35	Other Land Transport	-0.010	0.011	0.103	-0.079	0.028	-0.014	0.200	2.471
		(0.35)	(0.11)	(0.66)	(1.93)	(0.24)	(0.09)		
36	Water Transport	0.027	0.008	0.153	-0.032	0.007	-0.100	-0.009	1.750
		(1.45)	(0.10)	(1.84)	(0.43)	(0.08)	(1.19)		
37	Air transport	0.061	-0.005	0.343	0.002	-0.022	-0.117	0.181	1.737
		(2.31)	(0.07)	(2.53)	(0.20)	(0.25)	(0.86)		
38	Other Transport Services	0.022	-0.033	0.131	0.016	0.020	-0.256	0.621	2.364
		(2.41)	(0.49)	(1.44)	(2.48)	(0.29)	(3.38)		
39	Communications	0.001	-0.033	0.174	-0.608	0.127	-0.070	0.790	1.793
		(0.16)	(0.37)	(1.29)	(6.25)	(1.37)	(0.49)		
40	Banking & Finance	0.013	0.105	0.005	0.028	-0.149	-0.017	0.491	1.232
		(1.22)	(1.27)	(0.58)	(4.45)	(1.81)	(1.88)		

Table I(b)′ (v)— Bils-Hall model (b)′ , OLS, Sample period: 1972-1998, Dependent variable: Dp_{it}

		constant	p^w_{it} - p_{it-1}	mc^*_{it} - p_{it-1}	$tfpg_{it}$	p^w_{it-1} - p_{it-1}	mc^*_{it-1} - p_{it-1}	$\bar{R}^2$	*DW*
41	Insurance	0.012	0.070	-0.138	0.031	-0.096	0.132	0.455	2.039
		(0.49)	(1.13)	(1.77)	(4.85)	(1.49)	(1.73)		
42	Professional Services	0.043	-0.021	0.309	-0.017	0.061	-0.207	0.210	2.417
		(3.17)	(0.20)	(2.61)	(1.58)	(0.60)	(1.37)		
43	Computing Services	0.031	0.088	0.037	0.098	0.100	-0.043	0.722	1.188
		(4.58)	(1.29)	(5.79)	(2.86)	(1.48)	(7.66)		
44	Other Business Services	0.017	-0.033	0.259	-0.077	0.051	-0.258	0.373	1.656
		(1.50)	(0.61)	(3.24)	(1.77)	(0.91)	(2.95)		
45	Public Administration & Defence	-0.027	0.020	0.931	-0.012	-0.019	-0.836	0.887	2.588
		(0.97)	(0.50)	(9.25)	(2.91)	(0.49)	(4.61)		
46	Education	-0.077	0.067	0.597	-0.020	0.025	-0.145	0.819	2.059
		(3.09)	(1.58)	(6.19)	(2.39)	(0.59)	(0.89)		
47	Health & Social Work	-0.065	0.072	0.306	-0.015	-0.062	0.029	0.481	1.950
		(2.84)	(1.63)	(4.12)	(1.33)	(1.38)	(0.30)		
48	Waste Treatment	-0.006	0.132	0.141	-0.333	-0.008	-0.164	0.524	0.941
		(0.40)	(1.73)	(2.54)	(3.20)	(0.10)	(2.93)		
49	Miscellaneous Services	0.079	-0.003	0.250	0.000	0.028	-0.097	0.267	1.015
		(2.09)	(0.03)	(1.92)	(0.01)	(0.27)	(0.73)		
	Sum of $\bar{R}^2$							23.419	

Table II (i) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^*_{it-1}, y_{it-2} - y^*_{it-2}, p^w_{it-1} - p_{it-2}, p^w_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$p^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^2 p_{t+1}$	$D^2 n_{it+1}$	$\bar{R}^2$
01	Agriculture	0.344	0.027	0.261	-0.131	-0.100	-5.273	-0.035
		(5.24)	(1.28)	(5.06)	(1.10)	(0.58)	(0.78)	
02	Coal	0.100	0.012	0.215	0.710	-1.800	-0.395	0.442
		(4.53)	(0.38)	(4.24)	(3.53)	(5.52)	(2.52)	
03	Oil & Gas etc	0.133	0.742	0.014	-0.575	1.605	0.536	0.764
		(4.18)	(16.31)	(1.14)	(2.87)	(5.60)	(1.52)	
04	Other Mining	0.003	-0.004	-0.030	0.651	-0.947	0.181	-0.602
		(0.20)	(0.31)	(1.41)	(3.93)	(6.00)	(0.19)	
05	Food	0.011	-0.007	0.028	0.068	0.009	9.559	-0.164
		(2.09)	(0.42)	(9.27)	(1.09)	(0.21)	(2.68)	
06	Drink	0.318	0.074	0.346	-0.430	-0.322	-3.053	0.486
		(8.93)	(3.40)	(7.38)	(2.91)	(1.67)	(2.77)	
07	Tobacco	1.267	-0.164	1.037	-0.385	0.606	3.999	-2.474
		(9.15)	(8.30)	(8.47)	(3.54)	(2.66)	(4.27)	
08	Textiles	0.065	-0.001	0.090	0.073	0.260	0.259	0.289
		(3.53)	(0.12)	(2.28)	(0.82)	(8.74)	(0.76)	
09	Clothing & Leather	-0.007	-0.100	0.021	1.040	-0.353	4.302	-5.198
		(1.37)	(3.10)	(0.49)	(4.19)	(5.08)	(3.01)	
10	Wood & Wood Products	-0.007	0.054	-0.031	0.938	-0.128	0.687	-0.711
		(0.37)	(2.95)	(1.14)	(4.55)	(1.11)	(0.26)	

Table II (ii) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Δp_{it}

Instruments: $y_{it-1} - y^{*}_{it-1}, y_{it-2} - y^{*}_{it-2}, p^{w}_{it-1} - p_{it-2}, p^{w}_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, \Delta p_{it-1}, \Delta p_{it-2}, \Delta p_{t-1}, \Delta p_{t-2}, \Delta n_{it-1}, \Delta n_{it-2}$

		constant	$p^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δp_{it+1}	$\Delta^{2} p_{t+1}$	$\Delta^{2} n_{it+1}$	$\bar{R}^{2}$
11	Paper, Printing & Publishing	0.035	0.022	0.096	0.466	-0.382	24.782	0.627
		(1.07)	(0.93)	(1.17)	(2.08)	(2.98)	(2.73)	
12	Manufactured Fuels	-0.357	0.071	-0.219	0.070	-0.171	4.556	-0.559
		(7.26)	(2.02)	(8.50)	(0.64)	(0.67)	(2.28)	
13	Pharmaceuticals	-0.044	0.265	-0.141	0.244	0.129	-4.323	0.005
		(2.84)	(7.64)	(5.69)	(2.02)	(0.95)	(3.02)	
14	Chemicals nes	0.093	0.004	0.113	0.384	0.486	-6.282	-1.503
		(3.50)	(0.13)	(3.07)	(1.45)	(3.06)	(1.78)	
15	Rubbers & Plastics	0.048	0.009	0.133	0.593	0.233	3.553	-0.792
		(1.29)	(0.32)	(1.17)	(3.11)	(1.89)	(1.63)	
16	Non-Metallic Mineral Products	0.046	0.066	0.075	0.623	-0.462	-0.736	0.660
		(2.17)	(3.12)	(1.86)	(5.51)	(5.39)	(1.51)	
17	Basic Metals	0.061	0.164	0.213	0.390	-0.272	-0.585	-0.563
		(5.48)	(3.62)	(4.59)	(1.85)	(1.38)	(0.30)	
18	Metal Goods	0.141	-0.070	0.389	0.940	-0.610	11.556	-4.494
		(2.95)	(1.53)	(2.81)	(7.71)	(4.80)	(2.52)	
19	Mechanical Engineering	0.016	0.019	0.048	0.523	-0.504	-0.632	0.412
		(1.64)	(2.11)	(1.81)	(4.87)	(6.69)	(0.69)	
20	Electronics	-0.054	-0.126	0.066	-0.617	0.169	-3.916	-1.981
		(2.01)	(2.48)	(1.32)	(3.62)	(0.39)	(2.56)	

Table II (iii) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Δp_{it}

Instruments: $y_{it-1} - y^{*}_{it-1}, y_{it-2} - y^{*}_{it-2}, p^{w}_{it-1} - p_{it-2}, p^{w}_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, \Delta p_{it-1}, \Delta p_{it-2}, \Delta p_{t-1}, \Delta p_{t-2}, \Delta n_{it-1}, \Delta n_{it-2}$

		constant	$p^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δp_{it+1}	$\Delta^2 p_{t+1}$	$\Delta^2 n_{it+1}$	$\bar{R}^2$
21	Electrical Engineering	0.002	0.114	-0.052	0.114	-0.328	-1.209	0.655
		(0.36)	(2.75)	(1.29)	(0.59)	(2.59)	(1.69)	
22	Instruments	-0.066	0.040	-0.071	0.790	-0.195	-3.462	0.205
		(1.93)	(3.74)	(2.09)	(5.03)	(2.11)	(2.05)	
23	Motor Vehicles	0.061	0.150	0.104	1.018	-0.201	-2.514	0.004
		(5.50)	(5.43)	(6.02)	(7.91)	(1.82)	(6.32)	
24	Aerospace	0.008	0.127	0.076	0.072	0.087	0.682	0.010
		(1.08)	(3.31)	(2.92)	(1.21)	(0.63)	(0.88)	
25	Other Transport Equipment	0.060	0.130	0.198	0.530	0.281	-0.300	-0.845
		(4.51)	(2.67)	(4.59)	(2.22)	(2.93)	(0.35)	
26	Manufacturing nes & Recycling	-0.057	0.120	-0.212	0.534	-0.451	-4.619	-0.723
		(2.56)	(2.29)	(3.59)	(2.05)	(2.78)	(1.69)	
27	Electricity	0.112	-0.032	0.066	0.557	0.353	-3.617	-0.655
		(0.99)	(0.82)	(0.61)	(2.87)	(1.38)	(3.42)	
28	Gas Supply	0.067	0.222	0.086	-0.206	-1.132	0.460	-0.695
		(0.71)	(1.92)	(0.74)	(0.91)	(1.24)	(0.63)	
29	Water Supply	-0.189	0.146	-0.166	-0.070	-0.951	4.020	0.438
		(3.21)	(6.37)	(3.49)	(0.84)	(8.36)	(3.70)	
30	Construction	0.291	0.210	0.314	-0.236	0.345	-6.267	0.402
		(11.22)	(10.97)	(10.46)	(1.17)	(1.80)	(4.54)	

Table II (iv) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^{*}_{it-1}, y_{it-2} - y^{*}_{it-2}, p^{w}_{it-1} - p_{it-2}, p^{w}_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$p^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^{2} p_{t+1}$	$D^{2} n_{it+1}$	$\bar{R}^2$
31	Retailing	0.062	0.151	0.223	0.042	-0.508	5.976	-0.261
		(3.48)	(4.87)	(2.62)	(0.25)	(2.69)	(0.82)	
32	Distribution nes	0.032	0.109	0.036	-0.088	-0.223	16.104	-0.013
		(0.58)	(6.43)	(0.43)	(0.67)	(2.58)	(1.95)	
33	Hotels & Catering	0.310	-0.068	0.347	-0.230	-0.365	5.861	0.017
		(7.51)	(4.37)	(7.05)	(1.50)	(2.91)	(1.12)	
34	Rail Transport	0.011	0.005	-0.006	-0.090	-0.735	-0.053	-0.046
		(0.87)	(0.21)	(0.31)	(0.58)	(5.54)	(0.67)	
35	Other Land Transport	0.024	-0.060	0.069	1.789	-0.118	-7.796	-4.205
		(0.83)	(1.07)	(0.89)	(3.78)	(0.43)	(1.02)	
36	Water Transport	0.083	-0.084	0.061	0.433	-0.092	0.177	-0.574
		(1.57)	(2.11)	(0.84)	(2.58)	(0.30)	(0.50)	
37	Air transport	0.273	-0.200	0.332	1.378	-0.560	0.291	-2.013
		(2.16)	(4.10)	(1.78)	(4.45)	(1.26)	(0.12)	
38	Other Transport Services	-0.017	-0.047	-0.069	0.805	-0.338	-7.107	0.156
		(0.80)	(1.45)	(1.81)	(4.40)	(1.47)	(1.17)	
39	Communications	0.302	0.378	0.472	-0.947	-0.494	-23.557	0.052
		(5.50)	(12.90)	(4.85)	(4.54)	(1.82)	(1.83)	
40	Banking & Finance	-0.049	-0.106	-0.034	-0.637	-3.061	18.414	-4.600
		(2.54)	(3.05)	(3.36)	(1.18)	(3.69)	(2.13)	

Table II (v) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^*_{it-1}, y_{it-2} - y^*_{it-2}, p^w_{it-1} - p_{it-2}, p^w_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$p^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^2 p_{t+1}$	$D^2 n_{it+1}$	$\bar{R}^2$
41	Insurance	0.034	0.029	0.005	0.101	0.376	-0.220	-0.592
		(0.62)	(0.76)	(0.09)	(0.31)	(5.53)	(0.07)	
42	Professional Services	-0.045	-0.094	-0.063	0.426	-1.500	12.713	-1.031
		(2.02)	(1.97)	(1.85)	(2.36)	(4.03)	(2.25)	
43	Computing Services	-0.043	-0.036	-0.027	1.503	-0.497	-0.519	0.464
		(4.06)	(1.43)	(1.77)	(12.44)	(10.70)	(28.00)	
44	Other Business Services	0.114	0.081	0.178	0.182	0.411	-10.509	-0.658
		(4.53)	(2.36)	(2.67)	(0.61)	(1.27)	(3.79)	
45	Public Administration & Defence	0.120	0.062	0.413	0.034	-0.172	8.651	0.857
		(25.58)	(16.29)	(25.26)	(1.01)	(3.50)	(4.23)	
46	Education	0.228	0.236	0.708	-0.768	0.166	-6.398	0.463
		(3.93)	(6.74)	(3.91)	(2.86)	(0.31)	(0.32)	
47	Health & Social Work	0.171	0.019	0.607	-0.195	0.114	5.523	0.407
		(12.94)	(3.29)	(13.10)	(1.02)	(1.48)	(1.31)	
48	Waste Treatment	0.074	0.158	0.036	-0.356	0.129	-0.468	0.359
		(2.17)	(4.85)	(1.16)	(3.92)	(0.82)	(1.31)	
49	Miscellaneous Services	0.698	-0.178	0.953	0.184	-0.211	0.445	-1.187
		(6.69)	(3.05)	(6.27)	(1.68)	(1.18)	(0.20)	
	Sum of $\bar{R}^2$							-28.997

Table $\overline{\text{II}}$ (i) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^{*}_{it-1}, y_{it-2} - y^{*}_{it-2}, \bar{p}^{w}_{it-1} - p_{it-2}, \bar{p}^{w}_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$\bar{p}^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^2 p_{t+1}$	$D^2 n_{it+1}$	$\bar{R}^2$
01	Agriculture	0.319	0.025	0.242	-0.018	-0.145	-8.525	0.050
		(4.48)	(1.21)	(4.32)	(0.12)	(1.04)	(1.25)	
02	Coal	0.088	0.002	0.161	0.813	-1.751	-0.373	0.408
		(3.94)	(0.07)	(3.14)	(4.65)	(7.40)	(2.22)	
03	Oil & Gas etc	0.138	0.655	0.017	-0.416	1.878	0.297	0.833
		(5.54)	(23.34)	(1.95)	(7.01)	(16.56)	(2.82)	
04	Other Mining	0.007	-0.007	-0.029	0.634	-1.010	0.207	-0.587
		(0.42)	(0.61)	(2.02)	(4.74)	(3.95)	(0.33)	
05	Food	0.011	-0.008	0.030	0.078	0.013	9.271	-0.158
		(4.10)	(0.65)	(7.93)	(1.32)	(0.47)	(7.39)	
06	Drink	0.160	0.070	0.171	-0.109	-0.948	-1.119	0.750
		(3.31)	(7.14)	(2.96)	(1.22)	(4.15)	(1.42)	
07	Tobacco	0.379	-0.060	0.287	-0.022	-1.450	1.363	-0.143
		(4.61)	(4.04)	(3.97)	(0.25)	(3.27)	(1.67)	
08	Textiles	0.124	-0.023	0.219	0.094	0.156	1.547	-0.032
		(5.84)	(1.93)	(5.02)	(0.93)	(1.99)	(2.76)	
09	Clothing & Leather	-0.007	-0.043	0.005	1.246	-0.383	1.547	-1.381
		(1.45)	(2.30)	(0.13)	(6.09)	(11.36)	(3.03)	
10	Wood & Wood Products	0.064	0.038	0.084	-0.336	0.530	3.953	-0.414
		(3.18)	(2.38)	(2.19)	(1.54)	(6.25)	(1.96)	

Table $\overline{\text{II}}$ (ii) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^*_{it-1}, y_{it-2} - y^*_{it-2}, \bar{p}^w_{it-1} - p_{it-2}, \bar{p}^w_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$\bar{p}^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^2 p_{t+1}$	$D^2 n_{it+1}$	$\bar{R}^2$
11	Paper, Printing & Publishing	0.023	-0.019	0.062	1.143	-0.863	-23.718	0.534
		(0.99)	(0.66)	(1.05)	(5.71)	(3.93)	(2.26)	
12	Manufactured Fuels	-0.350	0.072	-0.222	0.102	0.068	3.501	-0.371
		(7.82)	(1.97)	(8.41)	(1.14)	(0.24)	(1.51)	
13	Pharmaceuticals	-0.009	0.220	-0.011	0.356	0.453	6.375	-0.912
		(0.64)	(6.02)	(0.52)	(2.49)	(2.95)	(2.73)	
14	Chemicals nes	0.066	-0.183	0.075	-1.158	-0.231	1.806	-2.165
		(1.50)	(6.27)	(1.22)	(4.42)	(1.06)	(2.66)	
15	Rubbers & Plastics	0.340	-0.144	0.920	1.273	-0.276	-6.928	-1.054
		(6.12)	(8.00)	(5.67)	(4.32)	(0.96)	(3.91)	
16	Non-Metallic Mineral Products	0.050	-0.048	0.087	0.817	-0.651	-0.623	0.668
		(1.87)	(1.52)	(1.69)	(5.15)	(6.77)	(1.24)	
17	Basic Metals	-0.006	-0.031	-0.067	0.447	1.157	0.848	-0.728
		(0.61)	(0.69)	(2.73)	(2.40)	(4.06)	(0.86)	
18	Metal Goods	0.041	-0.137	0.145	1.298	-0.863	4.517	-0.318
		(1.49)	(4.07)	(1.69)	(6.43)	(8.96)	(2.51)	
19	Mechanical Engineering	-0.017	0.003	-0.063	1.191	-0.786	-0.513	-0.056
		(0.77)	(0.26)	(1.16)	(5.51)	(4.13)	(0.43)	
20	Electronics	0.027	0.046	0.172	-0.341	0.369	-6.056	-1.622
		(2.63)	(1.44)	(4.98)	(1.38)	(0.81)	(2.34)	

Table II (iii) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Δp_{it}

Instruments: $y_{it-1} - y^*_{it-1}, y_{it-2} - y^*_{it-2}, \bar{p}^w_{it-1} - p_{it-2}, \bar{p}^w_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, \Delta p_{it-1}, \Delta p_{it-2}, \Delta p_{t-1}, \Delta p_{t-2}, \Delta n_{it-1}, \Delta n_{it-2}$

		constant	$\bar{p}^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δp_{it+1}	$\Delta^2 p_{t+1}$	$\Delta^2 n_{it+1}$	$\bar{R}^2$
21	Electrical Engineering	0.040	0.109	0.130	-0.024	-0.217	1.147	0.528
		(6.22)	(6.33)	(6.09)	(0.19)	(2.13)	(0.96)	
22	Instruments	0.015	0.066	0.016	-0.128	-0.014	2.133	0.276
		(1.24)	(5.63)	(1.30)	(0.94)	(0.19)	(2.11)	
23	Motor Vehicles	-0.077	-0.154	-0.102	1.408	-0.870	1.688	-0.894
		(2.48)	(2.43)	(1.83)	(13.93)	(4.34)	(2.57)	
24	Aerospace	-0.017	0.180	0.141	-0.042	0.568	0.825	-0.057
		(1.04)	(1.47)	(2.93)	(0.29)	(0.87)	(0.63)	
25	Other Transport Equipment	0.117	0.266	0.329	-0.205	0.247	-4.344	-0.412
		(13.48)	(5.75)	(11.04)	(2.13)	(2.45)	(6.16)	
26	Manufacturing nes & Recycling	0.053	-0.117	0.013	0.727	-0.884	-0.151	-0.570
		(1.96)	(3.37)	(0.21)	(6.12)	(4.73)	(0.11)	
27	Electricity	-0.098	0.103	-0.143	0.689	0.196	-7.471	-0.974
		(0.70)	(1.25)	(1.08)	(2.52)	(0.68)	(2.14)	
28	Gas Supply	0.238	0.085	0.298	0.689	2.318	1.560	-0.242
		(5.91)	(1.47)	(6.91)	(3.96)	(5.82)	(1.73)	
29	Water Supply	-0.282	0.113	-0.254	0.295	-0.991	-0.644	0.535
		(2.91)	(7.00)	(3.16)	(3.81)	(7.64)	(0.35)	
30	Construction	0.213	0.087	0.244	0.625	0.179	-11.476	-0.718
		(7.10)	(1.33)	(8.03)	(2.95)	(0.77)	(2.39)	

Table $\overline{\text{II}}$ (iv) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Δp_{it}

Instruments: $y_{it-1} - y^{*}_{it-1}, y_{it-2} - y^{*}_{it-2}, \bar{p}^{w}_{it-1} - p_{it-2}, \bar{p}^{w}_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, \Delta p_{it-1}, \Delta p_{it-2}, \Delta p_{t-1}, \Delta p_{t-2}, \Delta n_{it-1}, \Delta n_{it-2}$

		constant	$\bar{p}^{w}_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Δp_{it+1}	$\Delta^2 p_{t+1}$	$\Delta^2 n_{it+1}$	$\bar{R}^2$
31	Retailing	0.025	0.151	0.038	-0.099	-0.113	14.044	0.158
		(1.33)	(5.74)	(0.59)	(0.56)	(0.86)	(1.81)	
32	Distribution nes	0.138	0.003	0.190	0.671	-0.170	3.214	-0.393
		(3.07)	(0.12)	(2.93)	(2.98)	(1.00)	(0.31)	
33	Hotels & Catering	0.350	-0.127	0.387	-0.155	-0.277	-6.609	0.072
		(5.30)	(4.66)	(5.08)	(0.78)	(1.88)	(1.24)	
34	Rail Transport	0.029	0.077	-0.046	-0.786	-0.970	-0.229	-0.932
		(2.52)	(1.63)	(0.98)	(1.71)	(5.93)	(1.81)	
35	Other Land Transport	0.065	-0.115	0.036	1.346	-0.108	-19.981	-3.327
		(0.81)	(1.16)	(0.14)	(1.45)	(0.17)	(1.09)	
36	Water Transport	0.100	-0.075	0.083	0.518	-0.049	-0.124	-0.575
		(0.84)	(0.75)	(0.60)	(2.34)	(0.16)	(0.23)	
37	Air transport	0.218	-0.069	0.300	0.398	-0.034	0.686	-0.239
		(2.20)	(1.24)	(2.20)	(1.71)	(0.11)	(0.81)	
38	Other Transport Services	0.008	0.058	-0.038	0.378	-0.644	-16.825	0.372
		(0.48)	(3.10)	(1.32)	(2.96)	(2.50)	(2.87)	
39	Communications	-0.115	0.456	-0.157	-0.123	-1.138	-11.501	-0.007
		(1.04)	(7.68)	(0.76)	(0.54)	(2.16)	(0.46)	
40	Banking & Finance	0.022	0.232	0.047	0.874	0.188	13.285	-0.313
		(1.90)	(4.45)	(3.58)	(3.79)	(1.31)	(3.07)	

Table II (v) — Batini-Jackson-Nickell model, GMM, Sample period: 1974-1997, Dependent variable: Dp_{it}

Instruments: $y_{it-1} - y^*_{it-1}, y_{it-2} - y^*_{it-2}, \bar{p}^w_{it-1} - p_{it-2}, \bar{p}^w_{it-2} - p_{it-3}, mc_{it-1} - p_{it-2}, mc_{it-2} - p_{it-3}, Dp_{it-1}, Dp_{it-2}, Dp_{t-1}, Dp_{t-2}, Dn_{it-1}, Dn_{it-2}$

		constant	$\bar{p}^w_{it} - p_{it-1}$	$mc_{it} - p_{it-1}$	Dp_{it+1}	$D^2 p_{t+1}$	$D^2 n_{it+1}$	$\bar{R}^2$
41	Insurance	0.057	0.051	0.047	0.947	-0.164	-1.443	0.054
		(1.15)	(1.33)	(1.00)	(4.23)	(1.39)	(0.71)	
42	Professional Services	-0.016	-0.071	-0.019	0.955	-0.469	-0.129	-0.274
		(1.10)	(2.57)	(1.19)	(4.82)	(1.28)	(0.03)	
43	Computing Services	-0.044	-0.057	-0.018	1.708	-0.496	-0.526	0.311
		(5.31)	(2.04)	(1.54)	(15.43)	(8.09)	(24.08)	
44	Other Business Services	0.123	0.063	0.255	0.495	0.538	-9.421	-0.888
		(3.71)	(1.25)	(2.97)	(1.91)	(1.45)	(3.17)	
45	Public Administration & Defence	0.104	0.047	0.370	0.178	-0.261	10.021	0.798
		(19.01)	(7.29)	(16.71)	(6.45)	(6.03)	(5.52)	
46	Education	0.203	0.033	0.829	0.035	-0.280	36.381	0.667
		(6.17)	(2.01)	(7.29)	(0.25)	(0.92)	(2.67)	
47	Health & Social Work	0.114	0.030	0.410	0.279	-0.230	3.657	0.595
		(6.00)	(5.26)	(6.01)	(1.88)	(1.82)	(1.15)	
48	Waste Treatment	0.052	0.138	-0.005	-0.296	0.090	-0.662	0.067
		(1.48)	(4.89)	(0.14)	(2.53)	(0.59)	(4.06)	
49	Miscellaneous Services	0.471	-0.051	0.613	0.154	0.070	0.886	0.017
		(5.38)	(0.91)	(4.59)	(1.08)	(0.47)	(0.30)	
	Sum of $\bar{R}^2$							-13.064

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Data Appendix

Most of the data we use are obtained or derived from a data set developed by Cambridge Econometrics as part of work commissioned by the Bank of England. The aim of this work is to develop a set of accounting relationships using input-output analysis to show how changes in industrial and consumer prices can be associated with changes in labour, capital and imported costs, with changes in net taxes and with total factor productivity growth.

The dependent variable in our regressions is $\Delta p_{it} = p_{it} - p_{it-1}$, where $p_{it} = \ln(PVA_{it})$ and PVA_{it} is the price of value added for each industry. These series are derived from growth rates provided by Cambridge Econometrics, which are converted into price level indices with 1995=1.

To capture the effects of foreign competition we use $p_{it}^{w} = \ln(WP_{it})$ and $\overline{p}_{it}^{w} = \ln(\overline{WP_{it}})$, the latter constructed using smoothed exchange rate data. To construct WP_{it} we use United States data, first dividing current price GDP by constant price GDP for each industry to obtain price deflators. From 1977, industry GDP data for the United States is available from the US Bureau of Economic Analysis (BEA). Prior to 1977, these data are obtained from the OECD's International Sectoral Data Base (ISDB). The industrial classification used by the BEA differs somewhat from that used in the ISDB, so it is necessary to match the two sets of data. Table A1 below shows how we do this. The BEA price series for each industry is then extended back before 1977 by assuming they grow at the same rate as the relevant ISDB series. The industrial classification used by the BEA in turn differs from that used in that data set provided by Cambridge Econometrics. The next step, therefore, is to these two sets of data, with Table A2 showing how we do this. The resulting industry price deflators are then multiplied by sterling-dollar exchange rate and converted into index form with 1995=1 in order to derive WP_{it}. Similarly, we derive $\overline{WP_{it}}$ by multiplying the industry price deflators by a four-year moving average of the sterling-dollar exchange rate and converting them into index form with 1995=1.

Marginal cost is given by $mc_{it}^{*} = mc_{it} + \ln(MC/AC)_{it}$, where $mc_{it} = w_{it} - prod_{it}$, $prod_{it} = (y_{it} - p_{it}) - n_{it}$, $w_{it} = \ln(YFTW_{it})$, and $n_{it} = \ln(YFTE_{it})$. The variables $YFTW_{it}$ and $YFTE_{it}$ are industry wage rates and full-time equivalent employment respectively and are provided by Cambridge Econometrics. Industry value added is given by $y_{it} = \ln(VA_{it})$, where $VA_{it} = YIFE_{it} + SVTY_{it} + YP_{it}$. The variables $YIFE_{it}$, $SVTY_{it}$, and YP_{it} are the total compensation of employees, total taxes on expenditure less subsidies, and gross profits respectively for each industry, and are provided by Cambridge Econometrics.

As shown in equation **(20a)** in Section 2, the variable $(MC/AC)_{it}$ is derived as follows

$$\left(\frac{MC}{AC}\right)_{it} = \frac{1}{0.7}\left[1 + \frac{0.4\left(OT/H^{N}\right)_{it} + 0.33\left[\left(\Delta\tilde{n}_{it}\right)^{2}/\overline{\left(\Delta\tilde{n}_{it}\right)}\right]}{\left(OT/H^{N}\right)_{it} + \left(\Delta\tilde{n}\right)_{it}}\right]$$

where, $\Delta\tilde{n}_{it} = \frac{N_{it} - (1-d)N_{it-1}}{(1-d)N_{it-1}}$, $OT_{it} = H_{it} - H_{it}^{N}$, $N_{it} = YFTE_{it}$, and $d = 0.1$. The series H_{it}, H_{it}^{N} and OT_{it} are total hours, normal hours, and overtime hours respectively for each industry. From 1975, data for these series are obtained from the *New Earnings Survey*. Prior to 1975, we have obtained data for total hours and normal hours from the *Department of Employment Gazette*, calculated overtime hours as the residual and spliced the resulting data on to the post-1975 data.

Total factor productivity growth is given by Δtfp_{it} and is provided by Cambridge Econometrics.

The change in the price of aggregate gross value added is given by $\Delta p_{t} = p_{t} - p_{t-1}$, where $p_{t} = \ln\left(ABML_{t}/ABMM_{t}\right)$, and $ABML_{t}$ and $ABMM_{t}$ are the UK Office of National Statistics' series for the current and constant price respectively of gross value added measured at basic prices, excluding taxes less subsidies on products.

The measure of trend value added used to produce our measure of the output gap for each industry, $y_{it} - y_{it}^{*}$, is obtained by applying a Hodrick-Prescott filter $\left(l = 100 \right)$ to value added in each industry.

Table A1 – Matching ISDB and BEA industrial classifications to construct world price indices

ISDB	BEA
Agriculture, hunting, forestry and fishing	Agriculture, forestry, and fishing
Agriculture, hunting, forestry and fishing	Farms
Agriculture, hunting, forestry and fishing	Agricultural services, forestry, and fishing
Mining and quarrying	Mining
Mining and quarrying	Metal mining
Mining and quarrying	Coal mining
Mining and quarrying	Oil and gas extraction
Mining and quarrying	Nonmetallic minerals, except fuels
Construction	Construction
Manufactoring	Manufacturing
Manufactoring	Durable goods
Wood and wood products, incl furnitures	Lumber and wood products
Wood and wood products, incl furnitures	Furniture and fixtures
Non-metallic mineral products except products of petroleum and coal	Stone, clay, and glass products
Basis metal industries	Primary metal industries
Fabricated metal products, machinery and equipment	Fabricated metal products
Agricultural and industrial machinery	Machinery, except electrical
Electrical goods	Electric and electronic equipment
Transport equipment	Motor vehicles and equipment
Transport equipment	Other transportation equipment
Office and data processing machines, precision and optical instruments	Instruments and related products
Other manufacturing industries	Miscellaneous manufacturing industries
Manufactoring	Nondurable goods
Food, beverages and tobacco	Food and kindred products
Food, beverages and tobacco	Tobacco products
Textile, wearing apparel and leather industries	Textile mill products
Textile, wearing apparel and leather industries	Apparel and other textile products
Paper and paper products, printing and publishing	Paper and allied products
Paper and paper products, printing and publishing	Printing and publishing
Chemicals and chemical petroleum, coal, rubber and plastic products	Chemicals and allied products
Chemicals and chemical petroleum, coal, rubber and plastic products	Petroleum and coal products
Chemicals and chemical petroleum, coal, rubber and plastic products	Rubber and miscellaneous plastics products
Textile, wearing apparel and leather industries	Leather and leather products
Transport and storage	Transportation and public utilities
Transport and storage	Transportation
Transport and storage	Railroad transportation
Transport and storage	Local and interurban passenger transit
Transport and storage	Trucking and warehousing
Transport and storage	Water transportation
Transport and storage	Transportation by air
Transport and storage	Pipelines, except natural gas
Transport and storage	Transportation services
Communication	Communications
Communication	Telephone and telegraph
Communication	Radio and television
Electricity, gas and water	Electric, gas, and sanitary services
Wholesale and retail trade	Wholesale trade
Wholesale and retail trade	Retail trade
Finance, insurance, real estate and business services	Finance, insurance, and real estate

Table A1 – Matching ISDB and BEA industrial classifications to construct world price indices

ISDB	BEA
Financial institutions and insurance	Banking
Financial institutions and insurance	Credit agencies other than banks
Financial institutions and insurance	Security and commodity brokers
Financial institutions and insurance	Insurance carriers
Financial institutions and insurance	Insurance agents, brokers, and service
Real estate and business services	Real estate
Real estate and business services	Nonfarm housing services
Real estate and business services	Other real estate
Real estate and business services	Holding and other investment offices
Community, social and personal services	Services
Community, social and personal services	Hotels and other lodging places
Community, social and personal services	Personal services
Community, social and personal services	Business services
Community, social and personal services	Auto repair, services, and parking
Community, social and personal services	Miscellaneous repair services
Community, social and personal services	Motion pictures
Community, social and personal services	Amusement and recreation services
Community, social and personal services	Health services
Community, social and personal services	Legal services
Community, social and personal services	Educational services
Community, social and personal services	Social services
Community, social and personal services	Membership organizations
Community, social and personal services	Miscellaneous professional services
Office and data processing machines, precision and optical instruments	Electronic equipment and instruments
Financial institutions and insurance	Depository and nondepository institutions
Real estate and business services	Business, miscellaneous professional, & other services

Table A2 – Matching BEA and Cambridge Econometrics industrial classifications to construct world price indices

BEA	Cambridge Econometrics
Agriculture, forestry, and fishing	Agriculture
Coal mining	Coal
Oil and gas extraction	Oil & Gas etc
Mining	Other Mining
Food and kindred products	Food
Food and kindred products	Drink
Tobacco products	Tobacco
Textile mill products	Textiles
Apparel and other textile products	Clothing & Leather
Lumber and wood products	Wood & Wood Products
Paper and allied products	Paper, Printing & Publishing
Petroleum and coal products	Manufactured Fuels
Chemicals and allied products	Pharmaceuticals
Chemicals and allied products	Chemicals nes
Rubber and miscellaneous plastics products	Rubbers & Plastics
Stone, clay, and glass products	Non-Metallic Mineral Products
Primary metal industries	Basic Metals
Fabricated metal products	Metal Goods
Machinery, except electrical	Mechanical Engineering
Electronic equipment and instruments	Electronics
Manufacturing	Electrical Engineering
Electronic equipment and instruments	Instruments
Motor vehicles and equipment	Motor Vehicles
Other transportation equipment	Aerospace
Other transportation equipment	Other Transport Equipment
Miscellaneous manufacturing industries	Manufacturing nes & Recycling
Electric, gas, and sanitary services	Electricity
Electric, gas, and sanitary services	Gas Supply
Electric, gas, and sanitary services	Water Supply
Construction	Construction
Retail trade	Retailing
Wholesale trade	Distribution nes
Transportation services	Other Transport Services
Communications	Communications
Finance, insurance, and real estate	Banking & Finance
Insurance agents, brokers, and service	Insurance
Business, miscellaneous professional, & other services	Professional Services
Business, miscellaneous professional, & other services	Computing Services
Business, miscellaneous professional, & other services	Other Business Services
Social services	Public Administration & Defence
Educational services	Education
Health services	Health & Social Work
Electric, gas, and sanitary services	Waste Treatment
Services	Miscellaneous Services

APPENDIX

This appendix contains extracts from BJN (2000) and shows the steps we take to derive a pricing equation for industry i as a function of (lagged expectations of) past, present and future deviations of i-th industry prices from aggregate prices and as a function of $\hat{p}_{it}$

1.1 Definition and measurement

Algebraically, the labour share can be expressed as:

$$s_L \equiv WN / PY \quad \textbf{(1)}$$

where W is labour cost per employee, N is employment, P is the GDP deflator at factor cost, and Y is national income.

2.1 A static closed-economy pricing model

To unveil the relationship linking inflation and the share of labour, we need a model of the pricing behaviour of firms. This pins down the linkage between prices, inflation and marginal costs. For this purpose, we start by considering the static equilibrium level of prices, that is, the price that would prevail in the absence of adjustment costs. Thus we assume that the economy is inhabited by F identical firms, labeled i, and that technology is Cobb-Douglas and can be written as:

$$Y_{it} = A_{it} N_{it}^{a} \quad \textbf{(2)}$$

where $a > 0$, Y_{it} is value added output, N_{it} is employment and A_{it} represents an exogenous productivity index capturing shifts in labour productivity. This includes the impact of both capital and total factor productivity.[19] Following Layard, Nickell and Jackman (1991) ('LNJ' hereafter), we postulate that each firm faces a constant elasticity demand function, i.e.:

$$Y_{it} = (P_{it} / P_t)^{-h_{it}} Y_{dit} \quad \textbf{(3)}$$

[19] Capital is assumed fixed with regard to short-run variations in output.

where $h > 1$, P_{it} is the price of value added of firm i, P_t is the aggregate price of value added (i.e. the GDP deflator), and Y_{dit} is an exogenous demand index.

We then define the cost of producing output as:

$$C_t = W_{it} N_{it} + cK_i \qquad \textbf{(4)}$$

where W_{it} represents the labour cost per employee (consisting of wages plus non-wage labour costs) and cK_i is a predetermined capital cost, which is fixed with regard to short-run variations in output.

Using **(2)**, we can re-express cost as:

$$C_t = W_{it} Y_{it}^{1/a} A_{it}^{-1/a} + cK_i \qquad \textbf{(4a)}$$

so that marginal cost is equal to:

$$MC_t = (1/a)(W_{it} Y_{it}^{(1/a-1)} A_{it}^{-1/a}) = (1/a)(W_{it} N_{it} / Y_{it}) \quad \text{(from } \textbf{(2)}\text{)} \qquad \textbf{(5)}$$

The static equilibrium price P_{it}^* is hence given by:

$$P_{it}^* = m_{it}^* MC_{it} \qquad \textbf{(6)}$$

where m_{it}^* is the equilibrium mark-up of prices on marginal cost, i.e. $m_{it}^* = (1 - 1/h_{it})^{-1}$, which is decreasing in the demand elasticity.

2.2 Dynamic model based on quadratic adjustment costs

Following LNJ,[20] we now modify the basic pricing model to encompass quadratic adjustment costs of changing both prices and employment — a specification based on Rotemberg (1982). This gives a model that is preferable to Calvo (1983) because it enables us to incorporate employment adjustment costs more easily. As we will discuss shortly, these are a crucial source of the inertia usually observed in the UK and hence should not be ignored. Throughout, lower-case letters denote natural logarithms of the corresponding upper-case variables.

To simplify the analytical solution of the dynamic optimisation problem faced by firms, and ensure linear first-order conditions, we begin by approximating the firm's real profit objective ($j(p_i)$), by a Taylor expansion around p_i^* [p_t , $p_i^* = \ln P_t , \ln P_i^*$] based on **(6)**. Thus:

$$j(p_i) \simeq j(p_i^*) - (q/2)(p_i - p_i^*)^2 \qquad \textbf{(7)}$$

where $j'(p_i^*) = 0$ (since p_i^* is the equilibrium price) and $q = -j''(p_i^*) > 0$. We assume that the firm wishes to maximise an objective like **(7)**, but that it faces additional quadratic employment adjustment costs. When these are included, the firm's problem consists in deriving, at the start of period *t*, a price and employment path that solve:

$$\min E_{t-1} \sum_{s=0}^{\infty} f^s \left[\left(p_{i,t+s} - p_{i,t+s}^* \right)^2 + b_p/2 \left(p_{i,t+s} - p_{i,t+s-1} \right)^2 + b_n/2 \left(n_{i,t+s} - n_{i,t+s-1} \right)^2 \right] \qquad \textbf{(8)}$$

where f is a discount factor, and E_{t-1} denotes expectations formed on the basis of information available *at the end* of period *t*-1. Objective **(8)** is subject to the constraint that demand is met in each period, that is:

$$a_{it+s} + a n_{it+s} = -h\left(p_{it+s} - p_{t+s} \right) + y_{dit+s} \qquad \text{(all } s \geq 0\text{)} \qquad \textbf{(9)}$$

which is based on equations **(2)** and **(3)**.

[20] See Layard *et al* (1991), pp. 346 and ff.

We set the demand elasticity equal to a constant, imagining that, while it may fluctuate over the cycle, the firm treats it as constant when solving this problem.[21] Thus, using the constraint to eliminate employment, the problem reduces to:

$$\min E_{t-1}\sum_{s=0}^{\infty} f^{s} \left\{ \begin{array}{l} \left(p_{it+s}-p^{*}_{it+s}\right)^{2} + 1/2\left(b_{p}+b_{n}h^{2}/a^{2}\right)\left(p_{it+s}-p_{it+s-1}\right)^{2} - \\ b_{n}h^{2}/a^{2} \left[\begin{array}{l} \left(p_{it+s}-p_{it+s-1}\right)\left(p_{t+s}-p_{t+s-1}\right) + \\ 1/h\left(p_{it+s}-p_{it+s-1}\right)\left(y_{dit+s}-a_{it+s}-y_{dit+s-1}+a_{it+s-1}\right) \end{array} \right] \end{array} \right\} \qquad \textbf{(10)}$$

Since this is a quadratic problem, we invoke first order certainty equivalence and replace all future random variables by their expectations which, hereafter, we denote with the superscript 'e'.

To obtain first-order conditions for this problem, we differentiate **(10)** with respect to the price of the individual firm, p_{it+s}. Before doing so, for notational convenience, we re-express some sets of variables in the following way: $p_{it+s} - p^{e}_{t+s} \equiv \tilde{p}_{it+s}$; $b_{p} + b_{n}h^{2}/a^{2} \equiv a_{1}$; and:

$$\hat{p}_{it+s} \equiv p^{*}_{it+s} - p^{e}_{t+s} + b_{p}/q\left(f\Delta p^{e}_{t+s+1} - \Delta p^{e}_{t+s}\right) - b_{n}h/qa^{2}\left(f\Delta\left(y^{e}_{dit+s+1}-a^{e}_{it+s+1}\right) - \Delta\left(y^{e}_{dit+s}-a^{e}_{it+s}\right)\right) \qquad \textbf{(11)}$$

Then, the first order condition for the firm's profit maximisation problem is:

$$f a_{1}\tilde{p}_{it+s+1} - \left[q + a_{1}\left(f+1\right)\right]\tilde{p}_{it+s} + a_{1}\tilde{p}_{it+s-1} = -q\,\hat{p}_{it+s} \quad (s>0) \qquad \textbf{(11a)}$$

The standard (first period) solution to this second order difference equation (or Euler equation) is:

$$\tilde{p}_{it} = l\,\tilde{p}_{it-1} + \left(1-l\right)\left(1-fl\right)\sum_{j=0}^{\infty}\left(fl\right)^{j}\hat{p}_{it+j} \qquad \textbf{(12)}$$

where l is the unique stable root of:

$$f a_{1} l^{2} - \left[q + a_{1}\left(f+1\right)\right] l + a_{1} = 0 \qquad \textbf{(13)}$$

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[21] The fact is that it may change systematically over the years may, therefore, lead to shifts in the model's parameters.

We now make the expectations in **(12)** more explicit, i.e.:

$$p_{it} - E_{t-1}p_t = l\left(p_{it-1} - p_{t-1}\right) + \left(1 - l\right)\left(1 - fl\right)\sum_{j=0}^{\infty}\left(fl\right)^j E_{t-1}\hat{p}_{it+j} \qquad \textbf{(14)}$$

and shift **(14)** one period forward. By taking expectations dated $t - 1$, multiplying by $\left(fl\right)$ and subtracting from **(14)**, we obtain:

$$\left(p_{it} - E_{t-1}p_t\right) = fl\,E_{t-1}\left(p_{it+1} - p_{t+1}\right) - fl^2 E_{t-1}\left(p_{it} - p_t\right) + l\left(p_{it-1} - p_{t-1}\right) + \left(1 - l\right)\left(1 - fl\right)E_{t-1}\hat{p}_{it} \qquad \textbf{(15)}$$