New Keynesian Pricing Behaviour: an Analysis of Micro Data

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Introduction

- Estimates of New Keynesian Phillips Curves typically rely on macro-economic data. The influence of expected price increases on actual price increases is poorly identified.
- Studies of price setting and price changes typically look at the interval between price changes.
- We use a survey conducted by the Confederation of British Industry since 2008 to investigate the New Keynesian Phillips Curve.
- We apply Rotemberg's model to the data

Questions of Interest

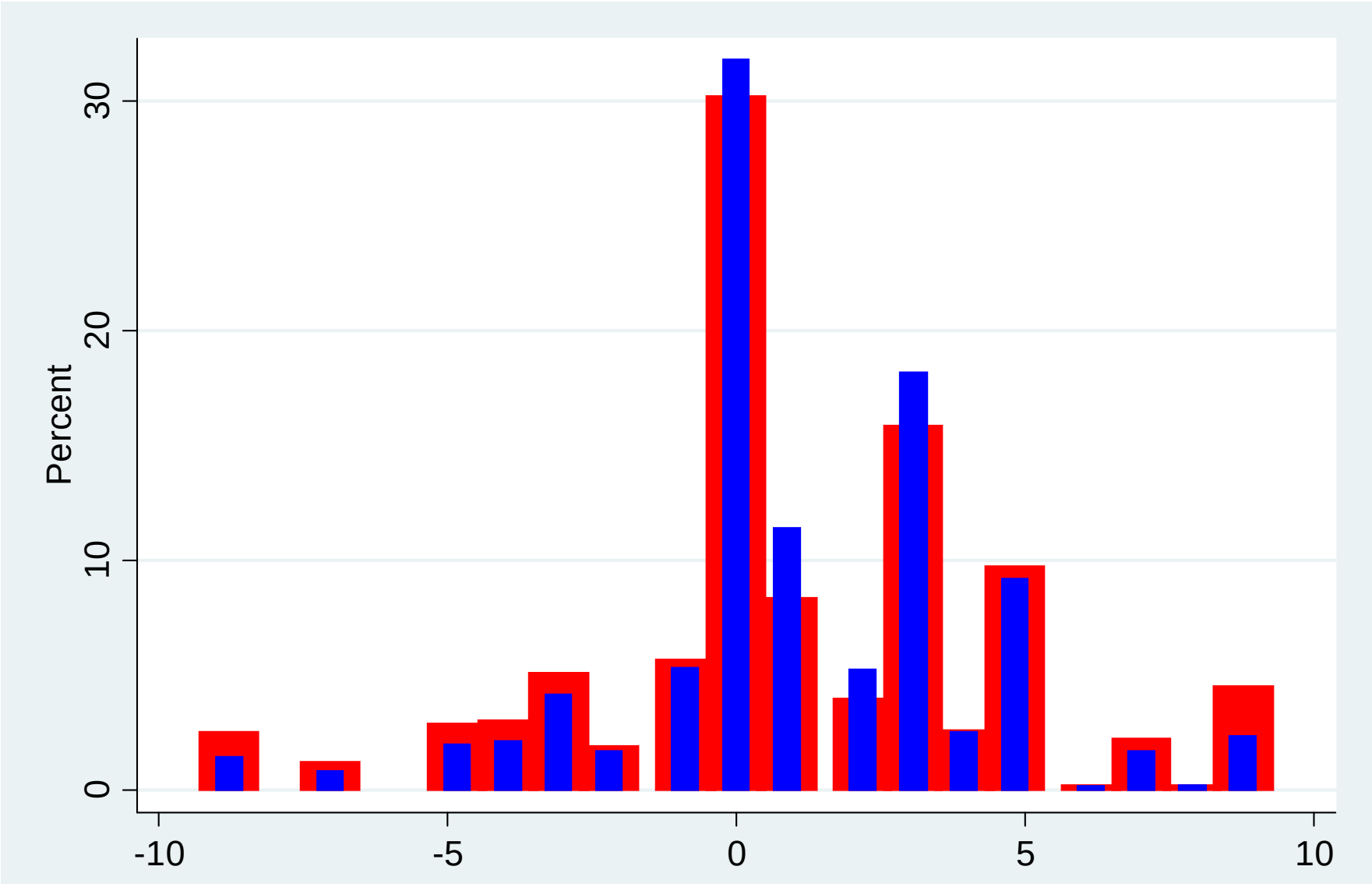
1. What has been the percentage change over the past 12 months in your firm's own average output price for goods sold into UK markets and what is expected to occur over the next 12 months?
2. What is your capacity utilisation, measured as a percentage of full capacity?
3. Excluding seasonal variations, what has been the trend over the past three months with regard to average costs per unit of output?
4. What factors are likely to limit (wholly or partly) your capital expenditure authorizations over the next twelve months? To answer this question, firms can select multiple factors out of: inadequate net return on investment; uncertainty about demand; shortage of internal finance; shortage of labour, including managerial and technical staff; inability to raise external finance; cost of finance; other; n/a. From these answers, we only use cost of finance.

The Dynamics of the CBI Survey

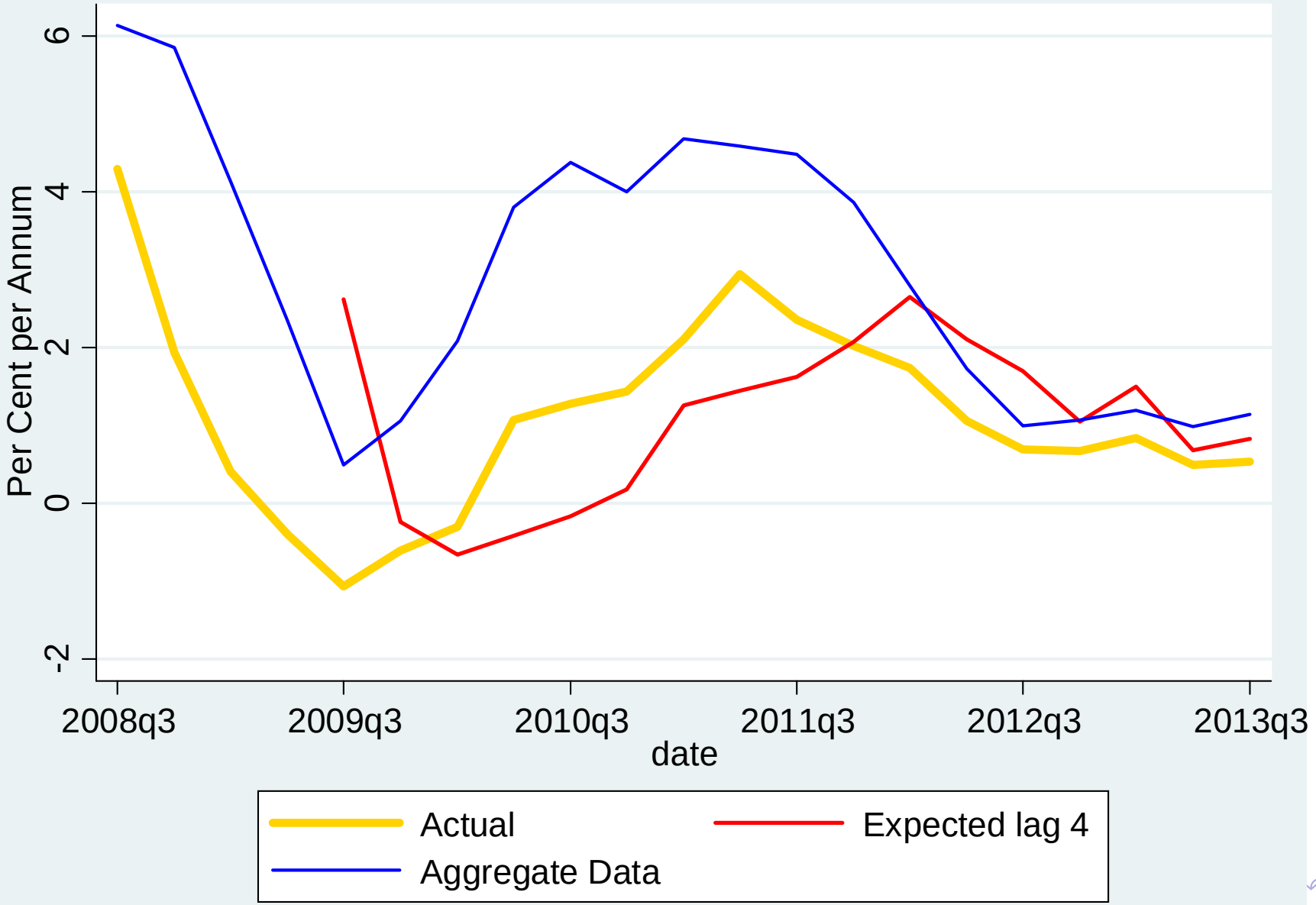
					Employees			
date	Enter	Exit	Re-enter	Total	<25	25-149	150-749	750+
2008q3	327		0	327		262	44	21
2009q3	56	206	100	416	15	308	62	31
2010q3	46	182	125	397	19	279	64	35
2011q3	40	171	128	430	23	323	50	34
2012q3	24	165	141	384	18	279	51	36
2013q3	18	146	110	358	16	262	48	32

Table: The Dynamics of the Panel of Respondents to the *Industrial Trends Survey*

The Distribution of Responses on Past and Expected Price Increases



Aggregated Past and Expected Price Increases



The Relationship between Past Price Changes and SIC 2-digit Output Price Movements

		Employees			
	All Firms	<25	25-149	150-749	750+
Δ logPPI	.255	.123	.216	.490	.405
	(.032)***	(.099)	(.035)***	(.116)***	(.086)***
Const.	-.011	-.152	.104	-.741	.235
	(.126)	(.436)	(.149)	(.319)**	(.369)
Observations	1688	126	1211	227	124
Groups	719	60	500	99	59

Dependent Variable: Price Change over Last 12 Months

Significant levels * 10% ** 5% ***1%

Table: The Relationship between reported Price Changes and the Corresponding 2-digit SIC Producer Price Changes

Tests of Expectations Bias

		Employees			
	All Firms	<25	25-149	150-749	750+
Expectation	.190	.265	.090	.506	.619
	(.032)***	(.094)***	(.038)**	(.096)***	(.088)***
Constant	.629	.179	.793	.139	.523
	(.083)***	(.199)	(.101)***	(.223)	(.241)**
Observations	1716	130	1226	233	127
Groups	723	62	502	100	59

Dependent Variable: Price Change over Last 12 Months

Significant levels * 10% ** 5% ***1%

Table: The Relationship between Expected Price Changes and Subsequent Out-turns

Formation of Price Change Expectations

	OLS	IV
Past own price increase (last 12 months)	.314	.168
	(.023)***	(.073)**
its-CurrRateOper	.020	.001
	(.006)***	(.025)
CPI inflation	.167	.292
	(.073)**	(.105)***
its-PstCostPerUnit	.563	.584
	(.130)***	(.196)***
Const.	-1.332	
	(.509)***	
Observations	1679	752
Groups	718	262
Cragg-Donald Weak Identification		16.476

Dependent Variable: Expected Price Increase (next 12 months)

Significant levels * 10% ** 5% ***1%

The Standard NKPC with Rotemberg Pricing

Firms maximise the present discounted value of expected future profits, after taking account of costs of price adjustment:

$$\beta E_0 \sum_{t=0}^{\infty} \beta \lambda_t \left[p_t^f y^f - P_t \Psi_t^f - \frac{\gamma}{2} \left(\frac{p_t^f}{p_{t-1}^f} - 1 \right)^2 P_t y_t \right]] / P_t \qquad (1)$$

subject to the demand function

$$y_t^f(d) = \left(\frac{p_t^f}{P_t} \right)^{-\theta} y_t \qquad (2)$$

First-order Conditions

The first order condition is, with $\psi_t^f = \partial \Psi_t^f / \partial y_t^f$, the marginal cost of production,

$$0 = y_t^f (1-\theta) + \psi_t^f \theta y_t^f \tilde{p}_t^f - \gamma \pi_t^f \tilde{p}_{t|t-1}^f y_t + \beta E_t \left(\lambda_t \gamma \frac{(1+\pi_{t+1}^f)}{(1+\pi_{t+1})} \pi_{t+1}^f \tilde{p}_{t+1|t}^f y_t \right. \tag{3}$$

where $\tilde{p}_t^f \equiv \frac{P_t}{p_t^f}$, $\tilde{p}_{t|t-1}^f \equiv \frac{P_t}{p_{t-1}^f}$.

The linearised first-order condition is:

$$\hat{\pi}_t^f = \beta E_t \hat{\pi}_{t+1}^f + \frac{\theta \psi}{\gamma} \left(\hat{\psi}_t^f + \hat{p}_t - \hat{p}_t^f \right) \tag{4}$$

Temporal Aggregation

We write equation (4) together with three lags as

$$
\begin{aligned}
\hat{\pi}_t^f &= \beta E_t \hat{\pi}_{t+1}^f + \frac{\theta\psi}{\gamma}\left(\hat{\psi}_t^f + \hat{p}_t - \hat{p}_t^f\right) \\
\hat{\pi}_{t-1}^f &= \beta E_{t-1} \hat{\pi}_t^f + \frac{\theta\psi}{\gamma}\left(\hat{\psi}_{t-1}^f + \hat{p_{t-1}} - \hat{p}_{t-1}^f\right) \\
\hat{\pi}_{t-2}^f &= \beta E_{t-2} \hat{\pi}_{t-1}^f + \frac{\theta\psi}{\gamma}\left(\hat{\psi}_{t-2}^f + \hat{p_{t-2}} - \hat{p}_{t-2}^f\right) \\
\hat{\pi}_{t-3}^f &= \beta E_{t-3} \hat{\pi}_{t-2}^f + \frac{\theta\psi}{\gamma}\left(\hat{\psi}_{t-3}^f + \hat{p_{t-3}} - \hat{p}_{t-3}^f\right)
\end{aligned}
$$

If we add these equations together, the result is an equation in the four-quarter growth in prices, explained by the four-quarter growth in expected prices

$$\hat{\pi}_t^{4f} = \beta E_{t-3}\hat{\pi}_{t+1}^{4f} + \frac{\theta\psi}{\gamma}\left(\hat{\psi}_t^{4f} + \hat{p}_t{}^4 - \hat{p}_t^{4f}\right) + u_t \quad (5)$$

$$\begin{aligned} u_t = {} & \beta\left(E_t\hat{\pi}_{t+1}^f + E_{t-1}\hat{\pi}_t^f + E_{t-2}\hat{\pi}_{t-1}^f\right) \\ & -\beta\left(E_{t-3}\hat{\pi}_{t+1}^f + E_{t-3}\hat{\pi}_t^f + E_{t-3}\hat{\pi}_{t-1}^f\right) \end{aligned} \quad (6)$$

Variable Definitions: Prices

We use the consumer price index as a general price index, in common with much work on New Keynesian Phillips curves. The price series for the individual firms are compiled from the returns they have provided to the CBI. There are two practical problems. First of all, the responses relate to changes over four quarters. Secondly, the panel is incomplete.

Variable Definitions: Costs

The pricing equation requires marginal costs,which are of course equal to average costs with constant returns to scale. We explore a number of possible cost measures. The first is derived from the qualitative response to the question about changes in costs over the previous quarter.
The second is the log of Average Weekly Earnings (*lAWE*), the ONS measure of wage rates, and the third is the log of unit wage costs in manufacturing (*lUWC*).

Capacity

The survey also asks firms to report their capacity utilisation, as a proportion of maximum capacity. While we do not set out formally a model in which capacity utilisation rather than costs enters, we estimate, for completeness a model in which real domestic costs, $\hat{\psi}_t^{4f}$ are replaced by capacity utilisation (*Capac)*. Once again, in order to maintain the sample, the sector average is used where individual data for capacity utilisation are missing. In the model where price and cost terms enter, we represent both by nominal indices

Estimation

- We use a fixed-effects unbalanced panel estimator, using *gmm* to address possible endogeneity of the explanatory variables. We do not use overlapping observations.
- Expectations with a lag of three periods enter the model
- Valid instruments are variables relating to the firm at *t-4* or earlier and to other firms in the same sector at *t-3* or earlier.
- Estimation is carried out using the STATA command *xtivreg2*

Price Equations

Dependent Variable: Change in Prices over Last 12 Months				
log Price Level (4-q sum)	-.096	-.111	-.088	
	(.018)***	(.016)***	(.015)***	
log Real Price Level (4-q sum)				-.058
				(.015)***
Exp Price Change (3-per Lag)	.907	.675	1.096	.846
	(.103)***	(.124)***	(.133)***	(.183)***
Capacity Utilisation (4-q sum)				-.002
				(.0008)**
log Level of Costs (4-q sum)	.022			
	(.011)**			
log Av. Wkly Wage (4-q sum)		.07		
		(.018)***		
log Unit Wage (4-q sum)			.082	
			(.033)**	
Cragg-Donald	23.026	12.906	15.737	5.093
Homogeneity F(1,544)	33	8.1	0.05	-

Returns to Scale

Employees	All Firms	<25	25-149	150-749	750+
Changes in Capacity Utilisation and Change in Costs					
Polyserial correlation	0.010	0.022	0.021	-0.032	-0.102
standard error	(0.016)	(0.088)	(0.018)	(0.052)	(0.084)
Observations	5049	204	3806	639	400

Table: Correlations between Capacity Utilisation and Changes in Unit Costs

Employees	All Firms	<25	25-149	150-749	750+
Polychoric correlation	-0.024	0.110	-0.002	-0.130	-0.025
standard error	(0.014)*	(0.067)	(0.017)	(0.038)***	(0.054)
Observations	8790	395	6342	1183	715

Significant levels * 10% ** 5% ***1%

Table: Correlations between Output Changes and Changes in Unit Costs

Price Equations for Small and Large Firms

Dependent Variable: Change in Prices over Last 12 Months				
Employees	<150	150+	<150	1
log Price Level (4-q sum)	-.09	-.067		
	(.017)***	(.03)**		
log Real Price Level (4-q sum)			-.061	-
			(.017)***	(
Exp. Price Change (3-p Lag)	.983	1.346	.782	
	(.154)***	(.197)***	(.228)***	(.
Capacity Utilisation (4-q sum)			-.002	-1.
			(.001)*	(
log Unit Wage Costs (4-q sum)	.074	.079		
	(.037)**	(.061)		
Observations	664	163	664	
Cragg-Donald Weak	13.732	6.475	3.451	2
Homogeneity F	(1,440)=0.3	(1,101)=0.0		

Significant levels * 10% ** 5% ***1%

Conclusions

- Data collected in a survey of firms point to pricing behaviour consistent with New Keynesian theory.
- The model fits most plausibly when unit wage costs in manufacturing are used as the cost variable.
- Capacity utilisation does not prove a good proxy for marginal costs.
- Large firms are found to produce with increasing returns to scale and the model yields a coefficient on expected prices well above one for these
- Small firms produce with constant or decreasing returns and the coefficient on expected prices is 0.983 (0.675 to 1.291)