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Abstract

In this paper, we assess the cyclicality of mark-ups and profit margins within the United Kingdom, at both the aggregate and industry level. We find that the private sector labour share moves countercyclically, suggesting that the aggregate mark-up moves procyclically. This result survives when we consider more sophisticated measures of the mark-up. And this result is also supported by industry-level data. We find that the aggregate market sector profit share moves procyclically and that the cyclical behaviour of profit margins is largely homogenous across industries. Nevertheless, there is some evidence that margins moved against the cycle in the late 1990s, starting to fall in 1997, whereas GDP growth did not peak until 2000. In tandem with these cyclical movements, we also find that the market sector profit share has trended upwards since 1970, in contrast to the aggregate mark-up, which fell over the same period.

Key words: Mark-ups, profit margins.

JEL classification: E31, L11.

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Summary

In the United Kingdom, the Bank of England's monetary policy objective is to deliver price stability, which is defined by the Government's 2% inflation target. The Monetary Policy Committee does not seek to keep inflation at precisely 2% every month, which would be unrealistic, but instead aims to set interest rates so that inflation returns to the target within a reasonable time period. That makes it clear that understanding the dynamics of inflation after a disturbance (or 'shock') is absolutely critical. In particular, we need to understand how prices and wages move in response to economic events. The key aspect of this is the way in which firms set prices as a mark-up over costs. The mark-up is of course an important determinant of firms' profit margins, but also determines how movements in costs are translated into the prices, and therefore inflation. So understanding the dynamics of the mark-up, the subject of this paper, is fundamentally important if we want to understand the dynamics of inflation, and therefore maintain price stability.

Consequently, we assess how mark-ups and profit margins move over the business cycle within the United Kingdom, at both the aggregate and industry level. Economic theory does not give a clear answer to this question. In particular, the relationship between mark-ups and output is likely to depend on what factors are causing them to move. And the response of the mark-up to any particular shock will depend on how sticky are wages and prices, as well as on whether or not the 'desired' mark-up responds to the shock. Among our conclusions is that mark-ups and margins appear to move procyclically, increasing in booms. If so, this means that the dynamics of inflation differ between demand and supply-driven causes of inflationary pressure. Supply-side cost pressures may feed into inflation relatively slowly.

Under certain assumptions, the mark-up will be inversely related to the labour share (equivalent to real unit labour costs, the cost of wages per unit of output, adjusted for changes in the price level). We find that the private sector labour share moves countercyclically, ie the labour share is low when output is high. This suggests that the aggregate mark-up moves procyclically, ie is high when output is high. This result is in line with evidence from the United States. But in contrast to studies using US data, we found that more sophisticated measures of the mark-up also move procyclically. Industry-level data support the finding that the mark-up is procyclical.

We also find evidence suggesting that the average mark-up has fallen since around 1992. Since the average mark-up set by a particular producer will be inversely related to the degree of competition that he faces (more competition puts downward pressure on prices), this result suggests that competition has increased in most industries since 1992. We consider whether this increase in competition can be attributed to an increase in 'globalisation', or more precisely, the expansion of developing economies (in particular, China and India) and their increasing importance in the world trading system. But we do not find convincing evidence to suggest that globalisation explains the fall in average mark-ups.

We then consider profit margins as measures by the 'profit share': profits divided by the total value of output (turnover). We find that the aggregate market sector profit margin moves procyclically and that the cyclical behaviour of profit margins is largely the same across

industries. In particular, we did not find strong evidence that margins are more procyclical in less competitive industries. However, both mark-ups and margins started to fall in 1997, in line with survey measures of capacity utilisation, whereas GDP growth did not peak until 2000. That this fall in margins occurred more in the export-intensive industries suggests that the explanation lies in firms trying to remain competitive in the face of the large appreciation in sterling from 1996 to 1998. Finally, we found that the market sector profit margin has trended upwards since 1970. This is in contrast to the downward movement in mark-ups observed over the same period. The explanation for this divergence seems to be the marked rise in the capital-output ratio since the 1970s: that change would help to increase measured profits, offsetting the decrease caused by the fall in the mark-up.

Understanding the dynamics of mark-ups and margins is crucial to understanding the dynamics of inflation. If, as our results suggest, mark-ups move procyclically then it must be either that wages are stickier than prices or that firms' *desired* mark-ups move procyclically. If desired mark-ups do move procyclically, this will have ramifications for how we might expect the economy to respond to shocks. In particular, an increase in demand will lead to a rise in mark-ups whereas a rise in costs would lead firms to reduce their desired mark-ups. And that reduction in desired mark-ups would lead to a delaying of the pass-through of the rise in costs into an increase in inflation.

1   Introduction

Most monetary policy makers focus on achieving price stability, typically defined as low and stable inflation. But in order to achieve price stability, it is important to understand what the dynamics of prices (and inflation) are: in particular, what are the nature of nominal and real frictions associated with the adjustments of prices and wages in the economy. The answer to this question will have an important bearing for the monetary transmission mechanism as well as on what a monetary authority can and should seek to achieve. In an imperfectly competitive environment, firms set prices as a mark-up over their marginal costs. The mark-up will then be an important determinant of firms' profit margins, as well as determining how shocks to their costs are translated into the prices that they set. So, understanding the dynamics of the mark-up will be crucial to understanding the dynamics of inflation.

In addition, understanding the cyclical behaviour of mark-ups is crucial for understanding fluctuations in output. Mitchell (1941) suggested that it was the fact that costs rose as activity expanded – a direct result of the fact that labour, capital and other factors of production have diminishing marginal productivity – that eventually led to the end of a boom as profit margins were squeezed and investment fell as a result. But he also noted that there was a problem with this argument since firms could simply raise their prices to cover the increases in costs. For the story to hold, it must be the case that either prices are stickier than costs or firms would wish to reduce their mark-up in the face of higher demand.

Rotemberg and Woodford (1999) make the point that for output to increase either the mark-up must fall or the marginal cost of producing a given level of output must fall (or both). In this way of thinking, a fall in mark-ups towards the end of an expansion actually allows the expansion to continue rather than bringing it to an end. In addition, it suggests that one way of understanding business cycles is to decompose variations in output into that proportion which result from variations in average mark-ups, and that proportion which result from shifts in marginal costs.[1] And one way into this decomposition is to ask whether or not mark-ups do, in fact, vary negatively with output. This is a question we aim to answer in this paper.

Economic theory gives ambiguous predictions as to the cyclicality of the mark-up and margins. In particular, the comovement of mark-ups and output is likely to depend on the shocks that cause them to vary. And the response of the mark-up to any given shock will depend on how sticky are wages and prices as well as on whether or not the 'desired' mark-up responds to the shock. If desired mark-ups are constant and prices are flexible, then the actual mark-up would not vary at all over the cycle. If prices are sticky and wages are flexible the actual mark-up would fall in response to a positive demand shock. The intuition for this result is exactly that in Mitchell (1941), *viz.* that firms will hire extra labour to supply the extra output demanded and this will raise marginal cost; with prices sticky, the mark-up must fall. In a model in which both wages and prices are sticky, the effect of a demand shock on the mark-up will depend on the relative stickiness of wages and prices. If wages are stickier than prices, the mark-up will

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rise in response to an increase in demand; if prices are stickier than wages, the mark-up will fall.

But the desired mark-up may respond to a demand shock. If changes in demand lead to changes in the elasticity of demand – eg if preferences are not homothetic or if the composition of demand between different groups of agents, with different elasticities of demand, changed over the cycle – then the desired mark-up will change over the cycle.[2] The 'customer market' model of Phelps and Winter (1970) captures the idea that when firms lower their current price, they not only sell more output to their existing customers, they also expand their customer base; in turn, this means that they will be able to sell more output in the future at any given price. The model suggests that firms lower their desired mark-ups when current (gross) sales are low relative to expected future (gross) sales since so-doing increases their market share at a time when their profits are low anyway, enabling them to make higher profits on a larger customer base at a time when they are more able to raise their prices. Alternatively, the 'implicit collusion' model of Rotemberg and Woodford (1992) suggests that desired mark-ups are higher when current (gross) sales are low relative to expected future (gross) sales. This is because it is at such times that firms will wish to hold to the (implicit) collusive agreement since not doing will mean the loss of the higher future profits.

The effect of a shock to costs (for example, the price of oil) will, again, depend on whether or not the desired mark-up is constant. For a constant desired mark-up, other things equal, an increase in costs will lead to a fall in profit margins and the mark-up. The 'customer markets' model suggests that if a rise in the price of oil and imported intermediate goods caused current sales to fall (and the rise were thought to be temporary, so having a smaller effect on expected future profits), firms would reduce their desired mark-ups. And, this reduction in desired mark-ups would lead to a delaying of the pass-through of the rise in costs into an increase in inflation. The 'implicit collusion' model by contrast suggests that desired mark-ups would rise, leading to a larger increase in inflation for a given rise in costs.

The aim of this paper is to assess the cyclicality of mark-ups and profit margins both at the aggregate level and at the industry level.

Previous work on trying to assess the cyclicality of the mark-up and profit margins at the aggregate level have largely looked at US data. Rotemberg and Woodford (1999) provide an exhaustive review of the empirical evidence for the United States. They suggested that profits are 'well-known to vary procyclically'. (See, eg Hultgren (1965) and Domowitz et al (1986).) They found that the labour share tended to rise late in expansions and to fall late in recessions. This suggests that the mark-up tends to fall late in expansions and to rise late in recessions, in line with Mitchell's (1941) anecdotal evidence. But they found that the labour share was negatively correlated with the cycle (though the correlation coefficients were small) suggesting that the mark-up moves procyclically.[3] They then looked at more sophisticated measures of the

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[2] See Gali (1994) and Bils (1989) for papers that develop the idea of changes in the composition of demand leading to changes in the desired mark-up.

[3] These results are consistent with Boldrin and Horvath (1995), Gomme and Greenwood (1995) and Ambler and Cardia (1998).

mark-up that moved away from assuming Cobb-Douglas production, that added overhead labour and that added costs of adjusting labour. They found that these measures of the mark-up were countercyclical. In our paper, we aim to compare these results with results obtained using the same proxies for the mark-up but using UK (as opposed to US) data.

Balakrishnan and Lopez-Salido (2002) look at these different measures of the mark-up in the context of estimating a New Keynesian Phillips Curve (NKPC) and find, using UK data, that they look quite similar. This might suggest that, unlike the case for the US data, we are likely to find that the cyclical properties of the more sophisticated measures of the mark-up are no different to those of the labour share. Balakrishnan and Lopez-Salido also use a measure of the mark-up based on an 'open-economy' production function. We examine the cyclicality of this measure in our work below.

But aggregate movements in mark-ups and margins may be hiding heterogeneity in the way that mark-ups are set at the industry level. In order to address this issue, we follow the approach of Small (1997) and estimate mark-ups and margins in 31 different industries. In doing this work, we are particularly interested in the answers to two questions. First, we want to know the average size of the mark-up and profit margins in different industries and, in particular, whether mark-ups are larger than one. In other words, we are interested in finding out in which industries firms have some market power. Second, we want to know if mark-ups and profit margins are procyclical or countercyclical in all industries or whether their cyclicality varies across industries.

Previous work using UK data has found that both mark-ups and profit margins are procyclical: for example, Haskel *et al* (1995) and Machin and van Reenen (1993) using data on the manufacturing sector, and Small (1997) using data on 16 industries, both manufacturing and non-manufacturing. Our work aims to update and extend these results. Small found that average mark-ups were significantly greater than unity in all but a few manufacturing industries; one motivation for our paper is to see whether this still holds or whether competition has increased leading to a reduction in mark-ups since 1991 (the end of Small's data period).

The rest of the paper is structured as follows. In Section 2, we derive a representation of the mark-up and use this, in turn, to derive empirical measures whose cyclicality we investigate in Section 3. In Section 4, we assess the cyclicality of profit margins, relating our results to the results of Section 3. Section 5 concludes.

2 Some theory

The purpose of this section is to derive a representation of the mark-up which we can then use to derive empirical measures of the mark-up. We start with a firm that produces output, y, using labour input, h, fixed capital, k, and inputs of intermediate goods, $\mathbf{x}$, some of which may be imported. The firm's objective is to maximise its profits subject the technological constraint represented by its production function and the demand curve it faces for its product. It does this taking the prices of its inputs as given.

Mathematically, we can write this problem as:

Maximise $\qquad Py - Wh - rPk - \mathbf{q}\mathbf{x}$ (1)

Subject to $\qquad y = f(h, k, \mathbf{x})$ (2)

and $\qquad y = g(P)$ (3)

where r is the real (opportunity) cost of capital, and $\mathbf{q}$ is the vector of prices associated with the firm's inputs of intermediate goods. We denote the production function by $f(\bullet)$ and the demand curve by $g(\bullet)$. If we let the Lagrange multiplier on the constraint be given by P/μ, the first-order conditions with respect to the firm's choice of inputs will be:

$$\frac{W}{P}\mu = f_h(h, k, \mathbf{x})$$ (4)

$$r\mu = f_k(h, k, \mathbf{x})$$ (5)

$$\mathbf{q} = \frac{P}{\mu} f_{\mathbf{x}}(h, k, \mathbf{x})$$ (6)

Next consider the dual problem, which is to minimise the firm's costs subject to the production function. The solution to this problem implies the firm's cost function, $C(W, rP, \mathbf{q}, y)$. Differentiating this function with respect to y implies:

$$MC = \frac{\partial C(W, rP, \mathbf{q})}{\partial y} = W\frac{\partial h}{\partial y} + rP\frac{\partial k}{\partial y} + \mathbf{q}\frac{\partial \mathbf{x}}{\partial y}$$ (7)

where the partial differentials are evaluated at the cost-minimising level of output. Now, totally differentiating the production function implies:

$$dy = f_h(h, k, \mathbf{x})dh + f_k(h, k, \mathbf{x})dk + f_{\mathbf{x}}(h, k, \mathbf{x})d\mathbf{x}$$ (8)

Substituting this into equation (7) implies:

$$MC = \frac{Wdh + rPdk + \mathbf{q}d\mathbf{x}}{f_h(h, k, \mathbf{x})dh + f_k(h, k, \mathbf{x})dk + f_{\mathbf{x}}(h, k, \mathbf{x})d\mathbf{x}}$$ (9)

Using equations (4), (5) and (6) then implies:

$$MC = \frac{\frac{P}{\mu} f_h(h, k, \mathbf{x})dh + \frac{P}{\mu} f_k(h, k, \mathbf{x})dk + \frac{P}{\mu} f_{\mathbf{x}}(h, k, \mathbf{x})d\mathbf{x}}{f_h(h, k, \mathbf{x})dh + f_k(h, k, \mathbf{x})dk + f_{\mathbf{x}}(h, k, \mathbf{x})d\mathbf{x}}$$ (10)
$$= \frac{P}{\mu}$$

Hence, the mark-up of price over marginal cost, *P/MC*, is equal to μ.

We next use equation **(4)** to write the mark-up in terms of the labour share, *s*, and the elasticity of output with respect to labour input, ε_{yh}:

$$\frac{W}{P}\mu = f_h(h,k,\mathbf{x}) \Rightarrow \mu = \frac{Pf_h(h,k,\mathbf{x})}{W} = \frac{Py}{Wh}\frac{f_h(h,k,\mathbf{x})h}{y} = \frac{\varepsilon_{yh}}{s} \tag{11}$$

This is the basic formula we use to calculate the various mark-up measures we investigate.

3   The cyclicality of mark-ups

In this section, we examine the cyclicality of the economy-wide mark-up. We then go onto investigate the cyclicality of sectoral mark-ups using the same proxies but at a more disaggregated level.

3.1   The cyclicality of the aggregate labour share

Equation **(11)**, above, shows us that for production functions in which the elasticity of output with respect to labour is constant (including the Cobb-Douglas production function) the mark-up will be proportional to the inverse of the labour share. If the labour share moves countercyclically, then the mark-up will move procyclically. This suggests that examining the cyclicality of the labour share is a useful first pass at examining the cyclicality of the mark-up.

To construct our measure of the labour share we started with a series for 'compensation of employees over the whole economy including the value of social contributions payable by the employer'.[4] As suggested by Batini *et al* (2000), we adjust this series to include that part of the remuneration of the self-employed that represents a payment for their labour (rather than a return on their capital). To obtain a measure of the whole-economy labour share, we then need to divide this by GDP at basic prices (in current prices), but we follow Harrison *et al* (2005) and subtract off expenditure on actual and imputed rents as these do not represent produced output.

However, this measure of the labour share is likely to be misleading from the point of view of mark-ups in the economy since both the numerator and denominator will be affected by the contribution of the public sector. So we calculated a measure of the 'private sector' labour share by subtracting the compensation of employees paid by general government from the numerator and the amount of value-added attributable to the government from the denominator.

Chart 1 plots these measures of the labour share for the period 1976 Q2 to 2007 Q4. Both the private sector and whole-economy labour shares have been fairly stable over this period, although there is some evidence that the average private sector labour share might have increased, which would imply a fall in the mark-up.[5] We can also note that the private sector

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[4] Precise definitions of the data series used in Section 3 and how they were constructed are given in Appendix A.
[5] The evidence we present below on sectoral mark-ups suggests that there has, indeed, been such a fall since the early 1990s.

labour share has become more divorced from the whole-economy measure since around 2000; this has resulted from the rising share of government spending in value-added.

Chart 1: The evolution of the labour share
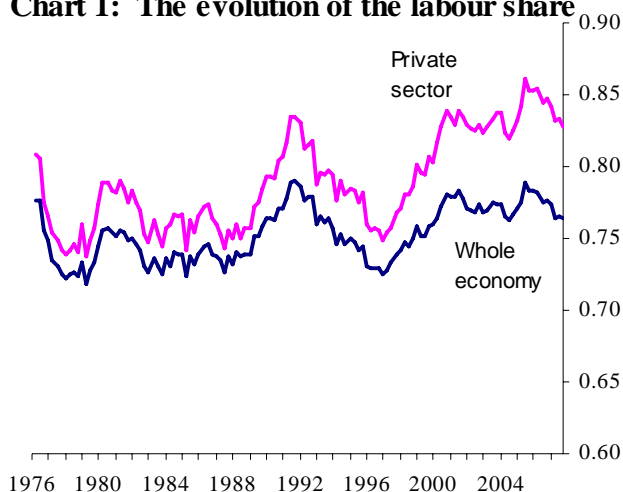
The next step is to relate movements in the labour share to the business cycle. Chart 2 again shows the private sector labour share over the period 1976 Q2 to 2007 Q4 but adds in the two recessions that have affected the United Kingdom during this time period: 1980 Q1 to 1981 Q1 and 1990 Q3 to 1991 Q3.[6] Chart 2 suggests that the labour share peaks at the trough of a recession, and falls in the ensuing expansion. That is, it appears to be countercyclical. This is given some mild confirmation by the fact that the correlation between the labour share and a dummy variable taking the value of unity in recessions and zero otherwise is 0.19 (close to the value obtained by Rotemberg and Woodford (1999) using US data). Unlike Rotemberg and Woodford, however, we find that the labour share is essentially uncorrelated with lagged values of this dummy variable. In addition, we can note that there has not been a recession in the United Kingdom since 1991, and the volatility of output has been greatly reduced, so it is harder to interpret the large 'cyclical' movements in the labour share since then.

Chart 2: Private sector labour share and UK recessions

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[6] We define a recession as at least two consecutive quarters of falling GDP.

Following Rotemberg and Woodford (1999), we carried out a more formal statistical analysis. In particular, we considered the correlation of the labour share with seven different measures of the cycle. Following Small (1997), three of these are from the *CBI Quarterly Industrial Trends Survey*: the percentage of firms reporting that their level of output is not below capacity; the percentage of firms reporting that their level of output is constrained by skilled labour shortages; and constrained by capacity (responses to questions 4, 14b and 14d respectively). The remaining four are: deviations of the log of market sector real value-added and the log of market sector total hours from HP-filtered trends; deviations of the log of market sector total hours from a linear trend; and growth in market sector real value-added. All data ran from 1976 Q2 to 2007 Q4. The results are reported in Table A.

Table A provides some evidence that the labour share is countercyclical. In particular, both the whole-economy and private sector labour shares are negatively contemporaneously correlated with all of our cyclical measures, with the exception of linearly detrended total hours where the correlation is positive in both cases. These results are in line with the findings of Rotemberg and Woodford (1999) for the United States. Trying to interpret the dynamic correlation results shown in Table A is not so straightforward. The CBI survey measures, together with the HP-filtered output measure, suggest that the labour share is negatively correlated with capacity from lags of two quarters to leads of three quarters, with the maximum negative correlations suggesting, tentatively, that the labour share leads capacity by anything between one and five quarters. The labour share is negatively correlated with current output growth; but, in this case, the evidence presented in Table A suggests that the labour share lags output growth by two quarters. The dynamic correlation of total hours with the labour share suggest the labour share is negatively correlated with, and leads, the cycle, whereas the dynamic correlation of linearly detrended total hours and the labour share suggests that it is positively correlated with, and lags, the cycle.

3.2 The cyclicality of other measures of the aggregate mark-up

But, in practice, the inverse of the labour share will not always be a good proxy of the mark-up. In particular, for more general, and possibly more realistic, production technologies, the mark-up will not be given by the inverse of the labour share since the elasticity of output with respect to labour will not be constant. Given this, we follow Rotemberg and Woodford (1999) and Balakrishnan and Lopez-Salido (2002) and derive some alternative measures of the mark-up.

Recall that the mark-up depends on the labour share, *s*, and the elasticity of output with respect to labour input, ε_{yh}. For a constant returns to scale production function in capital and labour, we can write this elasticity as a function of the capital-output ratio and the elasticity of substitution between labour and capital. To see this, consider the constant elasticity of substitution production function (in which θ represents labour-augmenting technical progress):

$$ y = \left(\alpha_k k^{1-\frac{1}{\sigma}} + \alpha_h \theta h^{1-\frac{1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{12} $$

Table A: Correlations of the labour share with cyclical indicators

	Percentage reporting output not below capacity	Percentage constrained by skilled labour shortages	Percentage constrained by capacity	HP-filtered private sector real value-added	Private sector real value-added growth rate	HP-filtered total hours worked	Linearly detrended total hours worked
Whole-economy labour share	-0.31	-0.29	-0.13	-0.36	-0.24	-0.11	0.14
Private sector labour share	-0.27	-0.26	-0.04	-0.30	-0.19	-0.11	0.14
Correlation of private sector labour share with leads and lags of cyclical indicator							
Lead six quarters	-0.20	-0.19	0.07	-0.29	0.07	-0.43	-0.05
Lead five quarters	-0.24	-0.24	0.03	-0.39	0.00	-0.46	-0.08
Lead four quarters	-0.26	-0.26	0.01	-0.36	-0.03	-0.39	-0.02
Lead three quarters	-0.28	-0.27	-0.01	-0.35	-0.04	-0.33	0.02
Lead two quarters	-0.29	-0.27	-0.03	-0.35	-0.09	-0.27	0.05
Lead one quarter	-0.29	-0.29	-0.05	-0.32	-0.06	-0.19	0.10
Lagged one quarter	-0.24	-0.22	-0.05	-0.22	-0.19	-0.02	0.18
Lagged two quarters	-0.20	-0.18	-0.03	-0.13	-0.21	0.08	0.21
Lagged three quarters	-0.14	-0.14	0.01	-0.03	-0.19	0.16	0.24
Lagged four quarters	-0.09	-0.08	0.05	0.05	-0.15	0.23	0.28
Lagged five quarters	-0.03	-0.02	0.09	0.12	-0.15	0.28	0.31
Lagged six quarters	-0.02	0.05	0.12	0.18	-0.13	0.32	0.33

In this case,

$$\varepsilon_{yh} = \frac{f_h(h,k)h}{y} = 1 - \frac{f_k(h,k)k}{y} = 1 - \alpha_k \left(\frac{y}{k}\right)^{\frac{1}{\sigma}-1} \tag{13}$$

Hence,

$$\mu = \left(1 - \alpha_k \left(\frac{y}{k}\right)^{\frac{1}{\sigma}-1}\right) \frac{Py}{Wh} \tag{14}$$

and, in terms of deviations from steady state

$$\hat{\mu} = \hat{\varepsilon}_{yh} - \hat{s} = \frac{1-\varepsilon_{yh}}{\varepsilon_{yh}} \frac{\sigma-1}{\sigma} \left(\hat{y} - \hat{k}\right) - \hat{s} = \frac{1-\mu s}{\mu s} \frac{\sigma-1}{\sigma} \left(\hat{y} - \hat{k}\right) - \hat{s} \tag{15}$$

We follow Rotemberg and Woodford (1999) in setting σ to 0.5. Given the results we report in Section 3.3 of this paper, we set the steady-state value of the mark-up to 1.2 (the value implied by the evidence we report in Section 3.3, below), implying a value of 0.47 for α_k.

Our second refinement is to suppose that firms have to hire 'overhead' labour; that is, they have to hire $\bar{h}$ units of labour regardless of the level of output produced.[7] Effective labour will now be given by $h - \bar{h}$ and the elasticity of output with respect to labour input by $\varepsilon_{yh} = \frac{h}{h-\bar{h}} \frac{f_h(h,k)h}{y}$.
Hence,

$$\mu = \frac{h}{h-\bar{h}} \left(1 - \alpha_k \left(\frac{y}{k}\right)^{\frac{1}{\sigma}-1}\right) \frac{Py}{Wh} \tag{16}$$

We again follow Rotemberg and Woodford (1999) and Balakrishnan and Lopez-Salido (2002) in setting $\frac{\bar{h}}{h}$ to 2/7 and, again, set the steady-state value of the mark-up to 1.2, implying, in this case, a value of 2.78 for α_k.

Our third refinement is to suppose that it is costly for firms to adjust their labour input. In this case, when firms hire more labour in response to an increase in demand today, they have to be mindful of both the cost of hiring these additional workers, and the potential cost of then having to reduce their workforce as demand returns to a more normal level in the future. In addition, firms may wish, rather than to pay these costs, to vary the intensity with which they work their current workforce. But this is likely to increase the marginal cost of producing extra output

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[7] As argued by Rotemberg and Woodford (1999), an alternative interpretation of this idea is that firms 'hoard' labour, employing a countercyclical fraction of their workforce in 'unproductive' activities, such as cleaning the factory or general maintenance of machinery.

anyway.[8] Either way, it would seem important to take account of labour adjustment costs when calculating the mark-up.

So following Pindyck and Rotemberg (1983), we suppose that, in addition to their wage bill, firms have to pay an adjustment cost equal to $\kappa h \phi\left(\dfrac{h}{h_{-1}}\right)$ where κ is the price of the inputs that must be purchased as part of the adjustment process and $\phi(\bullet)$ is a convex function with $\phi(1) = \phi'(1) = 0$. We assume that $\dfrac{\kappa}{W}$ is stationary.

In this case, we can write the mark-up as:

$$
\mu_t = \frac{\dfrac{h_t}{h_t - \bar{h}}\left(1 - \alpha_k\left(\dfrac{y_t}{k_t}\right)^{\frac{1}{\sigma}-1}\right)\dfrac{P_t y_t}{W_t h_t}}{1 + \dfrac{\kappa_t}{W_t}\left(\left(\phi\left(\dfrac{h_t}{h_{t-1}}\right) + \dfrac{h_t}{h_{t-1}}\phi'\left(\dfrac{h_t}{h_{t-1}}\right)\right) - E_t\left(\beta\left(\dfrac{h_{t+1}}{h_t}\right)^2 \phi'\left(\dfrac{h_{t+1}}{h_t}\right)\right)\right)}
\tag{17}
$$

(where β is the discount factor) and, in terms of deviations from steady state, as

$$
\hat{\mu}_t = \frac{1 - \mu s}{\mu s}\frac{\sigma - 1}{\sigma}\left(\hat{y}_t - \hat{k}_t\right) - \frac{\dfrac{\bar{h}}{h}}{1 - \dfrac{\bar{h}}{h}}\hat{h}_t - \xi\left(\hat{h}_t - \hat{h}_{t-1} - \beta E_t\left(\hat{h}_{t+1} - \hat{h}_t\right)\right) - \hat{s}_t
\tag{18}
$$

where $\xi = \phi''(1)\dfrac{\kappa}{W}$ and, following Rotemberg and Woodford (1999) we estimate two alternative measures of the mark-up with ξ set to four and eight, respectively.

Chart 3: Alternative measures of the mark-up

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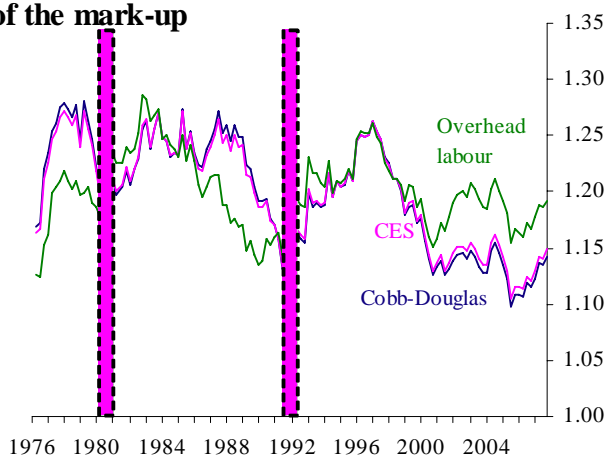
[8] One way that marginal cost might increase is if firms have to pay additional money to the workers over and above their negotiated wage to elicit the extra effort. 'Wage drift' – part of which represents payments made in compensation of varying work effort (ie overtime payments and merit-related pay increases) – has become an increasingly important part of total earnings in the United Kingdom in the past 20 years, suggesting that it is important to take this into account when calculating the mark-up.

Chart 3 shows the evolution of three of the mark-up measures based on a production function involving capital and labour: one based on a Cobb-Douglas production function (ie the inverse of the labour share), one based on a CES production function (see equation **(13)**) and one in which allowance is made for the presence of overhead labour (see equation **(15)**). In each case, the data runs from 1976 Q2 to 2007 Q4. As in Chart 2, the shaded areas show the two most recent recessions in the United Kingdom.

What is striking about Chart 3 is that the measure of the mark-up derived on the assumption of overhead labour seems to have risen over this time period while there is tentative evidence of falls in the other measures.[9] In the next subsection of the paper, we test econometrically whether or not the average mark-up between 1992 and 2003 was lower than that between 1970 and 1991 in different industries. In addition, we can note that the volatilities of our measures of the mark-up were not dramatically different after 1992 from what they were prior to 1992, although there is some evidence that their volatilities have decreased since 2000. This is in stark contrast to many macroeconomic variables (eg output and inflation), whose volatilities have fallen substantially since 1992: the period of the so-called 'Great Moderation'.

Leaving aside any changes in the average mark-up, though, these different measures appear to behave similarly over the cycle. In particular, they all fell in the quarters leading up to the recessions of 1980/81 and 1990/91 and rose in the following expansions, ie moved procyclically. Interestingly, the measure based on the assumption of overhead labour seemed to bottom out a year or so ahead of the 1990/91 recession and was actually rising at the time of the recession itself. Given this, it may be that this measure actually moves countercyclically; this is confirmed below. Again, it is hard to interpret the large 'cyclical' movements in the mark-up since 1992 as the UK economy has not seen a recession and the volatility of output has fallen dramatically; we take up this point below.

In all of these cases, we have assumed that firms use only capital and labour to produce output. But, in a small open economy such as the United Kingdom, a key component of costs will be the cost of imported raw materials, energy and intermediate goods. Equation **(6)** implies that we can write the mark-up as $\mu = \dfrac{P}{q_j} f_{x_j}(h, k, \mathbf{x})$ for any intermediate good j. But, again, we cannot observe the marginal product of these inputs so we need to make assumptions about the production function to go any further.

Balakrishnan and Lopez-Salido (2002) consider a constant returns to scale function in labour and imported intermediates of the form $y = \left(\alpha_M M^{1-\frac{1}{\sigma}} + \alpha_h (\theta h)^{1-\frac{1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$. In this case, we can write

---

[9] The rise in the 'overhead labour' measure is driven by the fact that employment has been much more stable since the late 1990s. The instability in employment acted to push down on the measure in the early part of our sample period with the result that it appears to have an upward trend in it.

$$\varepsilon_{yh} = \frac{f_h(h,M)h}{y} = 1 - \frac{f_M(h,M)M}{y} = 1 - \frac{\mu P_M M}{Py} = \frac{1}{1 + \dfrac{P_M M}{Wh}} = \frac{1}{1 + \left(\dfrac{\alpha_M}{\alpha_h}\right)^\sigma \left(\dfrac{P_M \theta}{W}\right)^{1-\sigma}} \tag{19}$$

Hence,

$$\mu = \frac{Py}{Wh\left(1 + \left(\dfrac{\alpha_M}{\alpha_h}\right)^\sigma \left(\dfrac{P_M \theta}{W}\right)^{1-\sigma}\right)} \tag{20}$$

and, in terms of deviations from steady state

$$\hat{\mu} = \hat{\varepsilon}_{yh} - \hat{s} = (1 - \mu s)(\sigma - 1)\left(\hat{P}_M - \left(\hat{W} - \hat{\theta}\right)\right) - \hat{s} \tag{21}$$

Following Balakrishnan and Lopez-Salido, we consider estimates of the mark-up derived from equation (**21**) with σ set to 1.3 and the steady-state mark-up again set equal to 1.2. We were careful to use a measure of the value of gross output rather than that of value-added when calculating the labour share as this is the price relevant for the theory. For the purposes of estimating this measure of the mark-up, we also assume that productivity follows a (log) linear trend with a rate of growth given by the average rate of growth of nominal wages less the rate of inflation of imported intermediate prices. Consequently, $\hat{\theta}$ is assumed to always equal zero.

Chart 4: 'Open-economy' measures of the mark-up
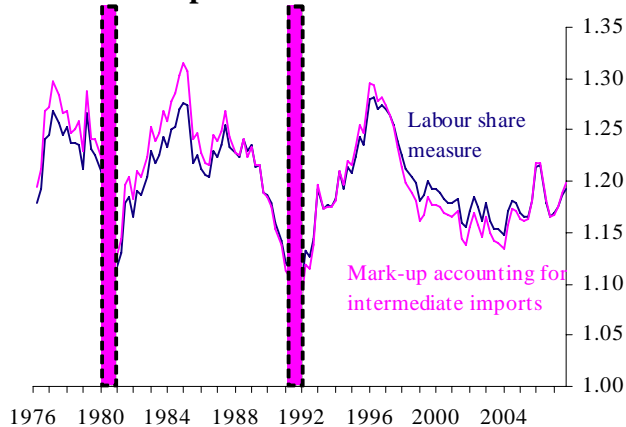
Chart 4 shows the evolution of two mark-up measures based on a production function involving labour and imported intermediates: one based on a Cobb-Douglas production function (ie the inverse of the labour share of gross output) and one based on a CES production function (see equation (**20**)). Again the data runs from 1976 Q2 to 2007 Q4. What is striking about this chart is that the measures seem near identical to each other. Again, they both appear to be clearly procyclical.

To examine more formally the cyclicality of our different measures of the mark-up, we

considered the correlation of our different measures of the mark-up with the capacity utilisation question in the CBI survey; that is, the cyclical level of output was associated with the percentage of firms not reporting that their level of output is below capacity. Table B shows that the measures of the mark-up based on standard Cobb-Douglas or CES production functions are positively correlated with contemporaneous capacity utilisation (as picked up in the CBI survey), that is, are procyclical. Furthermore, these measures suggest that the mark-up seems to lead the cycle by somewhere between three and six months. Against this, the measures that allow for overhead labour and costs of adjusting labour are countercyclical and seem to lag the cycle by about a year to a year and a half. These results are similar to, but not quite the same as, those found by Rotemberg and Woodford (1999, Table 2). Rotemberg and Woodford found that all these measures of the mark-up (except the 'Cobb-Douglas' measure) are countercyclical and lag the cycle by a year and a half. The differences in the findings may result from the cyclical variable chosen – they use expected declines in GDP – or may simply reflect differences between the United Kingdom and the United States. We intend to investigate this further in future work.

Table B: Cross-correlation of different mark-up measures with capacity utilisation

	Cobb-Douglas	CES in labour and capital	CES in labour and capital with overhead labour	CES in labour and capital with overhead labour and costs of adjusting labour $\xi = 4$	$\xi = 8$	CES in labour and imported intermediates
Lead six quarters	0.20	0.21	0.32	0.34	0.34	0.32
Lead five quarters	0.24	0.25	0.29	0.29	0.27	0.36
Lead four quarters	0.27	0.27	0.23	0.23	0.22	0.39
Lead three quarters	0.28	0.28	0.16	0.17	0.16	0.42
Lead two quarters	0.30	0.29	0.08	0.07	0.06	0.44
Lead one quarter	0.29	0.28	-0.01	-0.02	-0.03	0.45
Contemporaneous	0.27	0.26	-0.09	-0.09	-0.09	0.44
Lag one quarter	0.24	0.22	-0.20	-0.23	-0.23	0.38
Lag two quarters	0.20	0.17	-0.28	-0.29	-0.28	0.32
Lag three quarters	0.15	0.12	-0.37	-0.38	-0.35	0.23
Lag four quarters	0.09	0.06	-0.45	-0.45	-0.41	0.13
Lag five quarters	0.04	0.01	-0.49	-0.48	-0.43	0.02
Lag six quarters	0.00	-0.04	-0.51	-0.48	-0.42	-0.07

Note: Data run from 1976 Q2 to 2007 Q4.

One issue we did investigate is the extent to which these correlations may have altered since 1992 (since when there have been no recessions in the United Kingdom and the volatility of output has been much lower). Our results are shown in Table C. We find that, since 1992, all our measures of the mark-up are positively correlated with capacity utilisation (as picked up in the CBI survey) at all leads and lags up to six quarters. These findings strongly suggest that mark-ups are procyclical, in stark contrast to the Rotemberg and Woodford (1999) results. The question is how to interpret them. It could be that the lower volatility of capacity utilisation since 1992 makes these correlations harder to tie down. Or it could be that capacity utilisation itself (rather than the cycle *per se*) is what determines firms' mark-ups. Finally, it could be that mark-ups are unchanged but our measures are simply not capturing the increase in costs that comes from using capital more intensively at times of high capacity utilisation, while still

capturing the increase in prices. We leave a thorough investigation of these issues for further work.

Table C: Cross-correlation of different mark-up measures with capacity utilisation post-1992

	Cobb-Douglas	CES in labour and capital	CES in labour and capital with overhead labour	CES in labour and capital with overhead labour and costs of adjusting labour		CES in labour and imported intermediates
				$\xi = 4$	$\xi = 8$	
Lead six quarters	0.22	0.23	0.34	0.36	0.33	0.22
Lead five quarters	0.28	0.28	0.37	0.28	0.19	0.32
Lead four quarters	0.30	0.30	0.34	0.31	0.25	0.40
Lead three quarters	0.36	0.36	0.38	0.33	0.28	0.51
Lead two quarters	0.38	0.38	0.35	0.27	0.18	0.57
Lead one quarter	0.40	0.40	0.34	0.26	0.17	0.66
Contemporaneous	0.41	0.41	0.33	0.30	0.24	0.69
Lag one quarter	0.39	0.38	0.24	0.14	0.06	0.66
Lag two quarters	0.40	0.40	0.26	0.23	0.18	0.68
Lag three quarters	0.40	0.40	0.24	0.17	0.09	0.66
Lag four quarters	0.40	0.39	0.24	0.19	0.13	0.62
Lag five quarters	0.40	0.40	0.28	0.25	0.21	0.60
Lag six quarters	0.41	0.41	0.31	0.30	0.24	0.56

Note: Data run from 1992 Q1 to 2007 Q4.

3.3   The cyclicality of mark-ups in different sectors

In this subsection, we look at the cyclicality of mark-ups at the level of sectors and industries using the approach of Small (1997). Assume that the production function is given by $y = Af(h,k)$, where A represents total factor productivity. In this case, equation **(7)** implies that marginal costs can by approximated by:

$$MC = \frac{W\Delta h + rP\Delta k}{\Delta y - \frac{y}{A}\Delta A} \tag{22}$$

where $\Delta X = X_t - X_{t-1}$. This equation is not particularly useful to measure marginal cost, since some of the variables are unobservable, but we can rewrite it as:

$$\frac{\Delta y}{y} = \frac{Wh}{MCy}\frac{\Delta h}{h} + \frac{rPk}{MCy}\frac{\Delta k}{k} + \frac{\Delta A}{A} \tag{23}$$

If we assume constant returns to scale, approximate $\frac{\Delta x}{x}$ by the change in the log of x and rearrange, we obtain:

$$\Delta \ln\left(\frac{y_t}{k_t}\right) = \mu * s_t \Delta \ln\left(\frac{h_t}{k_t}\right) + \Delta \ln(A_t) \tag{24}$$

where μ is the average mark-up of price over marginal cost and s is the labour share.[10] To test the cyclicality of mark-ups we estimate a slightly modified version of this equation:

$$\Delta \ln\left(\frac{y_t}{k_t}\right) = (\mu + \mu_1 * cyc_t) * s_t \Delta \ln\left(\frac{h_t}{k_t}\right) + \Delta \ln(A_t) \tag{25}$$

where cyc_t is a measure of cyclical variation. The coefficient μ_1 in this equation shows the response of mark-ups to cyclical variation.

To estimate equations **(24)** and **(25)**, we use data from the Bank of England industry data set (BEID) for value-added, capital services, the labour share and hours worked for the industries in the market sector.[11] Our cyclical measures are, again, HP-filtered real market sector value-added, linearly detrended hours, HP-filtered hours and growth in real market sector value-added. Following Small (1997) we estimate equation **(24)** for each of the 31 industries as a system using three-stage least squares. This allows the individual industry average mark-ups to vary while taking into account that the errors may be correlated across equations, for example as a result of a common macroeconomic shock.

The results of this estimation are shown in Table D. We find that the mark-up is significantly greater than unity in thirteen industries, not significantly different from unity in a further seven, and significantly smaller than unity in eleven industries. In line with Small (1997), we find a relatively high mark-up in 'construction' and 'paper, printing and publishing'. In our results 'retailing' and 'business services', which were not separately identified by Small, also have higher relative mark-ups. Small found relatively lower mark-ups for 'textiles', 'metal products', 'chemicals' and 'motor vehicles'. We find similar results with the exception of 'chemicals'. However, our industry classification also includes 'pharmaceuticals', potentially less competitive than 'industrial chemicals', and so likely to have a higher mark-up.

Our results for the extraction industries suggest that the method outlined above may not be good for revealing the mark-ups in these industries. The low, or even negative, mark-ups in 'electricity and gas supply', 'waste treatment' and 'rail transport' may reflect the fact that for a large part of the sample period these industries were nationalised, and in some cases in receipt of government subsidy.

We tested the hypothesis that all industries had an average mark-up equal to unity, implying that all industries were competitive (or, at least, contestable), against an alternative hypothesis that the average mark-up was not equal to unity. A Wald test strongly rejects this null hypothesis. (We obtained a χ^2 value of 4967.84.) A Wald test of the null hypothesis that the average mark-up was the same in all industries was also rejected. (Here, we obtained a χ^2 value of 3369.81.)

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[10] The assumption of constant returns to scale may be strong. In particular, both 'overhead labour' and 'costs of adjusting labour' would imply a gross production function that exhibited increasing returns to scale.
[11] For a brief description of the BEID see Appendix B; Oulton and Srinivasan (2005) provides a complete description. We use the same 34 industries in our empirical analysis as they did in theirs except that we exclude public administration and defence, education and health and social work (industries 30, 31 and 32 in the BEID, respectively) so as to leave only the 'market sector'.

Table D: Estimates of the average mark-up by industry

Industries	Average mark-up
Agriculture	1.056 (0.346)*
Oil and gas extraction	-4.177 (0.490)**
Coal and other mining	0.082 (0.028)**
Manufactured fuel	0.480 (0.133)**
Chemicals and pharmaceuticals	1.219 (0.100)
Non-metallic mineral products	1.529 (0.052)
Basic metals and metal goods	1.550 (0.079)
Mechanical engineering	1.170 (0.142)*
Electrical engineering and electronics	0.909 (0.090)*
Vehicles	0.922 (0.064)*
Food, drink and tobacco	0.566 (0.047)**
Textiles, clothing and leather	0.792 (0.035)**
Paper, printing and publishing	1.886 (0.089)
Other manufacturing	1.644 (0.103)
Electricity supply	0.752 (0.059)**
Gas supply	-0.309 (0.056)**
Water supply	2.352 (0.156)
Construction	1.989 (0.120)
Wholesale, vehicle sales and repairs	1.479 (0.152)
Retailing	1.990 (0.087)
Hotels and catering	0.939 (0.104)*
Rail transport	-0.100 (0.039)**
Road transport	0.829 (0.045)**
Water transport	0.256 (0.125)**
Air transport	1.521 (0.071)
Other transport services	0.865 (0.111)*
Communication	1.272 (0.063)
Finance	1.228 (0.060)
Business services	1.751 (0.073)
Waste treatment	0.554 (0.100)**
Miscellaneous services	0.882 (0.187)*

Notes: Standard errors in parentheses. '*' indicates values that are not statistically different from unity; '**' indicates values that are significantly smaller than unity at the 5% significance level.

Using the results shown in Table D, we constructed an economy-wide estimate of the mark-up. To do this, we multiplied the average share in aggregate value-added of each industry over our full sample (1970–2003) by the average mark-up calculated for that industry. We found an average market sector mark-up of 1.2; that is why, when calculating the mark-up measures reported in Section 3.2 above, we set the average equal to this value.[12]

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[12] Britton *et al* (2000) report that the results in Small (1997) imply an estimate of the average mark-up of 1.4; using our approach and the mark-ups calculated here for equivalent sectors (shown in Table E, below) we obtain the same number, 1.4 for the average mark-up.

Next we tested the cyclical properties of the estimated mark-up in each industry. To do this, we first tried estimating equation **(25)** industry by industry. However, the standard errors were large and no coefficients were significant. So, instead, we followed Small (1997) in estimating the equations as a system using three-stage least squares and restricting the coefficient on the cyclical variable to be the same across industries. Table E shows the coefficients on the cyclical component of the mark-up. For HP-filtered private sector value-added and both hours measures, the coefficients are positive and significant. Conversely, the coefficient on real value-added growth is negative and significant. Apart from this anomaly, these findings are in line with Small (1997), *viz.* industry-level mark-ups are procyclical.

Table E: Estimates of the cyclicality of the mark-up

Cyclical indicator	Coefficient
HP-filtered GDP	1.301 (0.375)
Linearly detrended hours	3.830 (0.293)
HP-filtered hours	4.787 (0.314)
Real value-added growth	-0.066 (0.005)

Note: Standard errors in parentheses.

One interesting question is whether the average mark-up has changed over time. Increased competitive pressures over the period may have reduced the mark-up that firms are able to achieve. We test this by splitting our sample into two periods. The first period, 1970–91, covers the period over which Small (1997) estimated the mark-up. The second period, 1992–2003, covers the introduction of inflation targeting to the United Kingdom.

$$\Delta \ln\left(\frac{y_t}{k_t}\right) = (\mu_1 + \mu_2 * D_{92}) * s_t \Delta \ln\left(\frac{h_t}{k_t}\right) + \Delta \ln(A_t) \qquad \textbf{(26)}$$

We estimate equation **(26)** for the industries in our sample that approximate to those used by Small (1997). D_{92} is a dummy variable that takes the value of zero from 1970 to 1991 and unity thereafter. Hence, μ_1 in equation **(26)** should approximate to Small's average mark-up in each industry, although there will be some differences arising from classification changes and the use of alternative data sources. The results of this estimation can be found in Table F. For most industries our estimated average mark-up is close to that found by Small over the same period. We find that for all industries except 'air transport' and 'financial services', the average mark-up has decreased since 1992. A joint significance test across the system that all the coefficients μ_2 are equal to zero is rejected. (We obtained a χ^2 value of 125.67.) This suggests that average mark-ups have declined since 1992.

This result is robust to the choice of date for the dummy variable. Indeed, replacing D_{92} with a linear time trend over the whole sample period also results in a significant, negative, coefficient for most industries. A joint significance test across the system that all coefficients on the time trend are equal to zero is rejected (χ^2 value of 237.45).

Table F: Estimates of the mark-up, before and after 1992

Industries	Industry used in Small (1997)	Small (1997) estimate of mark-up	Our estimate of the mark-up pre-1992	Change in mark-up since 1992
Chemicals and pharmaceuticals	Chemicals	0.790 (0.313)	1.509 (0.230)	-0.217 (0.463)
Non-metallic mineral products	Other mineral products	1.147 (0.202)	1.606 (0.136)	-0.420 (0.367)
Basic metals and metal goods	Metal manufacturing	1.247 (0.233)	2.087 (0.238)	-0.317 (0.486)
Mechanical engineering	Mechanical engineering	1.535 (0.171)	1.886 (0.366)	-0.970* (0.492)
Electrical engineering and electronics	Electrical engineering	1.395 (0.255)	1.631 (0.315)	-0.344 (0.327)
Vehicles	Motor vehicles	1.141 (0.136)	1.271 (0.141)	-0.420 (0.250)
Textiles, clothing and leather	Textiles	0.862 (0.159)	1.388 (0.154)	-0.743 (0.209)**
Paper, printing and publishing	Paper, printing and publishing	1.950 (0.611)	2.219 (0.237)	-0.282 (0.392)
Construction	Construction	1.564 (0.249)	3.675 (0.372)	-1.831 (0.504)**
Wholesale, vehicle sales and repairs	Distribution and repairs	1.382 (0.329)	3.285 (0.350)	-0.844** (0.307)
Retailing			2.603 (0.254)	-0.176 (0.2621)
Hotels and catering	Hotels and catering	1.447 (0.342)	1.337 (0.183)	-0.143 0.235
Rail transport			1.876 (0.452)	-2.187** (0.468)
Road transport			1.500 (0.195)	-1.150** (0.309)
Water transport	Transport	1.459 (0.292)	1.664 (0.392)	-1.374** (0.422)
Air transport			1.421 (0.241)	1.091** (0.347)
Other transport services			1.465 (0.334)	0.283 (0.387)
Communication	Communications	1.826 (0.401)	2.038 (0.134)	-0.989** (0.155)
Finance	Finance	1.282 (0.260)	1.492 (0.184)	0.215 (0.351)

Notes: Standard errors in parentheses. '*' indicates values that are significant at the 5% level; '**' indicates values that are significant at the 1% level.

Although not the main purpose of our paper, it is interesting to consider why average mark-ups might have fallen since 1992. The average mark-up set by a particular producer will be inversely related to the degree of competition that he faces. So, our result on mark-ups suggests that competition has increased in most industries since 1992.

But what might have been driving this increase in competition? An obvious candidate is 'globalisation', specifically the expansion of the Chinese and Indian economies and their increasing importance in the world trading system. Chen *et al* (2007) suggests that globalisation leads to increased competition (and lower mark-ups) in the short run. However, in the long run, companies relocate to those countries where labour is cheaper and competition domestically is reduced. If this is happening in the United Kingdom at the moment, it may be that we will see a recovery in mark-ups to their pre-1992 values over the next decade or so.

Using data on import shares by industry to provide a rough metric for the degree of openness of each industry, we can examine the extent to which 'globalisation' might have contributed to the decline in mark-ups noted above.[13] The share of each industry's total output which is imported has generally risen since 1989, consistent with the view that the UK economy has become more open over this period. There is some evidence that the labour share has risen (or conversely, the mark-up has fallen) the most in industries which have experienced the largest increases in import shares, at least within the manufacturing sector, but differences in the changes in import share across industries do not seem to be strongly related to differences in the changes in mark-ups identified in Table F. However, it is important to note that our inability to find a strong negative correlation between changes in import shares and changes in mark-ups does not necessarily imply that globalisation has not been an important factor in driving mark-ups over the past two decades. Rather, it may merely reflect that our measure of globalisation – import shares – is too crude to capture the changes witnessed in the world economy over this period.

A fall in the mark-up (increase in competition) will also have implications for the slope of the Phillips curve. In the Rotemberg (1982) model, an increase in competition will increase the response of inflation to a given movement in the mark-up. The intuition is that higher competition not only reduces the mark-up, but also makes changing prices relatively cheaper. For a given level of menu costs, a higher elasticity of substitution between different goods lowers the net cost associated with adjusting prices. As the economy moves closer to perfect competition the size of the optimal price adjustment falls which makes price adjustments relatively cheaper for a firm when facing quadratic adjustment cost. This promotes price flexibility and increases the slope of the Phillips curve.

However, in the Calvo (1983) model, lower mark-ups (increased competition) will either have no effect or decrease the slope of the Phillips curve. In this model, relative prices can differ across firms due to price staggering. The effect of competition will then depend on whether there are real rigidities. Where there are common factor markets, a given firm has less incentive to lower its price when other firms lower theirs. So, in this case, the degree of competition among firms does not affect the slope of the NKPC. But, if factor markets are segmented, a firm's marginal cost depends on both average output and its own output (and hence its relative price). When adjusting its price, the firm will not want too large a difference in its price relative to the average, to avoid loss of market share. This strategic complementarity means that relative prices can be rigid in the goods market. In this case, higher competition among firms will lower price flexibility and so the slope of the Phillips curve will decrease. Sbordone (2007) considers a version of this model in which the number of varieties of traded goods affects the degree of strategic complementarity. She finds that an increase in variety leads to a fall in the mark-up, but an ambiguous effect on the slope of the Phillips curve. Her empirical results suggest that

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[13] These import shares are calculated from the Supply and Use Tables published with the 2006 *Blue Book*. Using data from Table 2, we calculate the ratio of imported goods and services within each industry to the total output (domestic and imported) of that industry. These data are not available prior to 1989.

globalisation, although it has led to lower mark-ups, is unlikely to have reduced the slope of the Phillips curve.[14]

4 The cyclicality of profit margins

In this section, we examine the cyclicality of profit margins. Profit margins can be variously defined. One measure is the rate of return on capital: that is, the ratio of total profits to the value of the capital stock. But due to the difficulty of obtaining capital *stock* data at the industry level, we instead focus here on the profit share: that is, the ratio of total profits to the value of output.

There are two ways of measuring the value of output: gross or net of intermediate inputs. Correspondingly, there are two measures of the profit share given respectively by:

$$\frac{Py - Wh - \mathbf{q}\mathbf{x}}{Py} \text{ or } \frac{Py - Wh - \mathbf{q}\mathbf{x}}{Py - \mathbf{q}\mathbf{x}} \tag{27}$$

Some algebra enables us to write these expressions in terms of the mark-up as:

$$\frac{Py - Wh - \mathbf{q}\mathbf{x}}{Py} = 1 - \frac{1}{\mu} + r\frac{k}{y} \text{ and } \frac{Py - Wh - \mathbf{q}\mathbf{x}}{Py - \mathbf{q}\mathbf{x}} = 1 - \frac{1}{1 + \frac{1 - \frac{1}{\mu} + r\frac{k}{y}}{s}} \tag{28}$$

We can see from equation **(28)** that the cyclicality of the profit share will depend on the cyclicality of the mark-up (μ), the cyclicality of the opportunity cost of capital and the capital-output ratio. In addition, when output is measured net of intermediate inputs, the cyclicality of the profit share will also depend on that of the labour share.

4.1 The market sector aggregate profit share

Chart 5 shows the two measures of the market sector profit share – total profits as a proportion of gross output and of gross value-added – for the period 1970–2003.[15] Both measures have fluctuated markedly during this time. But the noticeable falls in the mid-1970s, the early 1990s and, to a lesser extent, the late 1990s provide some tentative evidence that the profit share is procyclical.

The cyclical behaviour of the market sector profit share can be more formally assessed using the following simple regression:

$$m_t^{mkt} = \alpha + \beta.cyc_t^{mkt} + \varepsilon_t \tag{29}$$

---

[14] Using Sbordone's (2007) model and calibration (except that we use a value of 1.2 for the steady-state mark-up) we find that the increase in value-weighted varieties reported by Broda and Weinstein (2006) would imply a fall in the steady-state mark-up from 1.2 to 1.18, in line with our empirical results.
[15] These measures of the market sector profit share were calculated using data from the BEID: total profits, gross output and gross value-added were summed across the 31 market sector industries noted in footnote 5.

where m_t^{mkt} is one of the two measures of the market sector profit share from Chart 5 and cyc_t^{agg} is a cyclical indicator.[16] $\beta > 0$ would support the hypothesis that market sector profit margins are procyclical, while $\beta < 0$ would indicate countercyclical behaviour; $\beta = 0$ would suggest acyclicality.

Chart 5: The market sector profit share
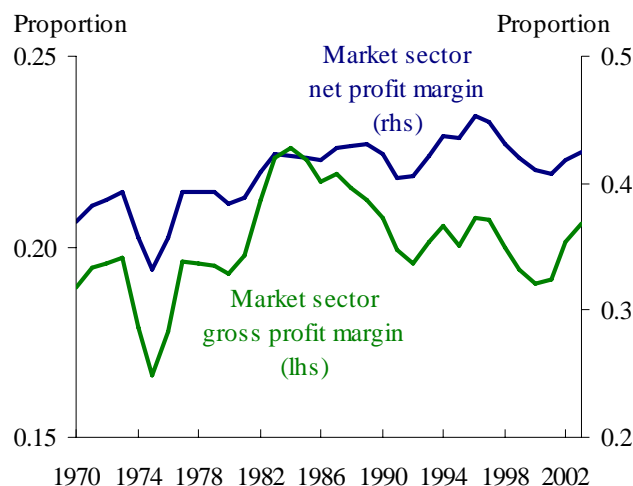
The results from these regressions, shown in Tables G(i) and G(ii), below, provide some evidence that the market sector profit share is procyclical: margins are positively correlated with five of the seven cyclical indicators, the exceptions being HP-filtered and linearly detrended hours. But these positive correlations are significant for only three of the seven indicators: market sector real value-added growth and the two CBI questions relating to capacity.[17] These results are broadly in line with Small (1997) which found, using pooled firm-level data, that profit margins are positively correlated with the CBI capacity questions. But in contrast to the results presented here, his measures of margins were also positively and significantly correlated with the number of firms from the CBI survey reporting their output to be constrained by labour shortages.

Table G(i): Estimates of the cyclicality of the profit share

	Measure of the market sector profit share							
	Net	Gross	Net	Gross	Net	Gross	Net	Gross
Constant	0.407**	0.201**	0.407**	0.201**	0.407**	0.201**	0.393**	0.194**
	(0.005)	(0.002)	(0.005)	(0.002)	(0.172)	(0.002)	(0.001)	(0.003)
HP-filtered GDP	0.124	0.034						
	(0.160)	(0.079)						
Linearly detrended hours			-0.192	-0.18**				
			(0.122)	(0.053)				
HP-filtered hours					-0.070	-0.097		
					(0.172)	(0.082)		
Real value-added growth							0.006**	0.003**
							(0.001)	(0.001)

Notes: Standard errors in parentheses. '*' indicates significance at the 10% level; '**' at the 5% level.

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[16] We use the same seven cyclical indicators as earlier: HP-filtered real private sector value-added, linearly detrended hours, HP-filtered hours, growth in real private sector value-added, and the three CBI questions.
[17] This is true for both measures of the market sector profit share and at both 5% and 10% significance levels.

Table G(ii): Estimates of the cyclicality of the profit share

	Measure of the market sector profit share					
	Net	Gross	Net	Gross	Net	Gross
Constant	0.364** (0.016)	0.180** (0.008)	0.421** (0.009)	0.206** (0.005)	0.376** (0.012)	0.190** (0.006)
CBI Q4: firms reporting capacity constraints	0.001** (0.000)	0.001** (0.000)				
CBI Q14b: firms reporting output constrained by labour shortages			-0.001 (0.001)	0.000 (0.000)		
CBI Q14d: firms reporting output constrained by capacity					0.002** (0.001)	0.001* (0.000)

Notes: Standard errors in parentheses. '*' indicates significance at the 10% level; '**' at the 5% level.

Appendix C contains charts plotting our two measures of market sector margins against each of the seven cyclical indicators. These charts suggest one reason why the correlations are not significant in a greater number of cases: market sector margins followed an upward trend over the period 1970–2003 and this could have obscured higher-frequency variation in the profit share.[18] Given that our earlier evidence suggests the mark-up to have been falling over this period, and that we would not expect the opportunity cost of capital to trend either up or down, equation **(28)** suggests that the upward movement in profit margins must have resulted from a rise in the capital-output ratio. And indeed this is in line with what happened to the capital-output ratio during this period. The other problem is the lack of a clear cycle in the data post-1992.

The charts also suggest that margins rose from about 1992 until about 1997 before falling thereafter.[19] Although the CBI question on capacity utilisation follows this pattern, some of our cyclical indicators (eg GDP growth) suggest that the economy troughed in about 1993 and did not reach a peak until about 2000. The fall in margins after 1997 was almost certainly a result of the large rise in the sterling effective exchange rate between 1996 and 1998. This rise meant that our exporters needed to accept a lower price in sterling in order to remain competitive abroad.

4.2 Profit margins in different sectors

Given that there is some evidence that the market sector profit share is procyclical, an obvious question is whether this result is common to all industries or, conversely, whether there are any particular industries or sectors which are driving this result. To investigate this issue, we re-ran

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[18] Of course, another reason could simply be that we do not have very good measures of the cycle. Furthermore, as we said earlier, the past decade has been a period of remarkable stability and this could have limited the identifying variation in our cyclical indicators.
[19] Similar movements in mark-ups occurred during this period, as can be seen in Charts 3 and 4.

the above regression using disaggregated data, ie we replaced the market sector profit share in equation **(29)**, m_t^{mkt}, by the industry/sector profit share, m_t^i, where i indexes the industry/sector:

$$m_t^i = \alpha + \beta^i.cyc_t^{mkt} + \varepsilon_t \tag{30}$$

We again use data from the BEID to estimate equation **(30)**, first taking the 31 market sector industries individually, and then aggregating them together into sectors to broadly match the SIC80 classification used by Small (1997).[20]

Turning first to results at the industry level, there is some evidence that procyclical profit margins are common to all industries: the β coefficients are generally positive and, with the exception of 'gas supply' and 'rail transport', there is at least one significant positive correlation with at least one of the cyclical indicators in every industry.[21] As was the case for the aggregate market sector profit share, these significant correlations are predominantly with the two capacity-related CBI questions and real value-added growth.

Appendix D contains charts graphing profit margins in each industry against the percentage balance of firms reporting capacity constraints in the CBI survey. These charts again suggest that margins within industries are more cyclical than might be supposed given our regression results: as with the aggregate market sector profit share, lower-frequency movements in profit margins seem to dominate the cyclical variation, such that margins in most industries end the sample period at a very different level to that at which they started. In some industries (eg 'water supply', 'wholesale, vehicle sales and repairs', 'retailing') margins moved gradually over time while in others (eg 'electricity supply', 'gas supply', 'rail transport' and 'water transport') margins were subject to a structural break at some point during the 1990s.

That said, the charts do suggest that margins in many of the industries moved the same way in the 1990s as the aggregate market sector profit share, that is, they rose from about 1992 to 1997 before falling in response to the rise in sterling. These movements occurred in a large number of industries, but seem to be most pronounced in the export sectors – consistent with the exchange rate explanation outlined above.[22] It also appears that this countercyclical behaviour persisted in a subset of the economy beyond the GDP growth peak in 2000: the charts suggest that margins in some industries hit a trough shortly after the turn of the century and then rose as the economy receded from its peak. But in contrast to the previous period of countercyclicality,

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[20] Three-stage least squares estimation was used for the sectoral regressions, but lack of sufficient observations precluded its use for the industry-level data.

[21] Results are available on request. The negative correlations occur predominantly with the two hours-based cyclical indicators. The 'manufactured fuel' industry does not quite fulfil this exception: profits as a share of gross output in this industry are significantly positively correlated (*p*-value of 5.4) with CBI Q14b (output constrained by labour shortages); but this is the only positive and significant correlation.

[22] The industries in which margins most obviously peak before the cycle are: agriculture; oil and gas; coal and other mining; all of the manufacturing industries bar manufactured fuel; construction; wholesale, vehicle sales and repairs; retailing; hotels and catering; rail transport; water transport; air transport; finance; business services; waste treatment; and miscellaneous. Batini, Harrison and Millard (2001), following De Gregorio, Giovannini and Wolf (1994) define the export industries as: manufacturing; transport and communications; agriculture, forestry and fishing; and metal extraction and minerals.

the industries affected are not it seems concentrated within the export sector.[23] Indeed, there does not appear to be one single simple explanation for these movements, so it could be that industry-specific factors are driving margins during this period instead.

The difficulty in separating cyclical movements in margins from trend movements might be overcome by looking at a less disaggregated level. In fact, Small found highly significant procyclicalities at the sectoral level. To investigate this possibility, we aggregated our BEID industries to match, as near as possible, the SIC80 one-digit classification used by Small and then repeated the regressions.[24]

Table H: Results at the sectoral level

	SIC80 sector							
	Metals and chemicals (2) Measure of the profit share		Engineering (3) Measure of the profit share		Other manufacturing (4) Measure of the profit share		Retailing (6) Measure of the profit share	
	Net	Gross	Net	Gross	Net	Gross	Net	Gross
HP-filtered GDP	0.1859	0.0652	0.1035	0.0120	0.2733	0.1179**	0.2957**	0.1525
	(0.1522)	(0.0900)	(0.2857)	(0.0690)	(0.0987)	(0.0503)	(0.0942)	(0.1431)
Linearly detrended hours	-0.1408	-0.1350**	0.0391	-0.0812	-0.0248	-0.0109	0.0368	0.0224
	(0.1198)	(0.0674)	(0.2248)	(0.0525)	(0.0857)	(0.0425)	(0.0838)	(0.1142)
HP-filtered hours	0.0445	-0.0384	-0.0644	-0.0778	0.1142	0.0472	0.1285	0.0310
	(0.1660)	(0.0967)	(0.3056)	(0.0726)	(0.1151)	(0.0573)	(0.1121)	(0.1553)
Real value-added growth	0.0046**	0.0026**	0.0070**	0.0027**	0.0045**	0.0018**	0.0046**	0.0011
	(0.0016)	(0.0009)	(0.0030)	(0.0006)	(0.0009)	(0.0005)	(0.0009)	(0.0015)
CBI Q4: firms reporting capacity constraints	0.0014**	0.0008**	0.0014*	0.0005**	0.0012**	0.0005**	0.0010**	0.0003
	(0.0003)	(0.0002)	(0.0007)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0003)
CBI Q14b: firms reporting output constrained by labour shortages	-0.0003	-0.0005	-0.0010	-0.0001	0.0003	0.0000	0.0004	0.0013**
	(0.0006)	(0.0003)	(0.0011)	(0.0003)	(0.0004)	(0.0002)	(0.0004)	(0.0004)
CBI Q14d: firms reporting output constrained by capacity	0.0030**	0.0015**	0.0043**	0.0012**	0.0025**	0.0010**	0.0020**	0.0004
	(0.0007)	(0.0004)	(0.0014)	(0.0003)	(0.0004)	(0.0003)	(0.0005)	(0.0007)

Notes: Standard errors in parentheses. '*' indicates significance at the 10% level; '**' at the 5% level.

Again, the results were mixed. In line with Small, we found that margins in the 'metals', 'engineering', 'manufacturing' and 'retailing' sectors are all positively correlated with the capacity questions from the CBI survey. Furthermore, the coefficients are similar across

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[23] The industries in which a trough in margins shortly after 2000 is most apparent are: agriculture; oil and gas; manufactured fuel; chemicals and pharmaceuticals; non-metallic mineral products; paper, printing and publishing; water supply; construction; hotels and catering; road transport; water transport; finance; waste treatment; and miscellaneous services.

[24] This matching of industries to sectors was relatively straightforward, with the exception of 'basic metals and metal goods' (BEID industry 7). This industry should be split between the 'extraction and manufacturing' and 'engineering, vehicles and metal goods' sectors (sectors 2 and 3). But an absence of data to inform this split forced us to include it, in its entirety, in sector 2.

industries, corroborating Small's conclusion that 'there are only relatively minor differences in the behaviour of firm profit margins over the business cycle in the various sectors of manufacturing and in retailing'.[25] But in contrast to Small, the correlations with CBI question Q14b (the percentage balance of firms reporting output constrained by labour shortages) are insignificant and, on the most part, negative too. Of the other cyclical indicators, only real value-added growth provides strong evidence that margins are procyclical across sectors. Table H below summarises these results. As was the case at both the aggregate market sector and industry levels, the lack of significant positive correlations between profit margins across sectors and the cyclical indicators seems mostly due to lower-frequency movements in margins.

Given that there is some – albeit limited – evidence that margins are procyclical at the sectoral level, it is interesting to ask whether cyclical changes at the sectoral level influence sectoral profit margins above and possibly beyond cyclicalities at the collective, market sector, level. To investigate this possibility, we used the BEID data to calculate the four non-CBI cyclical indicators at the sectoral level and re-estimated the above regressions to include them:

$$m_t^i = \alpha + \beta.cyc_t^{mkt} + \gamma.cyc_t^i + \varepsilon_t \tag{31}$$

The results were inconclusive. For both of the cyclical indicators based on hours, it appears that movements at the sectoral level are more important in driving sectoral profit margins than movements in the aggregate. But in the case of real value-added growth, it is movements at the total market sector level which are dominant. When the cyclical indicator is deviations of output from an HP-filter there is no clear pattern.

A further question is how industry-level cyclicality of margins is affected by the degree of competitiveness: that is, are margins more or less procyclical in industries which are more competitive? The answer to this question must reflect how the cyclicality of other variables, not least the relative degree of wage and price stickiness, varies with the degree of competitiveness. Earlier research for the United States (Domowitz *et al* (1986)) finds that margins are more procyclical in concentrated industries.[26] But we are unaware of any similar study using UK data.

Unfortunately, our data set does not include typical measures of competitiveness, such as the four-firm concentration ratio. Nor can we obtain these data at a consistent level of disaggregation. So we instead use the average level of profit margins, calculated over the whole sample period 1970–2003, as our indicator of the degree of competition within industries. And we compare these to the β's obtained in our estimates of equation **(30)** above.

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[25] Small (1997, page 19).

[26] Domowitz *et al* (1986) use a panel data set covering most of the US manufacturing sector at a highly disaggregated level. Their measure of margins is what we have defined here as the gross profit margin. But their cyclical indicators are different: they use the whole-economy unemployment rate as an indicator of aggregate cyclical conditions; and they take the percentage change in industry output as an indicator of industry cyclical conditions.

Table I presents the correlation between average margins at an industry level and various cyclical indicators.[27] The results suggest that the cyclicality of margins across industries is weakly, if not negatively, related to the degree of competitiveness as measured by average *net* profit margins. But there is some evidence that margins are more cyclical when the average *gross* profit margin is higher. That suggests that input costs are more cyclical in more competitive industries.[28] We intend to examine in further work whether these results are sensitive to the sample period used: Domowitz *et al* (1986) found that concentration only affected the degree of cyclicality of margins in the period 1970–81 and not in the earlier period 1958–69.

Table I: Correlations between competitiveness and cyclicality of margins across industries

	Correlation between βs and average profit margins							
	Whole-economy		Market sector		Coefficients significant at the 10% level only		Coefficients significant at the 5% level only	
Cyclical indicator	Net	Gross	Net	Gross	Net	Gross	Net	Gross
HP-filtered GDP	-0.030	0.619	-0.070	0.633	-0.377	0.876	-0.568	0.898
CBI Q4: firms reporting capacity constraints	-0.092	0.371	-0.257	0.369	0.101	0.711	0.055	0.584
CBI Q14d: firms reporting output constrained by capacity	0.044	0.481	-0.091	0.477	-0.048	0.739	-0.237	0.740

5 Conclusions

In this paper, we assessed the cyclicality of mark-ups and profit margins within the United Kingdom, at both the aggregate and industry level.

Turning first to mark-ups, our finding that the private sector labour share moves countercyclically suggests that the aggregate mark-up moves procyclically. This result is in line with evidence from the United States. But in contrast to studies using US data, we found that more sophisticated measures of the mark-up that departed from the assumption of Cobb-Douglas production and/or took into account the openness of the UK economy also move procyclically. This corroborates the results from other work using UK data; for example Balakrishnan and Lopez-Salido (2002) found that, when calculated using UK data, the various measures of the mark-up all look quite similar.[29] Against this, we also found that measures that

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[27] HP-filtered GDP was selected because it is the indicator for which the correlation between average margins and βs across the four *sectors* is highest. The two CBI questions were chosen because they were the indicators that most strongly suggested that margins are procyclical, as measured by the number of significant positive correlations.

[28] This result seems intuitive to us: in more competitive industries, with lower average margins, firms have less of a buffer between cost and price. So in order for production to remain profitable, input costs must fall when the cycle worsens and prices fall. But firms in less competitive industries have a larger cushion to offset falling prices and so the need to reduce input costs is lessened. Thus input prices are more cyclical the more competitive is the industry.

[29] In the case of the mark-up calculated using the 'open-economy' production function, this is because the degree of substitution between labour and imported intermediates is close to unity.

allow for overhead labour and costs of adjusting labour are countercyclical and seem to lag the cycle by about a year to a year and a half. Industry-level data support the idea that the mark-up is procyclical: when mark-ups are calculated at this more disaggregated level and the degree of cyclicality is restricted to be equal across industries, we still find that mark-ups move positively with the cycle.

We find that the level of mark-ups does vary widely throughout the economy: a Wald test easily rejected the hypothesis that the average mark-up over the period 1970–2003 was equal across all industries. Our results suggest that firms have some degree of market power in thirteen of our industries, spread across both the manufacturing and service sectors.[30] But we also find some evidence that the private sector mark-up has trended down since the 1970s, perhaps reflecting increased competitive pressures.

Our findings on the cyclicality of profit margins largely replicate those for mark-ups: the results suggest that the aggregate market sector profit share moves procyclically and that the cyclical behaviour of profit shares is largely homogenous across industries. In particular, we did not find strong evidence that margins are more procyclical in less competitive industries. In tandem with these cyclical movements, we also found that the market sector profit share has trended upwards since 1970. This is in contrast to the downward movement in the aggregate mark-up observed over the same period. The explanation for this divergence seems to be that the marked rise in the capital:output ratio outweighed the fall in the mark-up.

Both mark-ups and margins started to fall in 1997, in line with the CBI survey measure of capacity utilisation, whereas GDP growth did not peak until 2000. That the fall in margins occurred more in the export-intensive industries suggests that the explanation lies in firms trying to remain competitive in the face of the large appreciation in sterling from 1996 to 1998.

Understanding the dynamics of mark-ups and margins is crucial to understanding the dynamics of inflation. If, as our results suggest, mark-ups do move procyclically then it must be either that *desired* mark-ups move procyclically or that wages are stickier than prices. Trying to distinguish between these alternatives seems like a useful avenue for future work. Alternative approaches to looking at the relative degree of wage and price stickiness include examining the cyclical behaviour of real wages and how real wages react to demand, and other, shocks. In addition, one could survey firms to find out how wages and prices are set in practice and how often they are reviewed and/or changed.[31]

If desired mark-ups do move procyclically, this will have ramifications for how we might expect the economy to respond to shocks. In particular, a demand shock will lead to a rise in mark-ups whereas a supply shock, such as a rise in costs, that caused current sales to fall temporarily, would lead firms to reduce their desired mark-ups. And, this reduction in desired mark-ups would lead to a delaying of the pass-through of the rise in costs into an increase in inflation.

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[30] Estimating mark-ups over the reduced sample period from 1970 to 1991, our results are broadly comparable to Small (1997).

[31] Such a survey is currently being planned by the ECB's Wage Dynamics Network. See www.ecb.int/home/html/researcher_wdn.en.html.

Appendix A: Construction of the mark-up measures used in Sections 3.1 and 3.2

This appendix describes how we construct the different measures of the aggregate mark-up which we discuss in Sections 3.1 and 3.2. All four-letter codes refer to data published by National Statistics.

To construct the measures of labour share used in Sections 3.1 and 3.2 we start with the series *DTWM*, which is the compensation of employees over the whole economy including the value of social contributions payable by the employer. As suggested by Batini *et al* (2000), we adjust this series to include that part of the remuneration of the self-employed that represents a payment for their labour (rather than a return on their capital). We do this by multiplying *DTWM* by $\frac{MGRZ}{MGRZ - MGRQ}$ where *MGRZ* is 'Employment' from the *Labour Force Survey* and *MGRQ* is 'Self-employed' from the *Labour Force Survey*. Since *MGRQ* is only available from 1992 Q2, we project this series back using *DYZN* prior to 1992 Q2.

To obtain a measure of the whole-economy labour share, we then need to divide this by a measure of GDP. We use GDP at basic prices (in current prices), which is given by GDP at market prices, *YBHA*, less the basic price adjustment, *NTAP*. We also follow Harrison *et al* (2005) and subtract off expenditure on actual and imputed rents as these do not represent produced output. The formula we use to calculate these is: $\frac{QTPS_{\bar{t}} GDQL}{400} \frac{GBFJ + ZAVP}{GBFK + ZAVQ}$ where $\bar{t}$ is the year of the most recent National Accounts rebasing, *QTPS* is 'Letting of dwellings' in current prices, *GDQL* is a chained-volume index of the 'Ownership of dwellings', *GBFJ* is 'Imputed rentals for housing' in current prices, *ZAVP* is 'Actual rentals for housing' in current prices, *GBFK* is a chained-volume measure of 'Imputed rentals for housing' and *ZAVQ* is a chained-volume measure of 'Actual rentals for housing'.

Hence, our formula for the whole-economy labour share is:

$$\frac{DWTM \dfrac{MGRZ}{MGRZ - MGRQ}}{YBHA - NTAP - \dfrac{QTPS_{\bar{t}} GDQL}{400} \dfrac{GBFJ + ZAVP}{GBFK + ZAVQ}} \tag{A1}$$

But, this measure of the labour share is likely to be misleading from the point of view of mark-ups in the economy since both the numerator and denominator will be affected by the contribution of the public sector. To do this, we need to subtract the compensation of employees paid by general government from the numerator and the amount of value-added attributable to the government from the denominator. For 'Compensation of employees paid by general government' we use a seasonally adjusted version of *NMXS*. For the amount of value-added attributable to the government, we use 'General government final consumption expenditure', *NMRP*.

Hence, our measure of private sector labour share will be given by:

$$\frac{(DWTM - NMXS(SA))\dfrac{MGRZ}{MGRZ - MGRQ}}{YBHA - NTAP - \dfrac{QTPS_{\bar{t}}GDQL}{400}\dfrac{GBFJ + ZAVP}{GBFK + ZAVQ} - NMRP} \tag{A2}$$

To go from the labour share measure of the mark-up to the measure given by equation **(14)** we need data on private sector value-added and private sector capital. For private sector value-added in current prices we could use the denominator of equation **(A2)**:

$$YBHA - NTAP - \frac{QTPS_{\bar{t}}GDQL}{400}\frac{GBFJ + ZAVP}{GBFK + ZAVQ} - NMRP \tag{A3}$$

To get to a real measure of private sector value-added, we start with a chained-volume index of GDP at basic prices, *ABMM*, and, again, subtract off expenditure on actual and imputed rents as these do not represent produced output. The formula we use to calculate these is: $\dfrac{QTPS_{\bar{t}}GDQL}{400}$ where $\bar{t}$ is the year of the most recent National Accounts rebasing, *QTPS* is 'Letting of dwellings' in current prices and *GDQL* is a chained-volume index of the 'Ownership of dwellings'. Finally, we subtract off general government final consumption expenditure, *NMRY*. Our resulting measure is given by:

$$ABMM - \frac{QTPS_{\bar{t}}GDQL}{400} - NMRY \tag{A4}$$

This is the 'volume' analogue of the 'value' measure given by equation **(A3)**.

For private sector capital, we used the measure of 'capital services' described in Oulton and Srinivasan (2003). It takes into account the composition of capital by weighting together stocks of different assets using their rental prices to calculate the weights. Seven assets are used in total: buildings and structures, plant and machinery, transport equipment, intangibles, computers, software, and telecommunications equipment.

To obtain the mark-up measure given by equation **(16)**, we need data on employment and $\bar{h}$. For employment, we simply use *MGRZ*. To obtain an estimate of $\bar{h}$, we simply use a Hodrick-Prescott filter to obtain a 'trend employment' series and set $\bar{h}$ equal to 2/7 times this. For the measure given by equation **(17)**, we again use *MGRZ* as the employment series.

Finally, to obtain the mark-up measure given by equation **(20)**, we need data on the price of imported intermediates and the wage, adjusted for productivity growth. To obtain a series on the price of imported intermediates, we follow Harrison *et al* (2005) and apply the following formula:

$$P_M = \frac{IKBI - 0.798BQAR - 0.498ENGD - ENGE - 0.369IKBC - ENGG}{IKBL - 0.798BPIA - 0.498ENGT - ENGU - 0.369IKBF - ENGW} \tag{A5}$$

where *IKBI* (*IKBL*) is total imports of goods and services in current (constant) prices, *BQAR* (*BPIA*) is imports of food, beverages and tobacco in current (constant) prices, *ENGD* (*ENGT*) is imports of cars in current (constant) prices, *ENGE* (*ENGU*) is imports of consumer goods other than cars in current (constant) prices, *IKBC* (*IKBF*) is imports of services in current (constant) prices and *ENGG* (*ENGW*) is directly imported business investment in current (constant) prices.

For private sector wages, we start with wages and salaries, *ROYJ*, and make the same adjustment to capture self-employed. For government wages, we subtract total employers' social contributions in the general government sector, *NMXR*, from total government sector compensation, *NMXS*, and seasonally adjust the resultant series. Hence, the private sector wage bill will be given by $\dfrac{(ROYJ - (NMXS - NMXR)_{SA})MGRZ}{MGRZ - MGRQ}$ and dividing this by *MGRZ* gives wages per head, $W = \dfrac{(ROYJ - (NMXS - NMXR)_{SA})}{MGRZ - MGRQ}$. As we said in the main text, we simply assumed that labour-augmenting productivity follows a (log) linear trend with a rate of growth given by the average rate of growth of *W* less the rate of inflation of P_M.

We also recalculated the labour share as the share of gross output rather than value-added. To obtain the value of gross output, we simply added total imports of goods and services in current prices, *IKBI*, to the private sector value-added measure shown in equation **(A3)**.

Finally, for 'total hours worked' – which we used as one of our cyclical variables – we were forced to use the whole-economy series: *YBUS*.

Appendix B: The Bank of England industry data set (BEID)

The data used in calculating mark-ups and margins at the industry, sectoral and market sector level, all come from the Bank of England industry data set (BEID). This data set, described in more detail in Oulton and Srinivasan (2005), covers the period 1970–2003. It contains annual data for 34 industries spanning the whole economy. For each industry, there are data in both nominal and real terms on gross output, value-added, profits, inputs of capital services and intermediates, and hours worked. Thus mark-ups and margins can be calculated on a consistent basis.

The capital services series are, again, constructed as described in Oulton and Srinivasan (2003), using rental prices to weight together stocks of seven assets: buildings and structures, plant and machinery, transport equipment, intangibles, computers, software, and telecommunications equipment.

The real intermediate index is a weighted average of purchases from other industries and from imports.

The BEID is constructed, where possible, from series produced by the Office for National Statistics. Furthermore, it is – prior to two adjustments being made – consistent with the official UK National Accounts (as given in the 2005 *Blue Book*) in real and nominal terms. The first adjustment is that series for real investment in computers and software are derived using US price indices, converted into sterling terms. The second adjustment is that the official level of software investment is adjusted upwards, as discussed in Oulton (2002). Additionally, the banking sector carries a larger weight in the data set than in the official data because the (negative) 'adjustment for financial services' is excluded.[32]

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[32] This modification is in line with changes recommended in ESA95.

Appendix C: Charts of private sector profit margins and cyclical indicators

Chart C1: Private sector profit margins and HP-filtered real value added

Deviation from HP-filter

Per cent

HP-filtered real value added (lhs)

Private sector GOS/GVA (rhs)

Private sector GOS/GO (rhs)
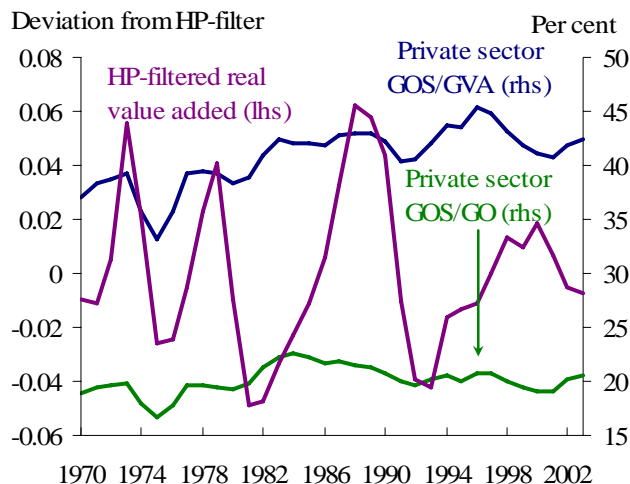
Chart C2: Private sector profit margins and HP-filtered hours

Deviation from HP-filter

Per cent

Private sector GOS/GVA (rhs)

HP-filtered hours (lhs)

Private sector GOS/GO (rhs)
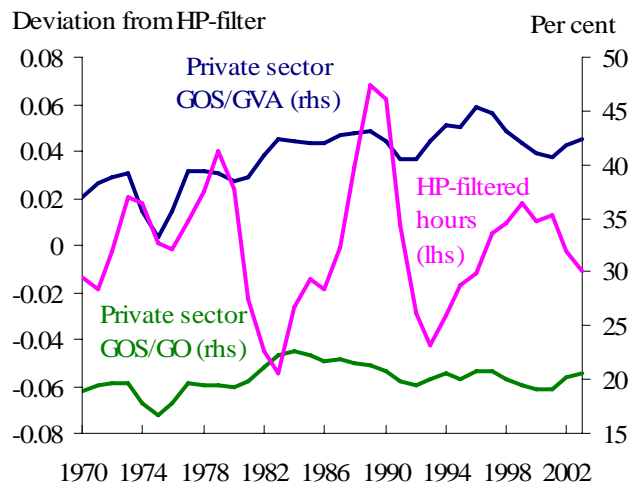
Chart C3: Private sector profit margins and linearly detrended hours

Deviation from linear trend

Per cent

Private sector GOS/GVA (rhs)

Private sector GOS/GO (rhs)

Linearly detrended hours (lhs)
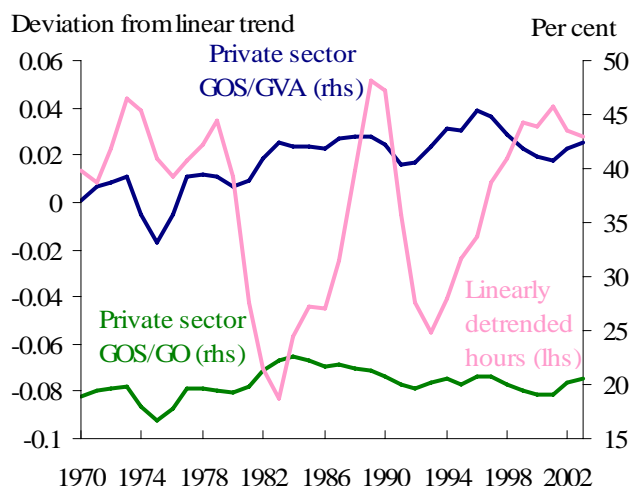
Chart C4: Private sector profit margins and real value added growth

Percentage changes on a year earlier

Per cent

Private sector GOS/GVA (rhs)

Real valued added growth (lhs)

Private sector GOS/GO (rhs)
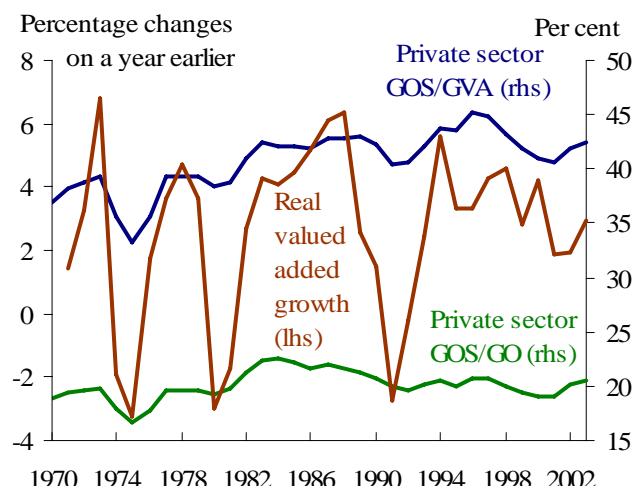
Chart C5: Private sector profit margins and the percentage balance of firms operating above capacity (CBI Q4)
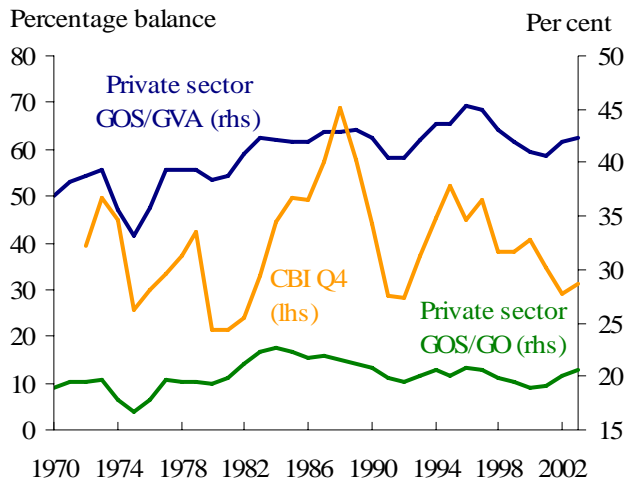
Chart C6: Private sector profit margins and the percentage balance of firms whose output is constrained by labour shortages (CBI Q14b)
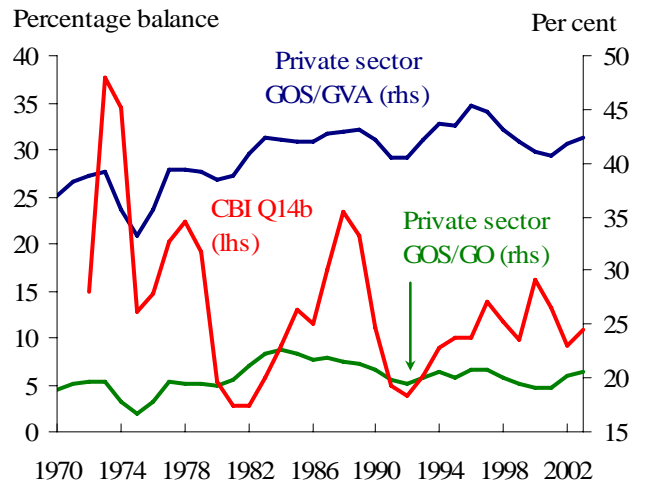
Chart C7: Private sector profit margins and the percentage balance of firms whose output is constrained by capacity (CBI Q14d)
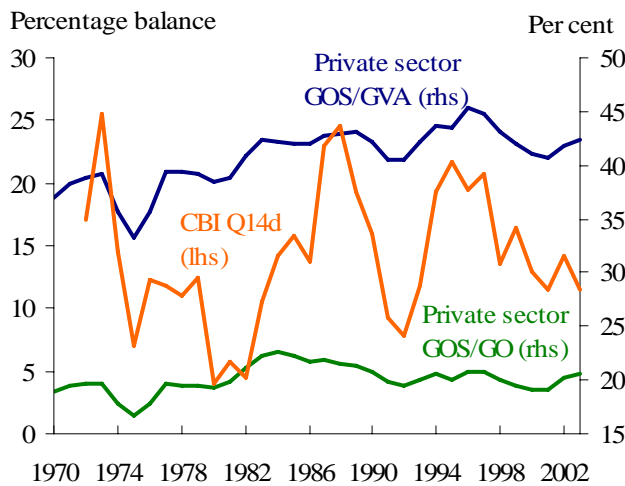
Appendix D: Charts of private sector profit margins by BEID industry and the percentage balance of firms operating above capacity (CBI Q4)

Key

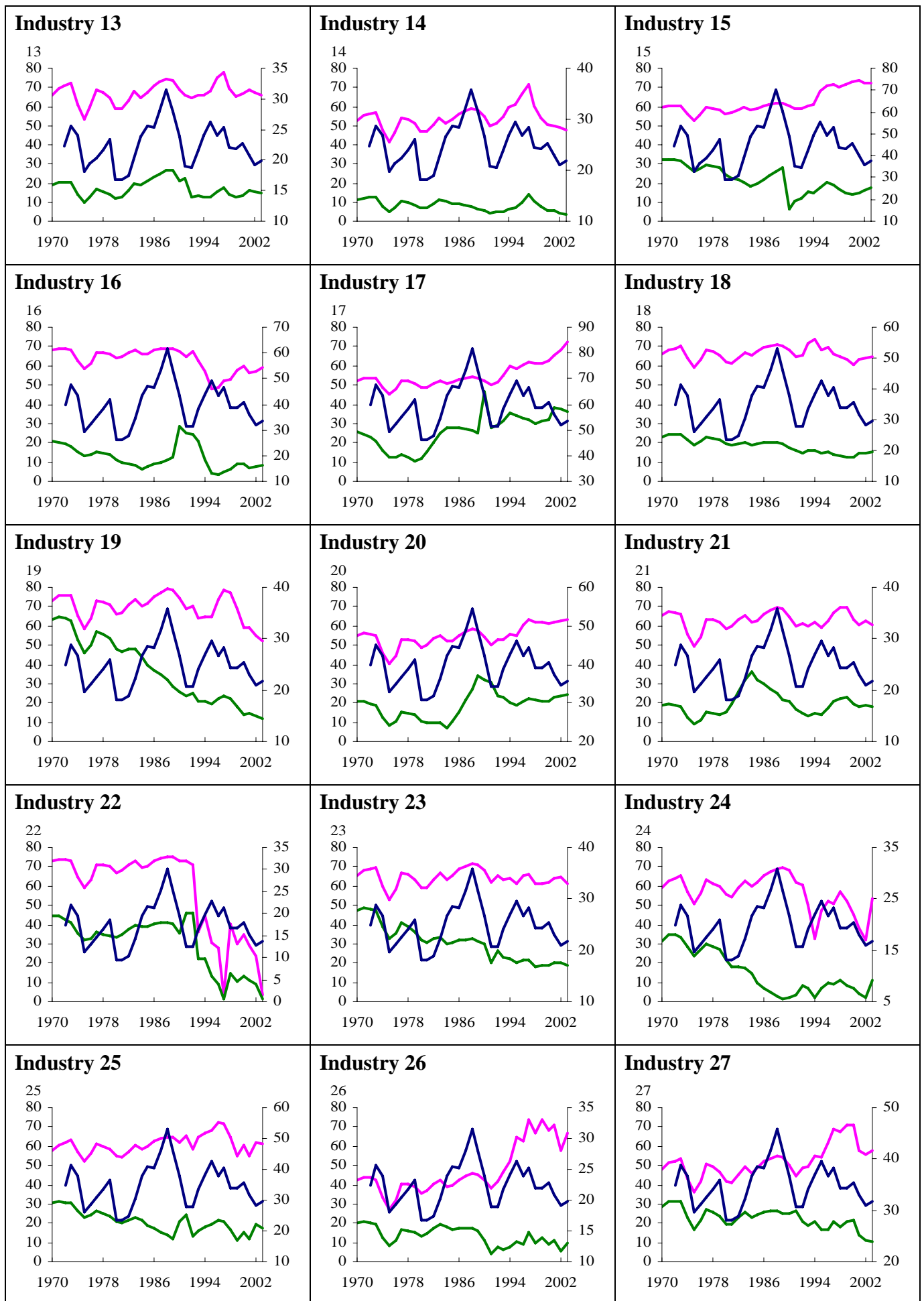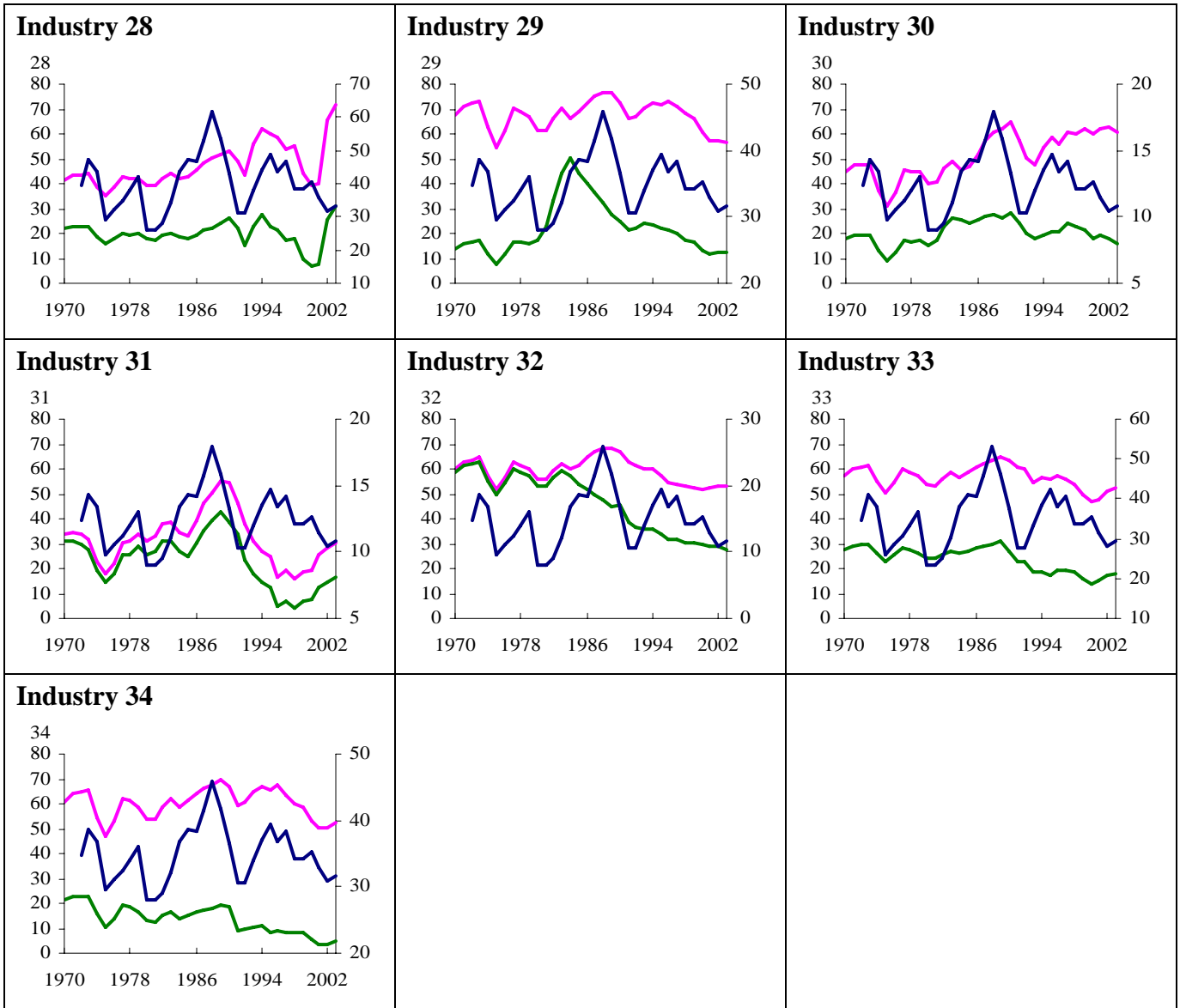———— Total profits as a share of gross value added (rhs)

———— Total profits as a share of gross output (rhs)

———— CBI Q4: Percentage balance of firms reporting capacity constraints (lhs)

Industry 13

13

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

35 · 30 · 25 · 20 · 15 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 14

14

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 15

15

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 16

16

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

70 · 60 · 50 · 40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 17

17

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

90 · 80 · 70 · 60 · 50 · 40 · 30

1970 · 1978 · 1986 · 1994 · 2002

Industry 18

18

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

60 · 50 · 40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 19

19

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 20

20

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

60 · 50 · 40 · 30 · 20

1970 · 1978 · 1986 · 1994 · 2002

Industry 21

21

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 22

22

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

35 · 30 · 25 · 20 · 15 · 10 · 5 · 0

1970 · 1978 · 1986 · 1994 · 2002

Industry 23

23

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 24

24

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

35 · 25 · 15 · 5

1970 · 1978 · 1986 · 1994 · 2002

Industry 25

25

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

60 · 50 · 40 · 30 · 20 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 26

26

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

35 · 30 · 25 · 20 · 15 · 10

1970 · 1978 · 1986 · 1994 · 2002

Industry 27

27

80 · 70 · 60 · 50 · 40 · 30 · 20 · 10 · 0

50 · 40 · 30 · 20

1970 · 1978 · 1986 · 1994 · 2002

Industry 28

Industry 29

Industry 30

Industry 31

Industry 32

Industry 33

Industry 34

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