Economic Commentaries

The relationship between resource utilisation and inflation: a micro data perspective

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Inflation normally rises when resource utilisation increases. In recent years, however, this relationship, which is known as the Phillips curve, has been increasingly called into question. Critics claim that increased competition from foreign firms and technological innovations have changed the correlation. But one problem with aggregate analyses of the relationship is that monetary policy can react to changes in resource utilisation to stabilise inflation. This can mean that the Phillips curve appears to have weakened, despite remaining unchanged at the firm level. This Economic Commentary uses micro data from the National Institute of Economic Research's Economic Tendency Survey and investigates the Phillips curve at the firm level. On the whole, the analysis shows that Swedish firms' selling prices are strongly linked to their resource utilisation and inflation expectations. The Phillips curve thus appears to be intact at the firm level.

In recent years, resource utilisation in Sweden has increased and according to several different measures it is now much higher than normal.[2] Nevertheless, inflation has only risen modestly in recent years. Normally, firms' costs rise faster when resource utilisation increases. Stronger demand also makes it easier for firms to pass on their cost increases to consumer prices. This leads to selling prices becoming higher when resource utilisation increases.

The fact that inflation has risen slowly despite resource utilisation being so high is not solely a Swedish phenomenon. Several analysts have therefore questioned the relationship between resource utilisation and inflation, or the so-called Phillips curve[3] (see, for instance, Borio et al, 2018, and Industriarbetsgivarna (Swedish Association of Industrial Employers), 2018). Critics often refer to the fact that product and labour markets have become more exposed to competition than before, either because of globalisation or developments in technology. Both factors can reduce firms cost increases and their scope to pass on cost increases to consumers.

The Riksbank has discussed the Phillips curve at the aggregate level in several articles.[4] But one problem with aggregate analyses is that monetary policy can react to changes in resource utilisation to stabilise inflation. This can make it appear as through the relationship weakens at an aggregate level, despite remaining unchanged at the firm level (McLeay and Tenreyro, 2018). One way of avoiding this problem is to use more detailed data for firms.[5] To gain a better understanding of the relationships at an overall level, it would appear to be a good idea to analyse corporate sector pricing. Ultimately, it is firms' overall pricing decisions that affect the development of inflation.

Data on Swedish firms is also interesting in a broader perspective. Sweden is a small, trade-dependent economy with firms that are very advanced with regard to technology. As these are the factors often pointed out in the criticism of the Phillips curve, the relationship between resource utilisation and selling prices should, if the criticism is correct, be particularly weak in Swedish data.

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[2] Resource utilisation cannot be observed. To acquire an estimate of this, one can use questionnaires, economic theory or statistical methods. All in all, the Riksbank assesses that resource utilisation is at present higher than normal, see page 27 of the Monetary Policy Report in October 2018.

[3] The term "Phillips curve" got its name from economist William Phillips and his study in 1958 of the relationship between normal wage growth and unemployment in the United Kingdom.

[4] See, for instance, the article "Resource utilisation and inflation" in Monetary Policy Report October 2016 or "The Phillips curve and monetary policy" in Monetary Policy Report June 2018.

[5] This is because monetary policy does not react to resource utilisation in individual firms.

This Economic Commentary supplements previous analyses of the Phillips curve by using micro data from firms. In total, just over 20,000 responses are used from the National Institute of Economic Research's (NIER) Economic Tendency Survey, gathered between 2010 Q2 and 2018 Q1.

Detailed data from Economic Tendency Survey

The Economic Tendency Survey is the largest and most widely followed business survey in Sweden. It is used extensively by economists and Swedish forecasters to gain a better understanding of economic developments or to make short-term forecasts.[6] Similar business surveys are used in other parts of the world.[7]

In the Phillips curve inflation depends on both firms' resource utilisation and their inflation expectations.[8] The Economic Tendency Survey includes questions to firms on both of these, see Table 1. Labour shortages, good sales situations, too small stocks and good profitability are all signs of a high level of resource utilisation. The firms' assessment of the situation within these four areas is used in constructing the Riksbank's indicator of resource utilisation.[9]

Tabell 1. Assertions and response alternatives in the Economic Tendency Survey

	Response alternative		
	(1)	**(2)**	**(3)**
Selling prices have over the last three months:	*Increased*	*Been unchanged*	*Decreased*
The firm at present has a labour shortage:	*Yes*		*No*
The sales situation is at present:	*Good*	*Satisfactory*	*Poor*
Goods stocks are at present:	*Too small*	*Just right*	*Too large*
Profitability is at present:	*Good*	*Satisfactory*	*Poor*
Prices in general will over the coming twelve months*: *How many per cent do you think they will increase/decrease?*	*Increase*	*Remain unchanged* *In %*	*Decrease*

Note. *The question is abbreviated in this table. The actual question is: How do you think prices in general (that is, Swedish consumer prices) will develop over the coming 12 months? Do you believe they will: "Increase", "remain unchanged" or "decrease".

The responses in the Economic Tendency Survey are often qualitative. This means that the respondents choose one of several response alternatives to questions, such as "increase", "remain unchanged" or "decrease". Inflation expectations one year ahead are measured both in per cent and qualitatively. Qualitative response alternatives are used in most business surveys as they are much easier to respond to than quantitative information.[10] One assumption is that firms' responses to the survey are linked to their actual development. But it may be the case that respondents just give routine replies to the surveys and that the responses in practice have no connection the firms' actual development.

In Müller (2009) and Lui et al (2011) qualitative data from business surveys is matched with quantitative outcomes for the same firms. In these studies the qualitative responses on the whole correspond to the actual outcomes. This strengthens confidence in the information

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[6] See, for instance, Hansson et al (2005) or Andersson and den Reijer (2015).
[7] See Banbura and Rünstler (2011).
[8] More specifically, inflation depends on firms' marginal costs and the discounted present value of future real marginal costs. In a conventional framework with price rigidity, however, there is an approximate relationship between resource utilisation and marginal costs. Periods of high demand (or demand above a normal level) are related to marginal costs that are higher than normal and vice versa. Academic literature uses different measures of resource utilisation as an approximation of firms' real marginal costs.
[9] See Nyman (2010)
[10] See the OECD's handbook for business tendency surveys:
http://www.oecd.org/sdd/businesstendencysurveysahandbook.htm

content of the surveys and also confidence in the responses to questions related to things that cannot be observed, such as expectations, reflecting true expectations.[11]

To achieve a clear connection to consumer prices, this Economic Commentary focuses on firms in the trade sector. The reason for this is that selling prices in the manufacturing, construction and service sector are often a mixture of producer and consumer prices.[12] In the trade sector there are more sub-sectors that often have a large share of goods sales directly to consumers.

Prices in the Economic Tendency Survey reflect the development of the CPI

The Economic Tendency Survey often summarises firms' responses in net figures. This shows the difference between the percentage of firms responding "increased" and "decreased" respectively each quarter to a specific question. If the net figure for the firms' selling prices is above zero, this means that more firms have raised their prices than have reduced them. A net figure below zero means that more firms have reduced their prices than have raised them.

As the question regarding firms' selling prices is repeated each quarter, one can see the net figure as a quarterly change in the consumer price index (CPI). Figure 1 shows how trading firms' net figures for selling prices taken from the Economic Tendency Survey have developed and is linked to quarterly changes in seasonally-adjusted goods prices in the CPI.

Diagram 1. The Economic Tendency Survey describes developments in goods prices relatively well
Net balance for selling prices (left scale) and quarterly changes (right scale).

Selling prices in retail trade (left hand scale)

CPI for goods (right hand scale)
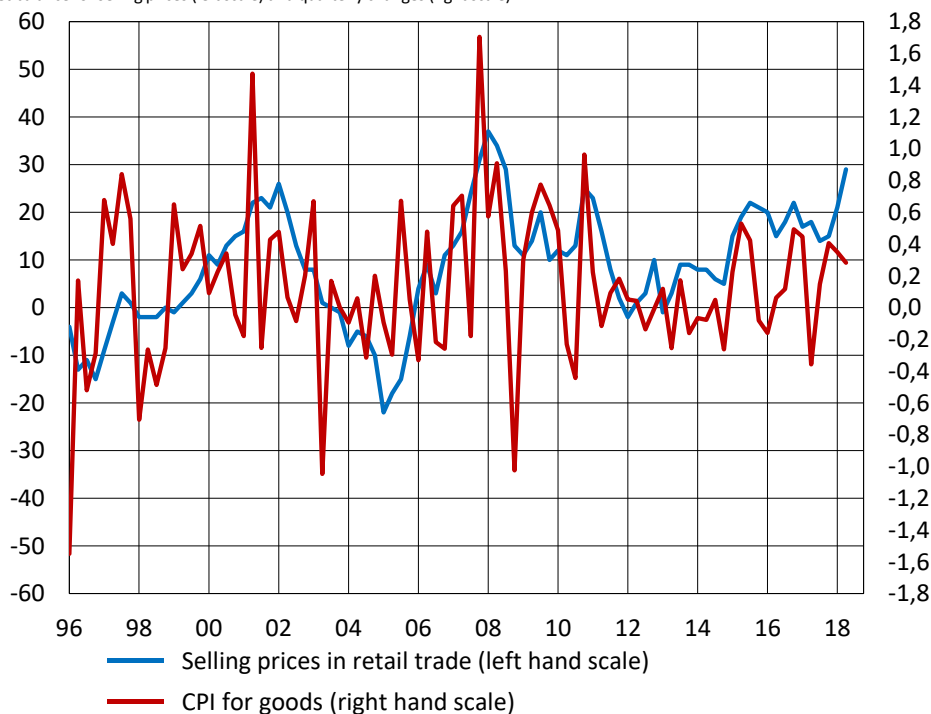
Note. The CPI is seasonally adjusted.

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[11] As far as the author is aware, no one has examined how responses to qualitative business surveys in Sweden are linked to quantitative results for the same firms.
[12] See Dellmo (1996).

Despite the CPI fluctuating substantially from one quarter to another, it is clear that the net figures from the Economic Tendency Survey capture the trend development.[13]
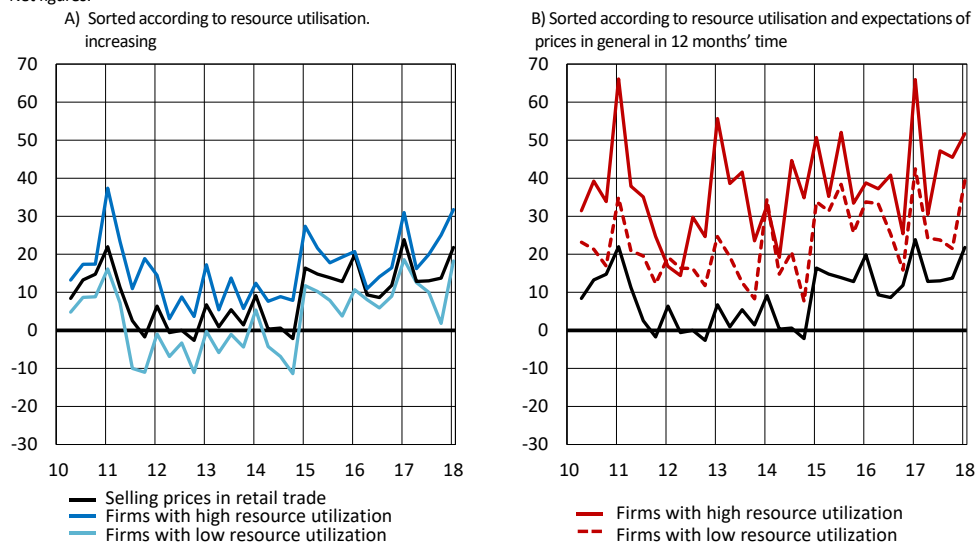
A high level of resource utilisation is linked to higher net balances for selling prices

A first step when investigating how firms' selling prices are linked to resource utilisation in the Economic Tendency Survey is to divide the respondents into two groups: one for firms with a high level of resource utilisation and one for firms with a low level.[14] The second step is then to calculate the groups' respective net figures.

Figure 2, panel A shows the results of this exercise. The blue line represents the net figures for firms with a high level of resource utilisation and the pale blue line is for firms with a low level of resource utilisation. The solid black line is the net figure for all trading firms.[15] Firms with a high level of resource utilisation always have a higher net figure than firms with a low level of resource utilisation. The net figures for firms with high resource utilisation are also higher than those calculated for all trading firms.

Diagram 2. Net balance for selling prices are higher with a high level of resource utilisation and expectations that prices in general will increase
Net figures.

A) Sorted according to resource utilisation. increasing

B) Sorted according to resource utilisation and expectations of prices in general in 12 months' time

— Selling prices in retail trade
— Firms with high resource utilization
— Firms with low resource utilization

— Firms with high resource utilization
- - Firms with low resource utilization

Note. The figures show an average of the net balance for selling prices calculated for the four measures of resource utilisation.

Expectations are also an important part of the relationship known as the Phillips curve. The firms are therefore divided further: into one group of firms with a high level of resource utilisation that also expect prices in general to increase and one group of firms with a low level of resource utilisation that also expect prices in general to increase.[16] Figure 2, panel B

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[13] This is illustrated by the fact that selling prices for trading firms correlate very well with the CPI for goods as an annual percentage change. See, for example, Frohm et al. (2018).

[14] The net balance for selling prices for a high level of resource utilisation are an average calculated for firms with good profitability, good sales, a shortage of labour or too small stocks. The net balance for prices when firms have a low level of resource utilisation are calculated for firms that have poor profitability, poor sales, no labour shortage or too large stocks.

[15] This net figure is what is reported per quarter on the National Institute of Economic Research's website. The difference is that the net figures there are weighted with the number of employees and calculated according to the population, while the net figures presented here are not weighted.

[16] On average over the period 47 firms respond that they have both a high level of resource utilisation and expect prices in general to increase going forward. For the group with low resource utilisation but expectations of an increase in prices in general going forward the figure is 104 firms on average.

shows that the firms expecting higher prices in general in twelve months' time, regardless of their level of resource utilisation, have higher net figures than those calculated for all firms.[17]

Net figures can be translated into prices of goods in the CPI.

Using a very simple method it is possible to translate the net figures from the earlier section into the development of prices for goods in the CPI basket. An important assumption in this exercise is that the black line in Figure 2 represents the outcome for goods prices in the CPI for the time period and that all other factors are held unchanged.[18]

The first step is to calculate the differences in net figures between firms with, for instance, a high level of resource utilisation (blue line in panel A) and all firms (black line) as well as the differences with the net figures for firms with expectations of higher prices in general (red lines in panel B). The second step also requires an estimation of how net balance for selling prices relate to goods prices in the CPI. This is to be able to determine how much higher the goods prices in the CPI would be if the net figures instead of the outcome (black line) were the same as for the firms with a high level of resource utilisation (blue line) or firms with expectations of higher prices (red lines). In a simple linear regression model described in Appendix 1, a unit increase in net balance for selling prices is related to an increase in the quarterly change in prices of goods in the CPI basket of around 0.014 percentage points.[19]

Figure 3 shows the alternative CPI indices under the assumption that all firms have a high level of resource utilisation (blue line) or expect higher prices in general going forward (solid or broken red line). When all firms have a high level of resource utilisation, the alternative development for the CPI as an annual percentage change is around 0.7 per cent on average over the time period (2011 Q1 to 2018 Q1), which is 0.4 percentage points more than for the outcome in the CPI. If the scenario is instead that all firms have had expectations of higher prices in general in twelve months' time, the alternative CPI development is much higher. With a high level of resource utilisation, the figure is on average 2 per cent (solid red line) and with a low level of resource utilisation (broken red line) on average 1.2 per cent during the period.
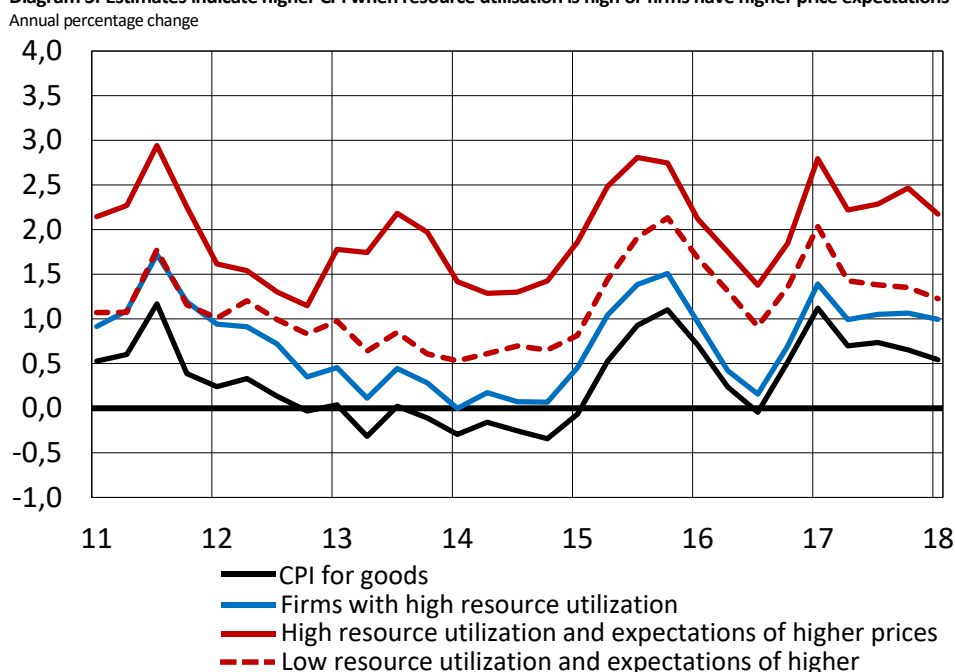
The method for creating these alternative CPI indices is very simple and should be interpreted with caution. For instance, only around one fifth of firms responded that resource utilisation was high during 2017. However, the exercise illustrates the relationship between resource utilisation, expectations of future inflation and selling prices in the Economic Tendency Survey and how they are linked to the CPI.

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[17] Here we use firms' expectations of prices in general in twelve months' time. A very similar picture appears if one instead used firms' own price plans three months ahead.

[18] Another way of expressing this is that all disruptions (for instance, exchange rate fluctuations and changes in the oil price) that affect the CPI are the same in the various scenarios as in the outcome for the CPI.

[19] This regression model estimates the non-seasonally adjusted quarterly change in prices of goods with dummy variables for the second, third and fourth quarters, an autoregressive term of the first order, AR(1) and the net selling prices. When more explanatory variables are added to the regression (quarterly change in unemployment, unit labour costs, commodity prices, nominal exchange rate and inflation expectations), the net figures are still significant, with the same signs and similar coefficients.

Diagram 3. Estimates indicate higher CPI when resource utilisation is high or firms have higher price expectations
Annual percentage change

CPI for goods
Firms with high resource utilization
High resource utilization and expectations of higher prices
Low resource utilization and expectations of higher

Prices increase more often with high level of resource utilisation

A further method of examining the Phillips curve at firm level is to estimate simple regressions for so-called categorical data.[20] These enable probability calculations to observe how firms' selling prices have changed, depending on their resource utilisation and inflation expectations.[21] Appendix 2 explains the categorical regression model.

Figure 4 shows an average of the results from four separate estimates. The blue line shows the probability of price increases when a respondent has a high level of resource utilisation (labour shortage, good sales, too small stocks and good profitability) and the red line shows the probability for a firm with low resource utilisation (no labour shortage, poor sales, too large stocks or poor profitability). The horizontal axis shows the firms' expectations of prices in general in the coming 12 months in per cent. The broken lines are 95-per cent confidence intervals.
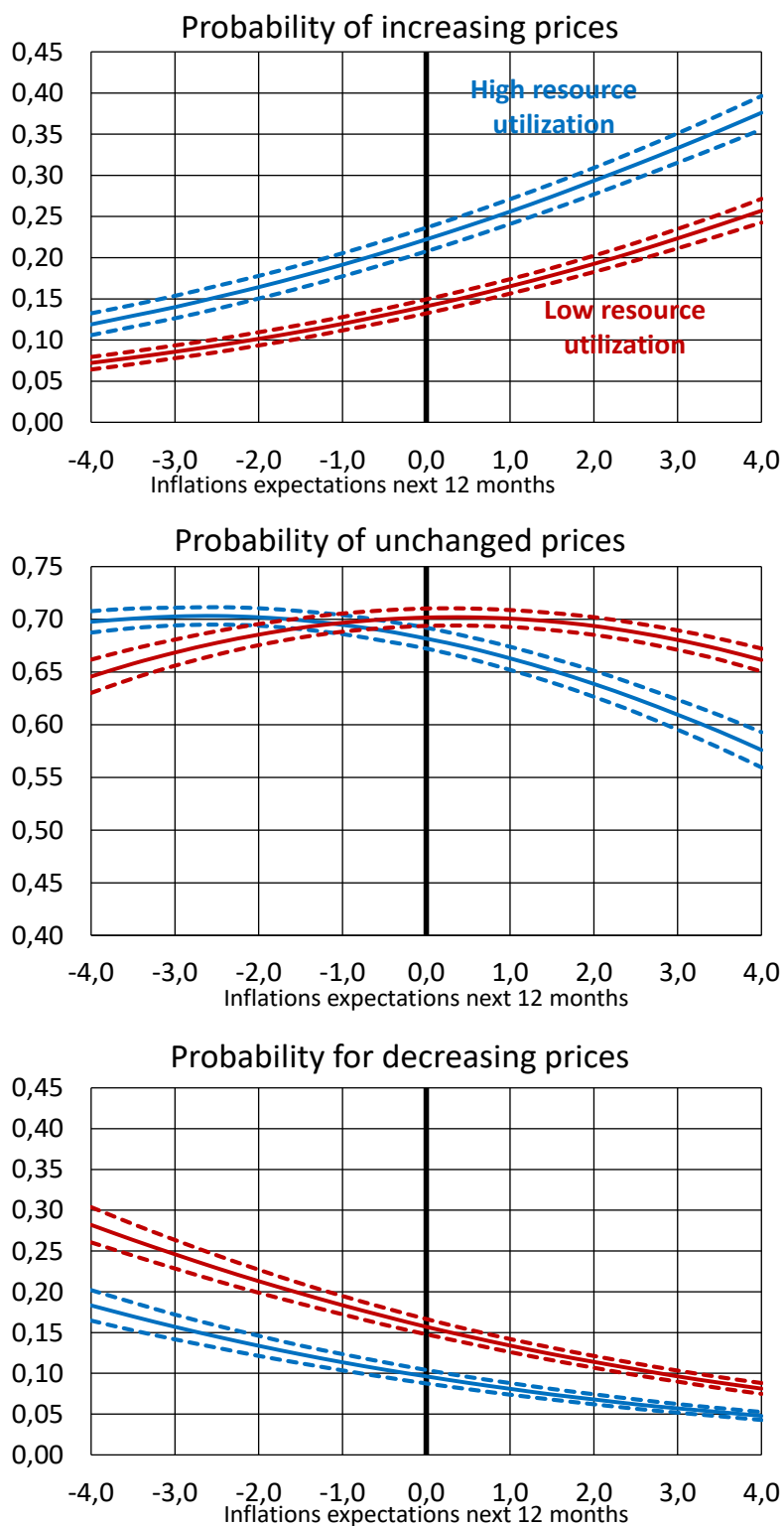
It is clear that firms with higher resource utilisation are more likely to respond that prices have "increased" than firms with low resource utilisation (see the upper panel in Figure 4). The probability also increases in line with inflation expectations. If inflation expectations increase from 0 to 2 per cent, the probability that the respondent has replied that the firms' prices have increased rises from just over 0.2 to 0.3, given that the firm has a high level of resource utilisation. However, the highest probability is that the respondents say that prices are "unchanged", regardless of whether the firm has a high or low level of resource utilisation (see the middle panel in Figure 4). When inflation expectations are low, there is a higher

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[20] The variables used in the regression are qualitative and not quantitative. The regression estimated is therefore a so-called ordered logit, where firms' prices over the past three months ("increased" "been unchanged" or "decreased") are explained by the firms' resource utilisation and expectations of prices in general twelve months ahead.
[21] Estimates of Phillips curves at firm level are nothing new. Gaiotti (2010) used the Italian central bank's Survey of Investment in Manufacturing to investigate how international trade affects the relationship between resource utilisation and changes in prices. Bryan et al (2014) investigated whether inflation expectations affect inflation outcomes for firms that take part in the Business Inflation Expectations survey carried out by the Federal Reserve Bank of Atlanta. Boneva et al (2016) used a panel of firms from the Industrial Trends Survey in the United Kingdom to investigate the causal correlation between firms' selling prices and inflation expectations.

probability of an "unchanged" response for firms with a high level of resource utilisation than for those with a low level. But as inflation expectations rise, the probability that selling prices will remain unchanged becomes lower.

Diagram 4. Higher resource utilisation and inflation expectations are linked to increasing prices.

Probability of increasing prices

High resource utilization

Low resource utilization

Inflations expectations next 12 months

Probability of unchanged prices

Inflations expectations next 12 months

Probability for decreasing prices

Inflations expectations next 12 months

Note. The broken lines are 95% confidence intervals.

The lower panel in Figure 4 shows the probability that firms will respond that prices have fallen. If the firms have a low level of resource utilisation, the probability increases when inflation expectations fall. This is also in line with the Phillips curve.

The results in the figures are based on estimates that do not take into account firm-specific characteristics of the fact that different aggregate factors (economic activity or total inflation) can affect firms' pricing. But even in more thorough analyses that do take this into account, the results the same: trading firms' selling prices in the Economic Tendency Survey are strongly linked their perception of resource utilisation and inflation expectations.[22] On the whole, therefore, the results from the NIER's Economic Tendency Survey are in line with international experiences: resource utilisation and in particular inflation expectations appear to be strongly related to the firms' selling prices.

The Phillips curve for prices appears to be intact in Sweden

In recent years, the so-called Phillips curve, which reflects the relationship between inflation and resource utilisation, has been increasingly called into question. This is often because one has used analyses of aggregate correlations that do not take into account the underlying shocks in the economy that can affect the relationships during certain time periods. Monetary policy can also react to changes in resource utilisation to stabilise inflation. This can mean that the aggregate relationship appears to disappear over time, while it actually still applies at firm level.

The micro data for firms used in this Economic Commentary can resolve some of these problems. This is because monetary policy does not react to events in individual firms. The analysis shows that there is a clear relationship between on the one hand the firms' selling prices and on the other hand their resource utilisation and inflation expectations. Although it is not possible to observe the exact level of resource utilisation in the economy, this indicates that the conventional Phillips curve is still intact.

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[22] The estimates have been repeated with so-called fixed effects for firms and trade sectors and for trade sectors and quarters. The results from the estimates do not change the conclusions. Nor do they change if one uses different empirical specifications of the Phillips curve, different samples or if one adds different time displacements. See Frohm (2019) for further details.

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Appendix 1

To gain an idea of how trading firms' total net balance for selling prices in the Economic Tendency Survey correlate with goods prices in the CPI, one can estimate a simple regression model:

$$\pi_t = c + \beta Netbalance_t + controls_t + \varepsilon_t \qquad (1)$$

where π_t is the percentage quarterly change for goods prices in the CPI. c is a constant, $Netbalance_t$ is the trade sector's total net balance for selling prices from the Economic Tendency Survey and $controls_t$ is a vector of control variables, including dummies for quarters 2, 3 and 4, an autoregressive term of the order of one, AR(1), KIX-weighted exchange rate, unit labour costs (ULC), quarterly change in unemployment and commodity prices. ε_t is a stochastic term.

The purpose of this exercise is not to establish any causal relationship between net balance for selling prices and the quarterly change in goods prices in the CPI. The idea is only to gain an impression of how much net balance for selling prices can be related to the quarterly change in the CPI.

Table A1 shows that an increase in net balance for selling prices of 10 units corresponds to an increase in the percentage change in the CPI of around 0.14 percentage points.[23]

Table A1: Linear regressions for quarterly changes in goods prices in the CPI

	(1)	(2)	(3)	(4)	(5)	(6)
Net balance	0.014*** (0.004)	0.012*** (0.004)	0.014*** (0.005)	0.014*** (0.005)	0.013*** (0.005)	0.009** (0.005)
KIX-weighted exchange rate		0.021* (0.011)	0.023** (0.010)	0.023** (0.010)	0.021** (0.010)	0.021** (0.009)
ULC		0.052 (0.162)	-0.095 (0.171)	-0.112 (0.177)	-0.023 (0.192)	0.124 (0.141)
Unemployment		-0.031* (0.016)	-0.032* (0.016)	-0.032* (0.016)	-0.032* (0.016)	-0.027* (0.016)
Commodity prices						0.038*** (0.011)
R^2	0.78	0.80	0.80	0.80	0.80	0.83
AR(1)	-0.133	-0.156	-0.199	-0.216	-0.185	0.311**
Further checks	No	No	Yes	Yes	Yes	No

Note. *, ** and *** mark a p-value below 0.1, 0.05 and 0.01. Further checks in column (3) are unemployment, in column (4) the unemployment gap and in column (5) the employment gap. Moreover, each regression contains dummy variables for quarters 2, 3 and 4. The KIX-weighted exchange rate is three quarters' average of the annual change, ULC is 12 quarters moving average of the quarterly change in unit labour costs and commodity prices are two quarters moving average of The Economist's price index for food and other commodities.

To translate the alternative net balance for selling prices to the development in the CPI we use (2):

$$\pi_{counterfactual_t} = \pi_t + \left(Netbalance_{alternativ_t} - Netbalance_{utfall_t} \right) * \beta \qquad (2)$$

where $\pi_{counterfactual_t}$ is the quarterly change in goods prices in the CPI in some of the different scenarios. This could be the development in the CPI if all firms had a high level of

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[23] This figure varies from 0.09-0.14 depending on which controls are used.

resource utilisation or if they expected prices in general to increase in 12 months. π_t is the quarterly change in goods prices in the CPI. $Netbalance_{alternativ_t}$ is the alternative net balance for selling prices calculated for firms with a high level of resource utilisation or for the firms with expectations of increasing prices in general in 12 months' time. $Netbalance_{utfall_t}$ is the net balance for selling prices calculated for all firms. β Is the coefficient in Table A1 column (1).

In this analysis $Netbalance_{utfall_t}$ represents the outcome for the CPI during each time period and when all factors are held constant. The size of the difference between the different scenarios and the CPI outcome depends on the difference between the alternative net balance for selling prices and the outcome for the net balance $\left(Netbalance_{alternativ_t} - Netbalance_{utfall_t} \right)$ and the coefficient β from Table A1.[24]

Appendix 2

The regression model estimated for categorical survey data is:

$$\pi^*_{fit} = X'_{fit}\beta + \varepsilon_{fit} \tag{2}$$

where f is a firm, i a trade sector and t is a quarter. π^*_{fit} is the actual price change in a firm, $X'_{fit}\beta$ is a vector of variables (the firms' resource utilisation and expectations of prices in general in 12 months' time) and ε_{fit} is a stochastic term. In the model the observed (qualitative) price change in the survey π_{fit} is related to the actual price change according to the rule: $\pi_{fit} =$ "minskat" $(k = 3)$ If $\pi^*_{fit} \leq u_1$, $\pi_{fit} =$ "oförändrad" $(k = 2)$ if $u_1 < \pi^*_{fit} \leq u_2$ and $\pi_{fit} =$ "ökat" $(k = 1)$ if $\pi^*_{fit} > u_2$

where u_1, u_2 and u_3 is the threshold estimated in the regression. The probability that a respondent f will give alternative k is shown by $p_{ik} = P\big(\pi_{fit} = k\big) = \Lambda\big(u_{k+1} - X'_{fit}\beta\big) - \Lambda(u_k - X'_{fit}\beta)$ where Λ is the cumulative distribution function (CDF). The results of the estimates are shown in Table A2.

Table A2: Ordered logit-regressions for selling prices the past three months

	(1)	(2)	(3)	(4)
Prices in general in 12 months' time	0.191*** (0.012)	0.181*** (0.012)	0.191*** (0.013)	0.186** (0.012)
Labour shortage	0.139*** (0.010)			
Current sales		0.421*** (0.034)		
Profitability			0.434*** (0.030)	
Current stocks				-0.132*** (0.045)
Pseudo R^2	0.02	0.03	0.03	0.02
Observations	14,072	14,307	14,307	14,307

Note. *, ** and *** mark a p-value below 0.1, 0.05 and 0.01. Standard errors in brackets.

[24] In the main text the coefficient 0.014 from column (1) in Table A1 is used. The scenarios for the CPI can thus be somewhat higher or somewhat lower than those given in the main text.

But the coefficients in ordered logit models are often difficult to interpret. It is therefore simpler to visually show estimated probabilities as to whether selling prices over the past three months have "increased" remained "unchanged" or "decreased" as in Figure 4.