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The NAICU and the Phillips curve–
An Approach Based on Micro Data*

Eva Köberl† and Sarah M. Lein‡

November 24, 2008

Abstract

In this paper we propose a straightforward method to derive a non-accelerating inflation capacity utilisation rate (NAICU) based on micro data. We condition the current capacity utilisation of firms on their current and planned price adjustments. The non-accelerating inflation capacity utilisation rate is then defined as the rate where a firm feels no price adjustment pressure. One of the main advantages is that this methodology uses structural aspects and does not make it necessary to operate with –often rather arbitrary– statistical filters. We show that our aggregate NAICU performs remarkably well as an indicator of inflationary pressure in a Phillips curve estimation.

JEL classification: E31; E32; E52

Keywords: prices, capacity utilisation, NAICU, Phillips curve.

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1 Introduction

The Phillips curve, which is the relationship between the deviation of unemployment from its natural rate and inflation, is at the heart of monetary economics. The definition of the natural rate goes back to Milton Friedman (1986) and more recently has become known by the acronym NAIRU, which stands for Non-Accelerating Inflation Rate of Unemployment (Gordon, 1997). It is important to note that in practice the NAIRU is a short-run concept and is distinct from the long-run natural rate of unemployment. This is because the long-run natural rate captures the long-run real equilibrium determined by the structural characteristics of labour and product markets. However, the NAIRU is defined solely in relation to the level of unemployment that is consistent with a stable rate of inflation in the short-run, and so it may be affected by the adjustment of the economy to past economic shocks. As the effects of adjustment to shocks fade away, the NAIRU will tend towards the long-run natural rate (Batini and Greenslade, 2006).[1] Estrella and Mishkin (2000) and Woodford (2002) emphasize that the short-run concept should be the main focus of monetary policy, not the long-run natural rate. This is because the variability in the short-run NAIRU contains information on future inflationary pressures that is disregarded when targeting the long-run natural rate. Thus, the Phillips curve trade-off is vertical at the unemployment rate that is equal to the NAIRU. Hence, the deviation of the current rate of unemployment from the NAIRU, the unemployment gap, contains information on upcoming inflationary pressure. Therefore, the Phillips curve relationship is one of the key ingredients for monetary policy making. Nowadays, the term Phillips curve is employed as a synonym for the short-run relationship between any measure of excess demand and inflation.

In empirical models, however, it has been found that other measures of excess demand

[1] Hence, when we refer to the non-accelerating rate we refer to a short-run concept of the natural rate, as proposed by Estrella and Mishkin (2000), throughout the paper. If we refer to a long-run natural rate, we explicitly state it.

perform much better as leading indicators of inflation, compared to the unemployment gap (Staiger et al., 1997). Stock and Watson (1999) suggest that especially the rate of capacity utilisation is one of the most reliable indicators for upcoming inflationary pressures. Therefore, it would be desirable to obtain an estimate of the current NAICU – the Non-Accelerating Inflation Rate of capacity utilisation (McElhattan, 1985). In spite of the NAICU being a theoretically appealing concept, it is unobservable in empirical macro data. Most traditional approaches estimate the Non-Accelerating Inflation Rate of Capacity Utilisation as the long term average of utilisation (i.e., it is simply assumed to be constant over time). However, due to structural change in the manufacturing sector, the NAICU is rather expected to be time varying (Gordon, 1997).[2] Other, more sophisticated statistical methods, such as the Kalman filter, typically impose strong priors on the smoothness of the trend or cycle, and generally assume that trend and cycle shocks are uncorrelated.[3] These restrictions lack support in theory, and moreover tend to shape the estimated components (Basistha and Nelson, 2007).

Furthermore, especially output and unemployment figures get heavily revised and real time estimates are often flawed (e.g. Orphanides and Williams, 2002). This is especially problematic as the end point estimates are most important for central banks to make forward-looking monetary policy decisions. For example, Orphanides and Williams (2005) show that the combination of monetary policy directed at tight stabilisation of unemployment near its perceived natural rate and large real-time errors in estimates of the natural rate contributed to poor macroeconomic performance in the U.S. during the 1970s.

Offering a NAICU measure that is directly observable, not subject to real time revisions

[2]For example, Nahuis (2003) provides some explanations for an upward shift in the NAICU: innovations, better management techniques and improved functioning of product and labour markets may have increased efficiency. Furthermore, increased competition stimulated by the establishment of the internal market and deregulation of product markets may have reduced entrepreneurs pricing power resulting in prices being increased by a higher level of demand.

[3]For example, the majority of the estimates employing a Kalman filter approach assume that the natural rate follows an AR(1) process. As the natural rate is unobserved, such assumptions are rather arbitrary.

and based on the theoretical idea of the non-accelerating rate, is the focus of this paper. To derive the NAICU in a theory consistent way, we rely on micro data information. More precisely, we use the KOF survey data that allows to observe the capacity utilisation rate and currently conducted and expected price adjustments at the firm level.[4] Hence, we can link the utilisation rate to the information whether, at that given utilisation rate, a firm has adjusted prices or expects to adjust prices, or not. If a given firm in the data set indicates that it does not adjust prices and does not expect to adjust prices in the next period, the utilisation rate the firm currently reports can be considered to reflect the firm-specific NAICU, defined as the rate of utilisation that is consistent with no change in prices. Our measure has advantages over previous estimates. First, it is available in real time on a quarterly basis and is not subject to revisions. Second, it is derived from micro data and explicitly takes into account the theoretical idea that the NAICU should reflect the rate of capacity utilisation that is consistent with a stable price level. Third, it is derived from very simple methods that are not subject to end-point adjustments or priors on the smoothness of the trend or cycle. Fourth, it takes into account heterogeneity at the firm level and, fifth, allows for time variation.

As this is the first measure of the NAICU that is directly observable, the illustration of the figure already covers valuable information. Especially, it shows to be quite volatile and time varying, which are the characteristics that Estrella and Mishkin (2000) expect from the theoretical idea of the non-accelerating rate. We test the performance of the micro based NAICU as measure of real activity in a hybrid version of the New Keynesian Phillips curve for Switzerland. We show that our measure performs remarkably well, yielding estimates close to the Galí et al. (2001) estimates for other countries using ex-post marginal cost or output gap data. The latter, however, are often subject to huge revisions in real time, which our measure is not. Furthermore, unit labor cost and output gap

[4]The exact data source is the KOF Swiss Economic Institute's quarterly Business Tendency Survey in the manufacturing sector.

measures for Switzerland are not significant in the estimates of the Swiss New Keynesian Phillips curve.

2 Data Description

In our analysis, we use firm level micro data. The data source is a business tendency survey in the Swiss manufacturing industry collected by the KOF Swiss Economic Institute. It covers the years 1985 first quarter to 2007 second quarter on a quarterly basis. This gives us 84007 observations in an unbalanced panel. Relating to prices, there are several qualitative questions in the survey. Firms are asked whether their selling prices (i) have been changed in the previous three months (denoted by $Sellingprice_{it}$ for firm i at period t) and (ii) will be changed in the following three months, $E_t(Sellingprice_{i,t+1})$. The answering options on both questions are increase (+1), decrease (-1) or left unchanged (0), whereas a non-response is treated as missing value. Relating to capacity utilisation, the firms are asked to quantify the capacity utilisation ($Utilisation_{it}$) within the past three months in percentage points, where the firms can choose from a range of 50% to 110% in five percent steps.

The distribution of capacity utilisation rates across firms shows a fair amount of heterogeneity which we show in Figure 1. For this example, we choose one point in time, here it is the first quarter in 2007.[5] It can be seen that 134 firms in the sample currently use 90% of their capacity. 89 use 80%, 83 use 100% and 33 use 110%.

The main idea behind our micro data based NAICU is that we build upon the theoretical requirement that the non-accelerating inflation rate is associated with a stable steady state rate of inflation. The steady state rate is usually assumed to be zero in the New Keynesian framework. Hence, firms operating at the non-accelerating inflation rate of capacity utilisation should not feel any pressure to adjust prices. Thus, we define the

[5] 2007 was year with favourable economic conditions and high average utilisation rates.

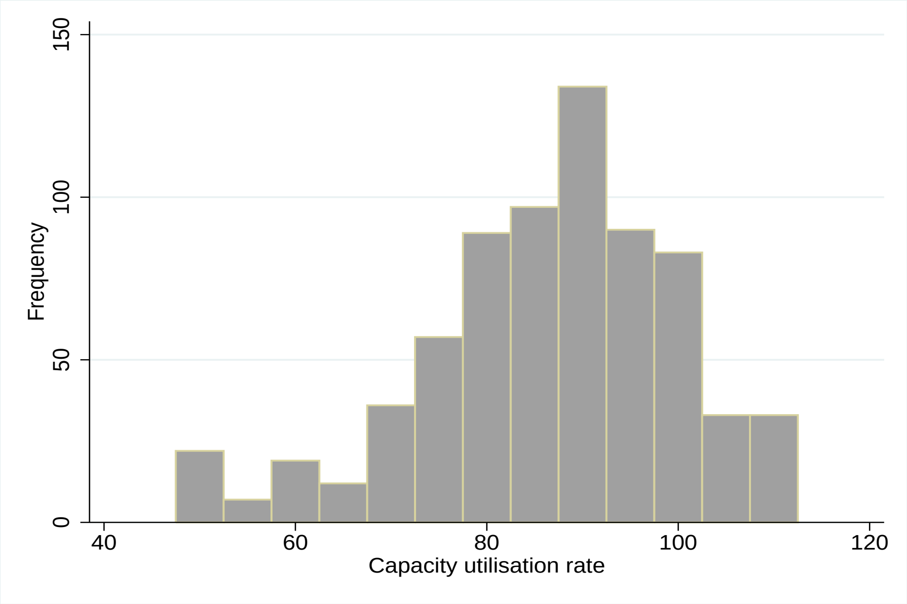

Figure 1: Distribution of capacity utilisation rates across firms in 2007Q1
Source: KOF Industry Survey.

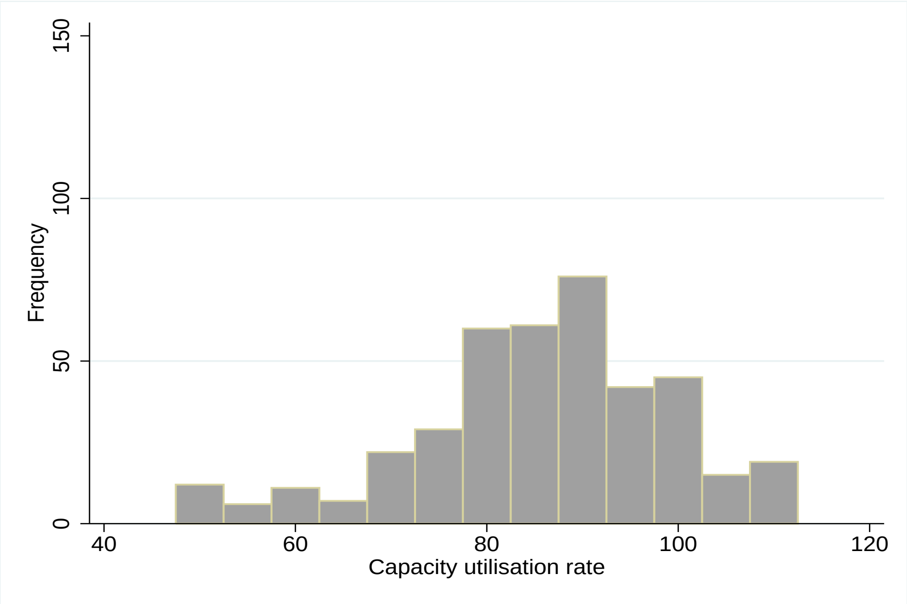

Figure 2: Distribution of capacity utilisation rates across firms that did not change prices in the current quarter and do not expect to change prices in the upcoming quarter in 2007Q1.
Source: KOF Industry Survey.

NAICU as the rate of capacity utilisation that is associated with *no change in prices and no expected change in prices*. The advantage of the data set is that we can directly link the information on price adjustments or expected price adjustments to the rate of capacity utilisation. Thereby, we can control for the unobserved heterogeneity across firms, as we can observe at the firm level which firm-specific capacity utilisation rate is related to price changes and which is not. Figure 2 shows the distribution of capacity utilisation rates including only firms that respond that they left their selling prices unchanged in the previous quarter and do not expect to change their prices in the upcoming quarter. When we exclude the firms that changed prices or expect to change prices, only 76 firms in the sample currently use 90% of their capacity, compared to the 134 observed before. 60 use 80%, 45 100% and only 19 utilise 110%. Hence, for almost 50% of the firms with a capacity utilisation of 90% prices change. For the other 50%, a utilisation of 90% is not associated with a pressure to raise prices in the short run. This already shows that the NAICU is very heterogeneous and shows substantial variation at the firm level. For this reason, we find it important to take into account heterogeneity when deriving a NAICU on the macro level. Furthermore, the firm-specific NAICU can be time varying due to several structural changes in the manufacturing sector over the two decades under review. See Gordon (1998 and 1999) for a discussion. The following chapter describes the details of the construction of our NAICU variable.

3 The NAICU Based on Micro Data

As mentioned in the introduction, the measure for the NAICU we propose has several advantages over other statistical measures derived from macro data. We use a bottom up approach, first constructing a firm-specific NAICU, which we then aggregate up to obtain a macro level NAICU.

We define the capacity utilisation rate of firm i that is consistent with no price adjustments conducted by firm i at quarter t as

$$NAICU_{it} = (Utilisation_{it} \mid Sellingprice_{it} = 0, E_t(Sellingprice_{i,t+1}) = 0.) \tag{1}$$

Thus, the current rate of utilisation is equal to the NAICU for firm i in t if it is associated with no price adjustments in the current or the upcoming quarter. We chose to condition on both current and next period's price adjustments, as some firms might not be able to adjust prices immediately, but still feel price pressure. Other firms might be able to adjust prices instantaneously.[6]

In a second step, we aggregate these firm level rates of capacity utilisation up to obtain a macro level time series. We weight the utilisation rates by firm size. As a measure of firm size we use the number of employees in firm i ($employee_{it}$). We furthermore define an indicator variable NR_{it}, which is one if firm i at time t is at its NAICU and zero otherwise. The sum of all employees in all firms, which currently operate at the NAICU is then

$$MaxweightNAICU_t = \sum_i employee_{it} * NR_{it}. \tag{2}$$

To obtain the macro level NAICU, we weight the firms which operate at their natural rate with their respective firm size

$$NAICU_t = \sum_i \frac{employee_{it} * NAICU_{it}}{MaxweightNAICU_t}. \tag{3}$$

To derive the current capacity utilisation rate in the economy at the macro level, we similarly use all capacity utilisation rates weighted by firm size and compute an aggregate measure

[6] Conditioning only on expected price changes or only on current price changes does not change any of the results substantially. The two series conditioning only on current and only on expected price adjustments are available from the authors upon request.

$$CU_t = \sum_i \frac{employee_{it} * Utilisation_{it}}{MaxweightCU_t} \tag{4}$$

where $MaxweightCU_t$ is defined as

$$MaxweightCU_t = \sum_i employee_{it}. \tag{5}$$

To obtain a time series for the capacity utilisation gap, we simply use the difference between the natural rate $NAICU_t$ and the current aggregate utilisation CU_t

$$GapCU_t = CU_t - NAICU_t. \tag{6}$$

We plot the series in Figure 3. It can be seen that the utilisation rate (CU) in the Swiss economy was on average around the NAICU in the beginning of the sample, whereas during the early nineties, utilisation rates are below the NAICU. From the end of the nineties to 2006, the average utilisation in Switzerland fluctuates around the NAICU. In the last two quarters of 2006 and 2007, the current average utilisation rate lies even above the NAICU. Another striking feature of the NAICU is that it appears to be more volatile than other measures of the natural rate. However, the usual smoothness of the natural rate measures is a result of rather arbitrary statistical smoothing (Ball and Mankiw, 2002). There is no theoretical reason for expecting the natural rate to be very smooth. For example, real shocks should affect the natural rate, which may cause the volatility in the NAICU series. Given that we focus on a short-run concept with the NAICU, it may also be expected to be more volatile. It might be worth recalling what the NAICU is: it is the level of capacity utilisation at which inflation will neither decrease nor increase. Theoretically, the level of the NAICU is not only affected by the long-run natural rate but also by all inflationary pressures due to short-term supply shocks, expectations, and possible speedlimit or persistence effects (see Estrella and Mishkin, 2000 or Camarero et al., 2005). Our measure of the NAICU is, during some periods, even more volatile than the average utilisation rate.[7] Note that we have not yet seasonally adjusted. Hence, the volatility might partially be caused by the seasonality and staggered price setting found in earlier studies (Rupprecht, 2007). Furthermore, as Lein and Köberl (2008) show, firms that are constrained to adjust their capacity in the short run are more likely to adjust prices. Hence, the firms are those that are included in the average utilisation rate, but not in the NAICU. Arguably, these are firms that have a stable utilisation rate, otherwise they would not report that they are constrained in capacity. Firms that are not constrained and can adjust their capacity in response to shocks are those that are included in the NAICU. As these are more likely to adjust to shocks by adjusting utilisation, the NAICU can be expected to display more volatility it the presence of shocks.

Furthermore, the volatility of such a structural measure is in line with a growing recent empirical literature. For example, the structural output gap series estimated by Neiss and Nelson (2005) is more volatile than HP filtered series. Basistha and Nelson (2007) derive the unemployment gap based on the forward-looking New Keynesian Phillips Curve. In addition, their estimates of the natural rate show a fairly volatile natural rate of unemployment. King and Morley (2007) come to a similar conclusion. They measure the natural rate of unemployment as the time-varying steady state of a structural vector autoregression (SVAR). Their findings show that its movements account for most of the variation in the unemployment rate, as well as substantial portions of the variation in aggregate output and inflation.

Compared to previous estimates of the NAICU, which usually assume that the NAICU is the long term average of capacity utilisation rates across time, we see several advantages of our approach. First, it is available in real time and not subject to revisions. Second, it

[7]The standard deviation of the NAICU is slightly lower than the standard deviation of average utilisation, as shown in the summary statistics reported in Table 3.

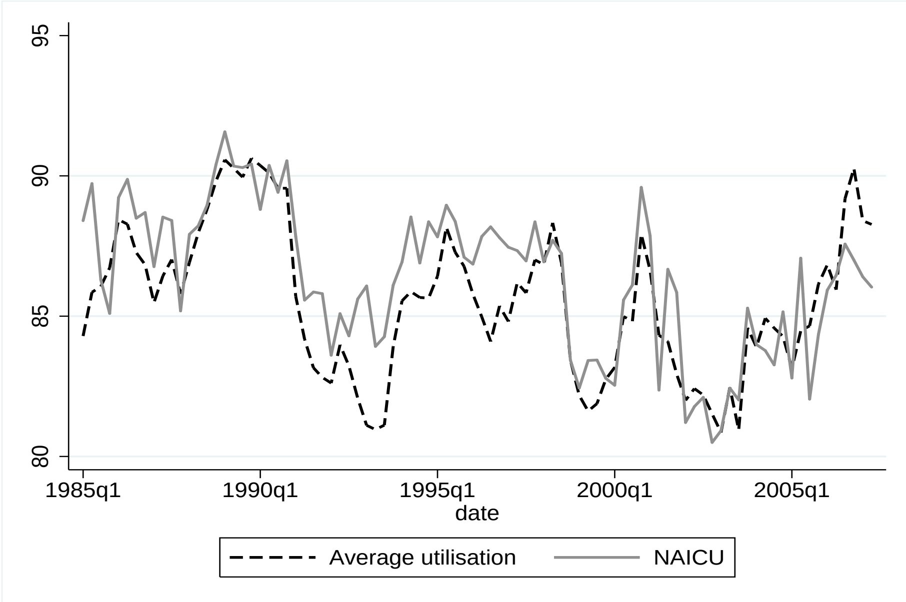

Figure 3: Capacity utilisation rates
Dashed line average utilisation rate CU_t, grey solid line $NAICU_t$, not seasonally adjusted. Source: KOF Quarterly Industry Survey.

is based on the theoretical idea of a natural rate. Third, it takes into account firm level heterogeneity. Fourth, it takes into account time variability of the natural rate. Fifth, it does not require statistical methods for smoothing that imply end point problems or other forms of uncertainty.

4 Phillips Curve Estimates

In this section, we test for the informational content of the capacity utilisation gap by including it in a Phillips curve regression. We compare the indicator with a measure of the capacity utilisation gap, where the NAICU is assumed to be equal to the long-term average of capacity utilisation rates, and two other commonly used measures, the output gap and unit labour costs.

4.1 Theoretical Framework

To obtain estimates for the Phillips curve relationship, we follow Galí and Gertler (1999) and Galí et al. (2001). They show that a hybrid version of the Phillips curve, i.e. where inflation depends on future expected and past inflation, can be derived when assuming that a fraction ω of firms uses simple rules of thumb to form their prices, based on the inflation rate observed in the previous period. A fraction $1-\omega$ sets prices forward looking in a Calvo type fashion. Hence, the aggregate price level evolves according to

$$p_t = \theta p_{t-1} + (1-\theta)\overline{p}_t^* \tag{7}$$

where $\overline{p}_t^*$ is an index for the prices newly set in period t, and $1-\theta$ is the probability that a given firm can adjust its price. Let p_t^f denote the price set by a forward looking firm and p_t^b the price set by a backward looking firm. Hence, the index of newly set prices evolves according to

$$\overline{p}_t^* = \omega p_t^b + (1-\omega)p_t^f \tag{8}$$

Firms that set prices in a forward looking manner choose their price at t to maximise expected discounted profits, where β is a subjective discount factor. The optimal reset price can be expressed as

$$p_t^f = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{mc_{t+k}^n\} \tag{9}$$

where mc_t^n are the deviations of a firm's nominal marginal cost at t from the steady state. The backward looking firms are assumed to obey a rule of thumb that has two features: first, there are no persistent deviations between the rule and optimal behaviour, i.e. in a steady state equilibrium the rule is consistent with optimal behaviour. Second, the price in period t given by the rule depends only on information dated $t-1$ or earlier. We also assume that the firm is unable to tell whether any individual competitor is backward looking or forward looking. This implies that backward looking firms set their prices equal to the average price set in the most recent round of price adjustments, with a correction for inflation

$$p_t^b = \overline{p}_{t-1}^* + \pi_{t-1} \tag{10}$$

where π_{t-1} is the inflation rate in period $t-1$, which is simply used as a forecast for current inflation.

Substituting (9) and (10) into (8) yields

$$\overline{p}_t^* = \omega(\overline{p}_{t-1}^* + \pi_{t-1}) + (1-\omega)[(1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{mc_{t+k}^n\}] \tag{11}$$

which we substitute into (7) and solve forward to obtain a hybrid Phillips curve

$$\pi_t = \lambda mc_t + \gamma^f E_t\{\pi_{t+1}\} + \gamma^b \pi_{t-1} \tag{12}$$

where

$$\lambda = (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1} \tag{13}$$

$$\gamma^f = \beta\theta\phi^{-1} \tag{14}$$

$$\gamma^b = \omega\phi^{-1} \tag{15}$$

$$\phi = \theta + \omega[1-\theta(1-\beta)] \tag{16}$$

To take the specification to the data, we follow Galí and Gertler (1999) and assume that there is an approximate proportional relationship between marginal cost and the deviation of an indicator of real activity (e.g. capacity utilisation, output gap, marginal cost) from its natural level near the steady state (Rotemberg and Woodford, 1998).[8] We thus replace the marginal cost measure with an expression for the capacity utilisation gap as an indicator for real economic activity. We include the linear relationship $mc_t = \kappa GapCU_t$ to derive our empirical equation

$$\pi_t = \lambda \kappa GapCU_t + \gamma^f E_t\{\pi_{t+1}\} + \gamma^b \pi_{t-1}. \tag{17}$$

4.2 Estimation and Results

For estimating the Phillips curve we employ data on inflation, inflation expectations and several measures of the output gap. Summary statistics can be found in Table 3.

We use two approaches to estimate equation (17). First, we follow Galí and Gertler (1999) and employ generalised method of moments (GMM). We can use the orthogonality conditions that can be derived from rational expectations where the forecast error of π_{t+1} should be uncorrelated with the available information dated in t. It follows from equation (17) that

$$E_t\{(\phi\pi_t - (1-\omega)(1-\theta)(1-\beta\theta)\kappa GapCU_t - \theta\beta\pi_{t+1})Z_t\} = 0 \tag{18}$$

where Z_t is a vector of variables dated at t and earlier and thus orthogonal to the inflation surprise in $t+1$. This condition forms the basis of the GMM estimation, where we use three lags of the inflation rate, the lagged import price inflation and the lagged output gap as instruments. The inflation rate and the import price inflation rate are obtained from the

[8] Corrado and Mattey (1997) provide a microtheoretic description of the proportional relationship between capacity utilisation and marginal cost. Neiss and Nelson (2005) provide support for this output gap proxy interpretation of marginal-cost based New Keynesian Phillips Curves. They show that employing structural measures of the output gap instead of smoothed trends explains why some earlier output gap based estimates of the Phillips curve have performed rather badly. Evidence in its favor is also provided by Galí (2002) and Woodford (2001).

Swiss Statistical Office (BFS). Summary statistics are given in Table 3 in the Appendix.

To check for the robustness of the results with respect to the GMM methodology we also run a separate regression using OLS with Newey West corrected standard errors.

Our GMM estimates are reported in Table 1. In column (1) we employ the NAICU gap $GapCU_t$ derived in this paper as a measure for real activity. We find parameter values that are close to the values for the euro area found in Galí et al. (2001), the coefficient on $GapCU_t$ is 0.04, and it is significant at the five percent level. Galí et al. (2001) find coefficient estimates of 0.04 for the euro area and 0.16 for the U.S. The estimates for the coefficients on expected and lagged inflation are 0.53 and 0.50 respectively. The estimates in Galí et al. (2001) for the euro area are 0.27 and 0.69, and 0.36 and 0.60 for the U.S. In columns (2) to (4) we replicate the estimations from (1), with the only difference being that we include other proxies for the output gap into the regressions. In column (2) we use the deviation of capacity utilisation from the long-run average (which is around 85.5 percent) $GapAvgCU_t$. This measure is commonly used as a measure for real activity with capacity utilisation data.[9] When using this variable, the coefficient on the estimated Phillips curve relationship is insignificant and wrongly signed. In column (3) we use the output gap constructed by HP filtering GDP. The coefficient estimate is correctly signed and the size is comparable to other Phillips curve estimates. However, it is statistically insignificant. We also use a measure of unit labour cost as an explanatory variable for the Phillips curve equation. The data is taken from a KOF calculation (ULC_t). The estimate reported in column (4) is correctly signed but also not significant.

[9] E.g., Nahuis (2003) assumes that the NAICU is constant. He obtains estimates of the NAICU for Germany, France, the Netherlands, Belgium and Italy. His estimates vary between 78.1 for Italy and 86.4 for France for the period 1986 to 1996.

Table 1: GMM parameter estimates, 1985Q1-2007Q2

	(1)	(2)	(3)	(4)
$E_t[\pi_{t+1}]^{GMM}$	0.5317***	0.5830***	0.5952***	0.5756***
	(0.0924)	(0.0958)	(0.1183)	(0.0939)
π_{t-1}	0.4983***	0.4421***	0.4296***	0.4519***
	(0.0815)	(0.0832)	(0.1035)	(0.0780)
$GapCU_t$	0.0440**			
	(0.0208)			
$GapAvgCU_t$		-0.0094		
		(0.0112)		
$GapGDP_t$			0.0180	
			(0.0241)	
ULC_t				0.3419
				(0.7162)
Constant	-0.0185	-0.0450	-0.1391	-0.2420
	(0.0496)	(0.0469)	(0.1524)	(0.4270)
Observations	86	86	86	86
Hansen J-Stat	0.52	0.14	0.36	0.04
p-value	(0.91)	(0.98)	(0.94)	(0.99)

Standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. Columns (1)-(4) report GMM estimates, where the expected inflation rate $E_t[\pi_{t+1}]^{GMM}$ is instrumented by three lags of the inflation rate, the lagged import price index and the lagged output gap. The import price index is taken from the Swiss Federal Statistical Office (BFS), the output gap is a HP filtered GDP series from the KOF. In column (1) the measure for the Phillips curve relationship is $GapCU_t$ as proposed in this paper. Column (2) employs the deviation of capacity utilisation from its constant long-run average $GapAvgCU_t$ as measure for real activity. Column (3) employs the output gap $GapGDP_t$ calculated by a HP filter. Column (4) uses the unit labor cost measure ULC_t calculated by the KOF Swiss Economic Institute. P-values of the Hansen J-Statistic are reported in brackets in the last row.

Table 2: OLS parameter estimates, 1990Q1-2007Q2

	(1)	(2)	(3)	(4)
$E_t[\pi_{t+1}]^{Forec}$	0.4640***	0.4413***	0.4043***	0.4719***
	(0.1146)	(0.1393)	(0.1337)	(0.1563)
π_{t-1}	0.7060***	0.6995***	0.7195***	0.6947***
	(0.0762)	(0.0858)	(0.0822)	(0.0888)
$GapCU_t$	0.0740**			
	(0.0331)			
$GapAvgCU_t$		-0.0065		
		(0.0178)		
$GapGDP_t$			-0.0435	
			(0.0296)	
ULC_t				1.1729
				(2.3234)
Constant	-0.2759***	-0.2890***	-0.0173	-0.3998
	(0.0829)	(0.0909)	(0.2045)	(0.243)
Observations	70	70	70	70
F-Statistic	312.6	253.3	351.1	216.6

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. Columns (1)-(4) report OLS estimates with Newey West corrected standard errors. The expected rate of inflation ($E_t[\pi_{t+1}]^{Forec}$) is the real-time consensus economics forecast for Switzerland, which is available from 1990 onwards only. In column (1) the measure for the Phillips curve relationship is $GapCU_t$ as proposed in this paper. Column (2) employs the deviation of capacity utilisation from its constant long-run average $GapAvgCU_t$ as measure for real activity. Column (3) employs the output gap $GapGDP_t$ calculated by a HP filter. Column (4) uses the unit labor cost measure ULC_t calculated by the KOF Swiss Economic Institute. P-values of the Hansen J-Statistic are reported in brackets in the last row.

The OLS estimates can be found in Table 2. To measure expected inflation, we employ the median forecast of professional economists for the next twelve months collected by Consensus Economics ($E_t[\pi_{t+1}]^{Forec}$).[10] As consensus economics data for inflation expectations is only available from 1990 onwards, the number of observations drops to 70. Analogous to Table 1, columns (1) to (4) report the estimates employing the different proxies for the output gap. In column (1) we report our estimates for the NAICU gap constructed in this paper. The estimated coefficient for the gap has a value of 0.07 and therefore it is somewhat higher than the GMM estimate. Also with OLS, the measure of the ouput gap is significant at the ten percent level. The coefficient on expected inflation is lower than the GMM coefficient, while the coefficient for lagged inflation is higher. Still, the estimates are close to the estimates in Galí et al. (2001) for Europe. As for the GMM results, neither of the other proxies for the output gap is significant at the ten percent level. These comparisons are encouraging and show some support for the gap measure derived from micro data, which we propose in this paper.

5 Conclusions

This paper proposes a straightforward method to derive an indicator of the Non-Accelerating Inflation rate of Capacity Utilisation (NAICU). We employ firm level survey data collected by the KOF Swiss Economic Institute, where we can directly observe a firm's current capacity utilisation rate *and* its current and desired price adjustments. Following the definition of the Non-Accelerating rate, we construct the NAICU by conditioning the capacity

[10]Consensus Economics conducts monthly surveys among professional economists from banks and public institutions. The survey asks for their expectations regarding inflation and other macroeconomic aggregates for the current and the upcoming year. The consensus forecast is the mean of these forecasts for the Swiss CPI. The data have been transformed to obtain a fixed one year ahead forecast horizon. The exact transformation proceeds as follows: for month m of a given year t , the expectation of inflation is defined as $(13-m)/12$ times the forecast for year t plus $(m-1)/12$ times the forecast for year $t+1$. We then employ the monthly series and aggregate it to a quarterly series by employing simple averages.

utilisation rate on no price adjustments. Compared to previous estimates of the NAICU, which usually assume that the NAICU is the long-term average of capacity utilisation rates across time, we see several advantages in this approach. First, it is available in real time and not subject to revisions. Second, it is based on the theoretical idea of a natural rate. Third, it takes into account firm level heterogeneity. Fourth, it takes into account time variability of the natural rate. Fifth, it does not require statistical methods for smoothing that imply end point problems or other forms of uncertainty. Included in a Phillips curve regression as an indicator for real activity, the NAICU is shown to outperform other measures such as unit labour costs or the output gap.

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Appendix

Table 3: Summary statistics

Variable	Obs.	Mean	Std:Dev.	Min	Max
π^{Forec}	71	1.741	1.125	0.555	4.416
π	90	1.826	1.638	-0.078	6.249
CU	90	85.503	2.687	79.175	90.625
$NAICU$	90	86.354	2.604	80.499	91.572
$GapCU$	90	-0.851	1.598	-4.967	3.271
$GapAvgCU$	90	0.000	2.687	-6.328	5.121
$GapGDP$	90	0.206	1.964	-4.190	4.416
ULC	90	0.030	0.063	-0.111	0.112