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Is There a Long Run Unemployment-Inflation Trade-off in Sweden?*

by

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Abstract

We present a small open economy version of Akerlof, Dickens and Perry (2000) and, based on Swedish data, we show that there exists a negatively sloped long run Phillips curve. Regressions on quarterly data 1963-2000 and estimated inflation expectations show that this Phillips curve is relatively robust and that an unemployment rate of close to two percent is consistent with an inflation target slightly above its present level of two percent. However, estimations based on survey data suggest that a considerably higher inflation rate, of around four percent, is necessary to yield a lowest sustainable unemployment rate. These latter estimates seem better adjusted to the recent Swedish macroeconomic experiences. If Sweden enters the EMU, and if the ECB targets inflation at a lower level than the Riksbank, employment as well as output will be lower than today. Moreover, if the inflation-unemployment trade-off differs widely across the member states of the EMU, then a single inflation rate in the EMU-area implies that long run unemployment rates will also differ across the member countries.

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1. Introduction

The notion of a negatively sloped Phillips curve has been at the center of economic policy discussions and macroeconomics ever since a model of the relation between inflation and unemployment was first presented in 1958.[1] The original form of this relationship reads $w_g = f(u) + kp$ where w_g is wage growth, u is unemployment, p is inflation and k is a constant. If inflation is interpreted as expected inflation, and if a fixed price mark-up is added, a negatively sloped price Phillips curve is obtained for the short run as well as the long run. This result provided policy makers for many years to come with an argument to intervene since it implies that the government has a choice between low inflation/high unemployment and low unemployment/high inflation by means of appropriate policy measures.

However, in the late sixties, Milton Friedman (1968) and Edmund Phelps (1968) pointed out that the value of the constant k is crucial for the interpretation of the long run Phillips curve. A value of k less than unity implies money illusion since wages then increase by less than prices. With a unit value of k the long run Phillips curve must be vertical at a "natural rate of unemployment". This observation suggested that governments should not intervene since, in the long run, unemployment cannot deviate from its natural rate. To this "natural rate" critique of Keynesian economic policy was later added the rational expectations revolution from which it was concluded that the government could not even stabilize unemployment around its natural rate.[2] Both of these highly influential schools thus concluded that the policy maker does *not* have a choice between unemployment and inflation. Since the natural rate is obtainable at any inflation rate, policy makers can only choose the inflation rate. In the late 20th century governments in many countries instructed their central banks to target inflation at historically low rates.

Despite the widespread recognition of the latter theories, the natural rate of unemployment has been notoriously difficult to identify in empirical studies. In particular, low and stable inflation rates have been shown to coexist with a wide range on unemployment rates. In recent years, studies by King and Watson (1994) and Fair (2000) have found that for the U.S. there exists a trade-off also in the long run between unemployment and inflation.

Also recent theoretical research has challenged the notion of a vertical long run Phillips curve by offering micro-economic rationales for a trade-

[1] Phillips (1958). See also Lipsey (1960).
[2] Lucas (1972), Sargent (1973).

off between unemployment and inflation. Akerlof, Dickens and Perry (1996), builds on the adverse effects of low inflation on real wage flexibility as originally discussed by Tobin (1972). Holden (2001) constructs a bargaining model based on legislation features that rules out nominal wage cuts and which gives workers a stronger bargaining position at low inflation. This, in turn, is shown to yield a higher unemployment level at low inflation rates. A basic feature of these studies, be it by assumption or by model prediction, is that agents for various reasons behave differently in low inflation periods than they do in high inflation periods.

A recent study by George Akerlof, William Dickens and George Perry (2000), (henceforth ADP) assumes a change in agents' behavior as the economy shifts between high and low inflation regimes. They specify a model that generates a negatively sloped long run Phillips curve at low rates of inflation. The point of departure, supported by numerical examples, is that at low inflation rates, firms' losses from disregarding inflation are modest. If inflation is disregarded at low inflation rates, the firm sets a lower wage and a lower price relative to nominal aggregate demand. Hence, unemployment can be sustained at lower levels than would be the case if inflation were fully accounted for. At high inflation, however, firms make large losses by neglecting inflation. Consequently, inflation will be fully accounted for, and wages and prices are adjusted to nominal aggregate demand, which implies that the long run Phillips curve regains its vertical position at high levels of inflation.

Their theoretical model is successfully estimated on U.S. data, and the results are surprisingly robust with respect to alternative data sources and specifications. Influenced by the ADP model, Wyplosz (2001) presents results using data on France, Germany, Switzerland and the Netherlands. He finds that the long-run unemployment rate is a non-linear function of inflation and his (preliminary) conclusion is that the ECB's view that very low inflation is good for the economy is not empirically supported.

A crucial feature of the ADP model is the identification of an inflation rate that minimizes unemployment. We denote this inflation rate the LSURI – the Lowest Sustainable Unemployment Rate of Inflation.[3] For the U.S., ADP find that macroeconomic policy should aim at an inflation rate between 1.5 and 4 percent if the lowest sustainable unemployment rate is to be obtained.

The notion of an LSURI is of a particular interest to countries like Sweden with an explicit inflation target. For instance, the inflation target of

[3] This lowest rate of unemployment need not be compatible with maximum output since productivity is low at minimum unemployment. See Section 3, below.

the Swedish Riksbank is set at two percent without much consideration of the question if this level of inflation is consistent with maximum output or minimum unemployment.[4] If an LSURI can be identified, this could constitute a reason to revise, upwards or downwards, the inflation target.

The idea of a rate of inflation that minimizes unemployment is however even more intriguing in face of the formation of the Economic and Monetary Union, EMU. Results in Wyplosz (2001) suggest that the European Central Bank should aim at an inflation rate of more than 5 %, i.e. way above the present inflation range of the ECB. Moreover, since a monetary union implies identical inflation rates across member countries, the uniform inflation rate that the ECB targets, below 2 percent, could well imply very different unemployment rates across the members. Unless LSURI is identical across European economies, individual countries could potentially obtain more output and employment outside the monetary union. In light of the fact that Sweden still is outside the union, information on the relationship between inflation and unemployment seems even more relevant.

The purpose of this paper is to estimate the ADP model on Swedish data so as to shed light on the effects of a two percent inflation rate and to see if other targets would tend to generate a lower long run unemployment level. Unlike ADP we will study a small open economy, which implies a dependence of data on external factors that need to be accounted for in the regressions.

Our regressions suggest that it is possible to come down to unemployment rates in the region of 2.0-2.5 percent. However, the inflation rate that yields this unemployment differs between regressions based on unobserved but estimated inflation expectations and observed data on expectations. Using estimated expectations our model suggests an inflation rate around 2.6 percent, while survey data imply a rate of approximately 4 percent.

In the next section we briefly present the microeconomic foundations of the basic assertion that agents, when setting wages and prices, do not fully account for inflation at low rates of inflation. We then proceed to the formal model in Section 3, and in Section 4 we present the empirical specification and our results. The final section offers some concluding remarks.

[4] Two percent, rather than zero, is chosen since it offers some margins to deflation.

2. Why inflation is disregarded at low rates

ADP offer a range of arguments as to why inflation would not be a major concern in wage- and price setting at low rates and we shall here only briefly review their arguments.

Firms are assumed to be either rational or "near-rational". One argument for why firms are not always fully rational is based on the psychology of perception, which suggests that an item must reach a threshold of importance before it is even perceived. This implies that firms would ignore factors that are considered to have only modest effects on profits. ADP show that losses from disregarding inflation are negligible at low inflation rates, and firms would then rather focus on other considerations of greater importance to profitability.[5] As Alan Blinder has argued, "a prominent definition of price stability is inflation so low that it ceases to be a factor in influencing decisions".[6] At a low enough inflation rate, nominal wage- and price contracts will be increasingly common.

An increase in inflation would lead to the setting of a higher wage or price, but the effect would be less than one for one. ADP offers several references to compensation consultants who advice against linking wage changes to changes in the cost of living. If automatic increases in wages and salaries are granted in response to inflation, this would reduce the amount of funds available to differentiate for performance.[7]

These arguments for why price increases not necessarily come through at full effect in wage increases are based on the assumption that the firm unilaterally sets the wage. For an economy like the Swedish where wages are partly bargained, one could argue that the Riksbank's explicit (two percent) inflation target would weaken the reasons to neglect inflation. The point of such a regime is that social partners can bargain for wage increases based on fairly "safe" forecast of two percent consumer price inflation for the contract period. This could increase the perception of inflation in firms where wages are bargained and ADP's argument above would apply only to wages and salaries unilaterally set by firms.

ADP argue that even if firms were rational, in the sense that they in all respects consider everything that can affect profits, they would not consider the actual inflation rate unless the employees fully appreciate the true

[5] As noted by ADP firms are, in this respect, no different from academic model builders who ignore factors that are of minor importance to the problem to be studied.

[6] Blinder et. al. (1998).

[7] ADP do not explain, however, why this argument would only be relevant at low rates of inflation.

inflation rate. There exist evidence that the lay public differs from professional economists in their views on inflation; wage and salary earners systematically underestimate the effects of inflation on the wages that their employers will want to pay them. The public would view inflation merely as a factor that reduces real wages, and unlike the economist, is unable to see that inflation also raises the nominal wage. This lack of general equilibrium thinking constitutes one reason for why wage- and price setters can be expected to less than fully incorporate low inflation rates. Also in this respect one can expect behavior to depend on the rate of inflation. Only at high enough inflation rates, when inflation is widely discussed in media and consumers see prices increase, will inflation enter workers' minds and can be considered to be a prominent argument in wage demands. Hence, both firms and workers are likely to pay attention to inflation only insofar that it exceeds some minimum level.

Both assumptions of near-rational firms or of rational firms with employees that underestimate the effects of inflation on the nominal wage will yield the same conclusion namely that the Phillips curve has a negatively sloped element at low rates of inflation. In fact, the model that we shall estimate can be thought of simply as a way of testing whether agents react differently to low inflation than to high inflation, irrespective of what the reason thereof may be. This means that even if we obtain evidence that low inflation is disregarded in wage and price setting, it is not possible for us to infer what the reasons thereof may be and, indeed, the true reason could be one that has not been mentioned above. It is only possible to conclude that evidence of a negatively sloped Phillips curve at low inflation levels is consistent with the presented arguments.

3. The model

Let $\overline{p}$ be the average consumer price level. For a small open economy, this price is determined as a weighted average of the prices set by domestic producers and foreign producers:

$$\overline{p} = (1-m)\overline{p}^d + m\overline{p}^m \qquad (1)$$

where $\overline{p}^d$ is the domestic consumer price, $\overline{p}^m$ the price of imported consumer goods, and m is the value of imports as a share of total consumption. Let M be the supply of money. The quantity theory, with a constant normalized to unity, then gives us real income (aggregate demand) as $M/\bar{p}$. We assume n monopolistically competitive firms that divide up total aggregate demand between them according to the relative prices for their respective goods. These firms may be either domestic or foreign but in the following we focus in solely on the behavior of domestic firms. Domestic firm i sets the price p_i^d for its product, and demand is divided between the firms according to the relative price for the output. This implies that demand for the output of firm i can be written as:

$$\frac{1}{n}\frac{M}{\bar{p}}\left(\frac{p_i^d}{\bar{p}}\right)^{-b} \tag{2}$$

where b is the price elasticity of demand.

There are two types of firms; rational firms indexed $j=r$ and near-rational firms, indexed $j=nr$. Firms set efficiency wages that minimize labor cost per efficiency unit. Effort (productivity) depends upon workers' outside opportunities. These are determined by two factors. The first is the standard argument that the higher is the unemployment rate the more effort is the worker willing to supply in order to avoid being laid off. The second argument is the perceived gap between the wage at their own firm and the outside wage. This perceived gap depends upon the current wage and a reference wage giving the perception of other workers' wages. Workers' reference wage is the same in the two types of firms, while firms, as shown below, will set different wages depending on whether they are rational or near-rational. Workers' actual effort in firm type j, e_j, is determined as:

$$e_j = -A + B\left(\frac{w_j}{w^R}\right)^a + Cu \tag{3}$$

where w_j is the wage paid by firms type j, w^R the worker's reference wage, u the unemployment rate, a a positive constant less than one and A, B and C are all positive constants. All workers determine the reference wage as $w^R = \bar{w}_{-1}(1+p^e)$, i.e. last years' average wage, $\bar{w}_{-1}$, plus expected inflation in consumer prices p^e.

Firms set prices and wages for the next period after having projected the effects of inflation on the reference wage of their workers. This *expected* reference wage, w^{eR}, determines the level of wages that a firm should pay. Let q_j denote, for firm type j, the share of expected inflation that is incorporated into the reference wage. If a firm is fully rational all expected inflation is considered and q_r = 1. For less than rational firms, or "near-rational" firms, we set $q_{nr} = 0$, which means that at low inflation a fraction of firms will totally disregard inflation for the reasons discussed in section 2.[8] For firm type j the expected reference wage is:

$$w_j^{eR} = \bar{w}_{-1}(1 + q_j p^e) \text{ for } j = r, nr. \tag{4}$$

We then see that only for rational firms (for which $q_r = 1$) will the reference wage be identical to workers' actual reference wage.

Let e_j^e be the effort that firm of type j expects to obtain from their employees. Firms know that unemployment will affect effort and hence they form expectations also about unemployment. Hence, firms paying w_j expect the effort level

$$e_j^e = -A + B\left(\frac{w_j}{w_j^{eR}}\right)^a + Cu^e \tag{3'}$$

where u^e is expected unemployment.

Since the two types of firms apply different reference wages, the wages they set will differ as well. The efficiency wage paid by each firm will be such that the unit labor cost in terms of expected effort (3'), w_j / e_j^e, is minimized. The first order condition implies that

$$w_j = \left[\frac{A - Cu^e}{B(1-a)}\right]^{1/a} w_j^{eR}. \tag{5}$$

The rational firm applies a higher reference wage and thus sets a higher wage than the near-rational firm, but, as seen in (5), the relation between the wage and the expected reference wage is identical in the two types of firms.

Wages are reset relative to the reference wage in each period and since wages in both types of firm are multiples of last period's average wage, they stand in the fixed ratio of $\frac{w_r}{w_{nr}} = (1 + p^e)$.

[8] One could assume that $0 \leq q_{nr} < 1$ in which case q_{nr} represents the share of inflation that is under-weighted. A similar interpretation applies in the case of rational firms with employees who underweight inflation.

Irrespective of the type of firms, prices are determined by a mark-up on the expected unit efficiency labor cost. The first order condition of the profit maximization problem implies that

$$p_j^d = \frac{b}{b-1}\frac{w_j}{e_j^e}, \tag{6}$$

where $b/(b\text{-}1)$ is the mark-up factor. Equation (6) shows that there is no long run one-to-one relationship between prices and wages. Changes in prices carry over not only to wages but also to productivity (effort) since the price is a mark-up on the wage in efficiency units and that inflation equals wage increases and productivity changes.

While $e_r = e_r^e$, actual and expected effort differ for near-rational firms, which must be considered when determining firm profits. Comparing (3) to (3') for $j=nr$ and using (5) we find that actual effort for near-rational firms obtains as $e_{nr} = e_{nr}^e((1+p^e)^{-a} + a - 1)/a$. With the demand function (2) and effort (3), profits, r_j, are determined as

$$r_j = \frac{M}{n\bar{p}}\left(\frac{p_j^d}{\bar{p}}\right)^{-b}\left[p_j^d - \frac{w_j}{e_j}\right] \tag{7}$$

where the term outside brackets represents firm j:s share of total demand and the brackets show the profits per unit of output sold, i.e. the price less the wage in units of actual effort. The losses of being near-rational rather than rational (i.e. the losses of neglecting inflation) are[9]

$$\frac{r_r - r_{nr}}{r_r} = 1-(1+p)^{b-1}\left[b-(b-1)\frac{a}{(1+p)^{-a}-1+a}\right]. \tag{8}$$

Analysis of (8) shows that at low levels of inflation the losses of being near-rational are low. (See ADP pp. 15-16.) Firms are assumed to be willing to accept small losses up to some level before they become fully rational and incorporate inflation into their wage- and price setting. Heterogeneity enters by assuming a normal distribution of this threshold with mean m and standard deviation s, and we obtain the fraction of near rational price setters as:

[9] In these calculations expected and actual inflation are assumed identical.

$$1-\Phi\left\{\frac{1-(1+p)^{b-1}\left[b-(b-1)\dfrac{a}{(1+p)^{-a}-1+a}\right]-m}{s}\right\}, \qquad (9)$$

where Φ is the standard cumulative normal distribution.

It is appropriate at this stage to summarize the equation system. The basic model consists of equation (1), two equations (4), equation (3), two equations (5) and two equations (6). These eight equations determine eight unknowns $\overline{p}, w_n^R, w_{nr}^R$, e, w_n, w_{nr}, p_r^d and p_{nr}^d on their level form. To obtain the Phillips-relation between changes in output price and the unemployment level, we shall transform these variables into their rate of change form, and determine Φ, which then is used to determine the average price level. It will then be straightforward to determine domestic price inflation in terms of unemployment and wage inflation.

To derive the price Phillips curve, we proceed as follows. Using equations (3') and (5) in equation (6) we may determine $p_{nr,t}^d$ and $p_{r,t}^d$. These are then used in

$$\overline{p}_t^d = \Phi p_{r,t}^d + (1-\Phi) p_{nr,t}^d \qquad (10)$$

which determines the average price level as a weighted average of prices of rational and near-rational firms. With the corresponding expression at *t-1*, and some tedious calculations, we obtain the change in domestic prices as

$$\frac{\overline{p}_t^d}{\overline{p}_{t-1}^d} = (1+p_t^d) = \left(\frac{A-Cu_t^e}{A-Cu_{t-1}}\right)^{\frac{1-a}{a}} (1+p_{w_{t-1}}) \frac{(1+\Phi p_t^e)}{(1+\Phi p_{t-1}^e)}. \qquad (11)$$

ADP derive (see their equation (13)) the short-run wage Phillips curve (with $q_{nr} = 0$) as $(1+p_{w,t}^d) = \left(\dfrac{A-Cu_t}{B(1-a)}\right)^{1/a} (1+\Phi p_t^e)$. Using the corresponding expression for one period back in (11) we obtain the short-run price Phillips curve as

$$(1+p_t^d) = \left(\frac{A-Cu_t^e}{A-Cu_{t-1}}\right)^{\frac{1-a}{a}} \left(\frac{A-Cu_{t-1}}{B(1-a)}\right)^{\frac{1}{a}} (1+\Phi p_t^e). \qquad (12)$$

Taking logs and making the same approximations as ADP yields

$$p_t^d = d - gu_t^e + \Phi p_t^e + g\Delta u_t^e . \qquad (13)$$

The change in expected unemployment enters here since this change will affect productivity. (Equation (13) deviates somewhat from the corresponding expression reported by ADP in their footnote 26.) Note that since we have an open economy, the LHS inflation rate refers to inflation in domestically produced and consumed goods while the RHS expected inflation refers to CPI.

The long run steady-state Phillips relation is characterized by equality between actual and expected inflation and by a constant (and known) unemployment rate. In our open economy version, where $p = (1\text{-}m)p^d + mp^m$ we assume that exchange rates adjust so that, expressed in domestic currency, $p^m = p^d = p$ holds for the long run. The Phillips relation then reduces to

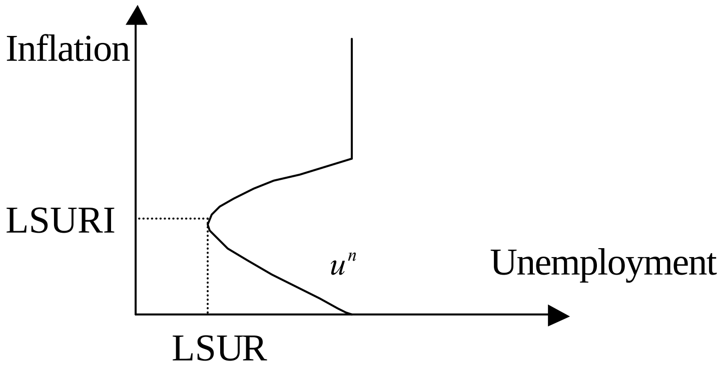
$$u^n - u = \frac{(1-\Phi)}{g}p \qquad (14)$$

where u^n may be denoted the "natural" rate of unemployment here defined as the rate that obtains when all firms are rational. This rate is obtained as $u^n = d/g$. Unemployment will remain at this rate for large enough inflation since Φ then equals one. The losses from disregarding inflation above a certain level (See ADP pp. 15-16) are large and firms will rationally include all inflation; hence Φ will be close to 1 at high inflation.

At $p = 0$, i.e. at price stability, actual unemployment is also at the natural rate since disregarding zero inflation then is rational. However, at low but positive inflation rates, the long run Phillips curve is no longer vertical. At these levels, firms are near-rational and disregard the inflation rate implying that they will set a wage rate that is lower than they would have if inflation were considered. With a lower wage, unemployment will be below the natural rate and the long run Phillips curve will include a negatively sloped segment.

At inflation rises, however, it will be more and more costly for firms to disregard inflation and they become more rational, i.e. they incorporate fully the inflation rate into wage and price setting. At some inflation rate, we enter a positively sloped segment of the Phillips curve that persists until inflation is so high that all firms are rational and the Phillips curve becomes vertical. This is illustrated in *Figure 1*.

Figure 1. A hypothetical Phillips curve



As is clear from *Figure 1*, there exists a lowest sustainable unemployment rate of inflation (LSURI) yielding the lowest sustainable unemployment rate (LSUR). However, in general this point does not maximize output. The point of output maximization is situated on the positive segment. This can be inferred by the following reasoning. As we raise inflation above zero, unemployment *decreases* and effort increases implying that output unambiguously goes up. Hence, LSURI is associated with a higher output level than any inflation rate lower than LSURI. However, as inflation increases above LSURI, unemployment *increases* while effort continues to increase. Thus, for any unemployment level between LSUR and u^n the points on the positive segment of the curve are superior to the corresponding point on the negative segment. Hence, while LSURI maximizes employment (minimizes unemployment), some point above LSURI maximizes output.

In the section that follows we proceed to determine the econometric specification of Ö.

Empirical specifications and data

In line with ADP, we approximate the argument in the standard normal c.d.f. as derived in (9) by $D + Ep_L^2$, where p_L^2 represents the effects of past inflation on the likelihood that people act rationally toward inflation and D and E are parameters. When ADP approximated the loss function by Ep_L^2 (where E was chosen so that the approximation was identical to the "true" loss at 5 percent inflation) this loss was never off by more than 3 percent of the true loss. Moreover, a constant term, D, is also included so as not to constrain the share of rational firms to 50 percent at zero inflation. (For the details, see the discussion in ADP pp.28-29.) The Phillips relation that we estimate becomes:

$$p_t^d = d + a_1 u_t^e + a_2 u_{t-1} + \Phi(D + Ep_{Lt}^2)p_t^e + kX_t + e_t \tag{15}$$

where d, D, E, a_1, a_2 and k are parameters, X is a vector of dummy variables, and e_i is the error term.

We proxy p_L by several different specifications suggested by ADP. One is a geometrically declining weighted moving average of past inflation:

$$p_{L,t} = (1-d)p_{L,t-1} + dp_{t-1} \tag{16}$$

in which d is estimated. An alternative specification is

$$p_{L,t} = \frac{\sum_{i=1}^{I}(1-il)p_{t-i}}{\sum_{i=1}^{I}(1-il)} \tag{17}$$

where l is estimated, i indexes quarters and I is set to 16 quarters back. In addition to these formulations, we also apply the following weighting procedure

$$p_{L,t} = \sum_{i=1}^{I} g_i p_{t-i}, \tag{18}$$

in which the parameters g_i are estimated ($0 \le g_i \le 1$ and $\sum_{i=1}^{I} g_i = 1$) and the lag length I is set to 16 quarters. To reduce the number of parameters in estimation we simplify (18) by restricting the g_i:s to be identical within each year.

Inflation expectations p^e are sometimes available in the form of survey data, but since such data often are missing the common practice is to estimate expectations. In determining p^e, we assume, like ADP do, adaptive expectation and apply (16)-(18) also for this variable. In addition, we also run regressions allowing the weights in (18) to differ across quarters. After having run the model based on these variations of adaptive expectations, we contrast the results thereof to those obtained using survey data on households' inflation expectations.

In determining expected unemployment, u^e, we set the lag length to either two or twelve periods. We first run regressions on open unemployment, but later vary these to include several alternative measures of unemployment.

Our relevant price inflation index for the dependent variable is one that measures prices of goods produced domestically and consumed domestically. For a closed economy, like the US for which ADP estimate their model, a relevant index may be the consumer price index. This, however, would not be the case for a small open economy like the Swedish. Taking the differences of (1), holding the import share constant, we may derive the relevant price inflation for goods produced and consumed in a small open economy as

$$p_t^d = \frac{\Delta p_t - m_t \Delta p_t^m}{p_{t-1} - m_t p_{t-1}^m} \tag{19}$$

which is our dependent variable.

We estimate the model using annualized quarterly data from 1963:1 to 2000:2. Our quarterly data are in turn based on the average value of the price level of the three months that constitute each quarter. To annualize our quarterly data we calculate the percentage change in the relevant price indices during the last four quarters.

Estimating the model for a small open economy implies that one must consider the dependence on external factors. As mentioned above, our dependent variable, inflation in products produced and consumed in Sweden, is determined as the difference between CPI and imported inflation. However, our inflation series for imported goods includes not only consumption goods but also intermediary goods. This introduces a measurement error into our domestic inflation series in periods when prices of intermediate goods move differently than prices of consumption goods. To account for this, we specify a number of dummy variables in particular to capture oil price increases in 1973-74 and 1979-1981 and decreases in 1986. Dummies also cover price hikes on food inputs in the early 1970s, the deviations between Swedish and foreign business cycles and the Swedish tax reform in 1990-91, and the extreme wage increases in 1995-96 that can be traced to foreign increases in prices of pulp and paper.

The variables are defined in greater detail in our appendix.

4. Results

Using maximum-likelihood methods we have estimated a total of 120 versions of the model by varying inflation expectations, measures of unemployment and sample periods. Out of these we consider 113 to have come out without any major problems in terms of identification, meaningful parameter estimates etc. For the remaining cases we ran into similar problems as ADP did for the US. For instance, in some of these regressions, the estimates of *D* and *E* tended to approach minus infinity and infinity, respectively. We cannot say whether this is because of data limitations or if data actually reject the hypothesis that Ö varies with inflation; if the true value of Φ is unity, *E* and *D* cannot be identified.

In the following result section we first focus on the results using estimated adaptive inflation expectations. We then compare these results to those obtained with survey data. These two different approaches are shown to yield interesting differences concerning the possibilities of minimizing unemployment at a low inflation rate.

4.1 Adaptive expectations

If the parameter *E* is zero, the coefficient on expectations will not vary with inflation, which would reject the theory. In 23 of our 24 regressions we find, though, that *E* is significantly positive as predicted by theory.[10] This is seen in *Table 1*, in which we present six estimations based on specifications that we believe are representative of our regressions. To get an overview of the full set of regressions, *Figure 2* displays the estimated lowest sustainable unemployment rate (LSUR) and the inflation that yields this rate (LSURI) in each regression. We find that the average estimate of the lowest unemployment is 2.08 percent, which is obtainable when inflation is targeted at 2.61 percent. We see in the figure that the vast majority of unemployment rates ranges between 1.6 and 2.5 percent and that most inflation rates range between 2.0 and slightly above 3.0 percent. We believe that these variations are small, considering the changes that we have made in the way expectations are formed across the regressions.

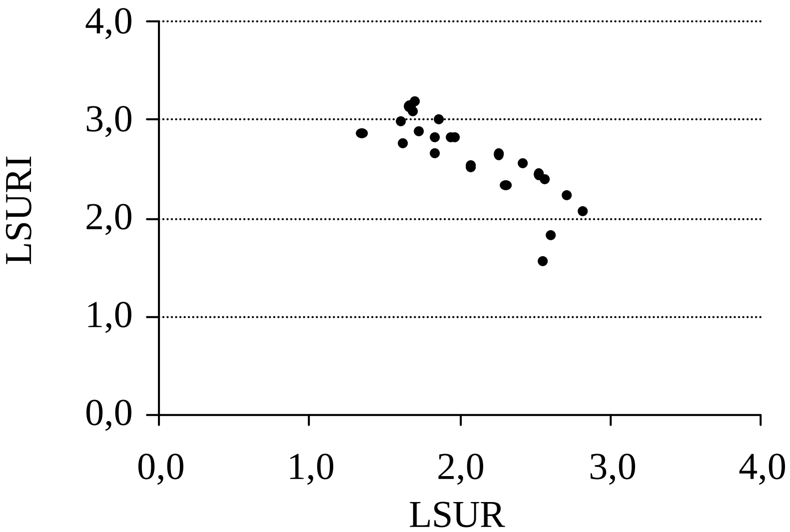
[10] As discussed in section 2, we use four alternative measures for p^e, three measures for p_L, and two alternative lag lengths for unemployment. This gives us 24 possible combinations. In one regression we obtained estimates that implied a Ö-coefficient equal to unity. We disregard this single regression in the following presentation.

Table 1. Estimated parameters for the long run Phillips curve 1963-2000[a]

Independent variables and characteristics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Constant	0.017 (5.07)	0.015 (3.73)	0.015 (4.13)	0.011 (2.94)	0.014 (4.08)	0.011 (3.36)
u_{t-1}	-1.177 (-2.55)	-0.975 (-1.85)	-1.139 (-2.41)	-1.070 (-2.00)	-1.089 (-2.36)	-1.035 (-2.02)
u_{t-2}	0.834 (1.78)	-0.002 (-0.01)	0.773 (1.60)	0.249 (0.28)	0.780 (1.67)	0.203 (0.22)
D (constant in coefficient on expectations)	-0.315 (-0.96)	0.047 (0.10)	0.259 (0.55)	0.466 (0.71)	0.141 (0.33)	0.570 (0.77)
E (coeff. of p_L in coeff. on expectations)	695.87 (3.43)	557.36 (2.28)	570.73 (4.58)	663.69 (2.95)	653.85 (3.73)	689.36 (3.04)
Method for constructing p_L	Geometrically declining weights, eq. (16)	Geometrically declining weights, eq. (17)	16-quarter MA with different weights for each year, eq. (18)	Geometrically declining weights, eq. (16)	Geometrically declining weights, eq. (17)	16-quarter MA with different weights for each year, eq. (18)
Method for constructing p^e	Geometrically declining weights, eq. (17)	16-quarter MA with different weights for each year, eq. (18)	16-quarter MA with different weights for each year, eq. (18)	Geometrically declining weights, eq. (16)	16-quarter lag with different weights for each quarter, eq. (18)	16-quarter lag with different weights for each quarter, eq. (18)
Unemployment measure	Open unempl.	Open unempl.	Open unempl.	Open unempl.	Open unempl.	Open unempl.
No. of unempl. lags	2	12	2	12	2	12
Sample period	1963:1-2000:2	1963:1-2000:2	1963:1-2000:2	1963:1-2000:2	1963:1-2000:2	1963:1-2000:2
LSURI	**2.98**	**2.81**	**2.64**	**2.38**	**2.54**	**2.23**
LSUR	**1.61**	**1.94**	**2.26**	**2.57**	**2.08**	**2.71**
$\Phi(p=0.0)$	30.0	51.9	60.2	67.9	55.6	71.6
$\Phi(p=2.0)$	39.9	60.6	68.7	76.4	65.5	80.1
$\Phi(p=4.0)$	70.7	82.6	87.9	93.1	88.2	95.3
$\Phi(p=6.0)$	97.0	98.0	99.0	99.7	99.4	99.9
$u(p=0.0)$	5.28	4.66	4.11	4.65	4.43	4.19
$u(p=2.0)$	2.15	2.23	2.40	2.63	2.21	2.73
$u(p=4.0)$	2.23	2.51	2.79	3.46	2.91	3.50
$u(p=6.0)$	4.81	4.29	3.94	4.57	4.31	4.17
DW-statistic	1.531	1.506	1.348	1.619	1.518	1.551
R^2	0.868	0.873	0.860	0.871	0.879	0.886

[a] Asymptotic t-values in parentheses. Detailed results for all regressions are available on request.

Figure 2. Lowest sustainable unemployment rate



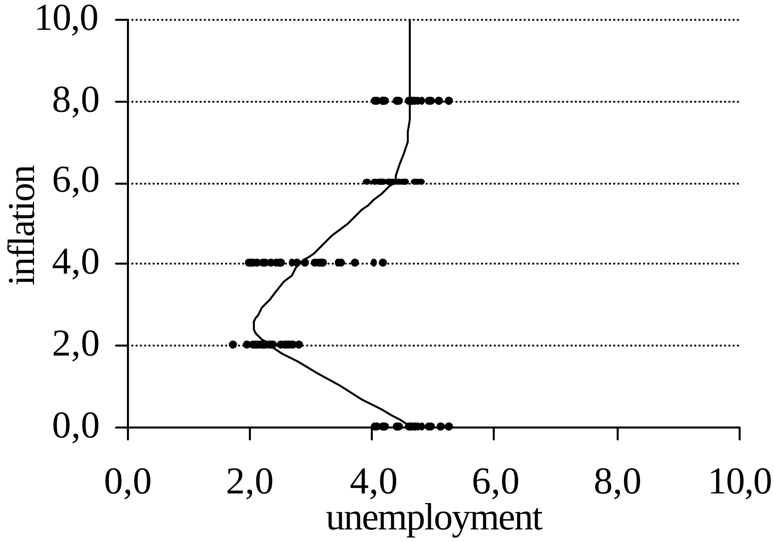
Source: Estimates from 23 regressions as described in the text. The mean of LSURI and LSUR is 2.61% and 2.08 %, respectively.

For the US, ADP report that the inflation rate that minimizes the rate of unemployment ranges between 1.6 and 3.4 percent. In comparison, the average LSURI in *Figure 2* is almost in the middle of the range obtained for the US. The lowest sustainable unemployment rate, however, is in general considerably higher for the US than for Sweden. ADP report that the lowest sustainable unemployment often exceeds 4 percent. Thus, the potential for achieving a sustainable and low unemployment rate seems considerably better for Sweden than for the US.[11]

In *Figure 3* we have plotted each estimated unemployment rate obtained at 0, 2, 6 and 8 percent inflation and fitted the Phillips curve through the average open unemployment rate at these inflation rates. To this we have then added the average LSUR/LSURI point to obtain the full Phillips curve. This “average Phillips curve” becomes vertical at around 7 percent inflation, implying that all agents are fully rational at this inflation rate. We also see from *Table 1* that the share of rational firms Φ at zero inflation varies across these models from 30 percent (model 1) to 72 (model 6). Thus, already at price stability a large share of the firms appears to act fully

[11] Note that this holds for open unemployment. The results are different when we measure unemployment in terms of *total* unemployment, i.e. when we include workers in labor market programs. Later in this section we shall show that the Swedish LSUR then becomes comparable to the US LSUR.

Figure 3. The Phillips curve



rational, i.e. to fully incorporate inflation into their wage and price decisions. Nevertheless, this share is small enough to yield the expected shape of the Phillips curve. At six percent inflation, the lowest share of fully rational firms is 97 percent implying that almost all firms take inflation into account at this rate. The share of rational firms at 6 percent is somewhat higher than that obtained by ADP for their US sample suggesting that adjustment is slightly faster in Sweden as inflation rises.

Figure 4. Coefficient on inflation 1963-2000

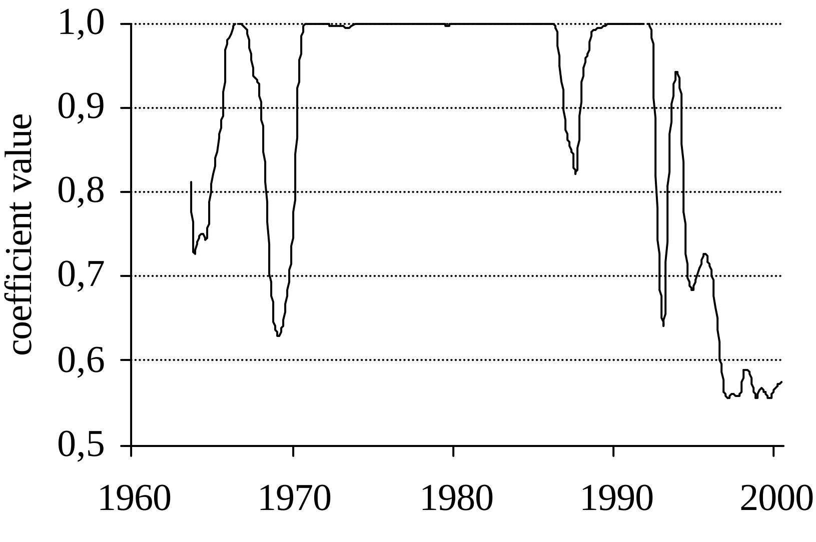


Figure 4 shows how the value of the coefficient on inflationary expectations Φ changes over time in one of the representative models.[12] There are large variations within the zero to unity range. The share of rational firms that fully incorporate inflation into wage- and price setting dropped to very low levels in the late sixties but increased rapidly to unity again when inflation increased in the early seventies. The ceiling of 1 was hit during most of the seventies and eighties. Then there is a large drop in the share of rational firms in the nineties when inflation dropped to close to zero. The overall impression is that firms react fast to changes in the rate of inflation.

The curvature of the "average Phillips curve" in *Figure 3,* may be used to illustrate the gains in terms of employment by changing the rate of inflation, for instance by moving from zero inflation to the rate that yields the minimum long run unemployment rate.[13] The marginal gains are the largest as we leave absolute price stability, and the gains are gradually reduced as we approach LSURI at 2.61 percent. The average unemployment reduction is close to 2.56 percentage points.[14] Our results therefore suggest that gains are to be made by allowing for tolerance towards inflation. In the last ten years, Sweden has experienced episodes of almost price stability combined with historically very high unemployment rates of around 8 percent. A monetary policy based on price stability appears to be connected with substantial costs in terms of high unemployment and production foregone.

Our estimated LSURI exceeds the present Swedish inflation target of 2 percent, which indicates that unemployment could be reduced further if inflation were targeted at just a slightly higher rate. At the present inflation target the minimum unemployment rate is, on average, 2.31 percent. The gain from accepting the slightly higher LSURI of 2.61 percent is .23 percentage points. If the European Central Bank targets inflation lower than two percent, Swedish membership in EMU would imply an even higher long run unemployment rate.

Robustness tests

So far, the results have indicated a great deal of robustness to variations in adaptive expectations. However, we are also interested in investigating how the model performs with respect to other definitions of unemployment and to other sample periods. We first explore the relationship between inflation and total, rather than open, unemployment. Since government expenditures

[12] This is model 5 of *Table 1.* Other models in *Table 1* yield similar curves.

[13] The gains from accepting an inflation rate at LSURI are also obvious in *Table 1.*

[14] Comparing this figure to the corresponding one in ADP we find that the average gain seems to be larger in Sweden. See Akerlof, Dickens and Perry (2000), Figure 9.

affect open unemployment, and also change over the business cycle, one could argue that total unemployment better captures the relevant labor market situation. We therefore want to see if the LSURI we obtained based on open unemployment also will yield a lowest sustainable total unemployment. Moreover, using total unemployment may simplify a comparison of our results to those that ADP obtained for the US since open unemployment would be considerably higher in Sweden in the absence of labor market programs.

Figure 5. The Phillips curve: total and open unemployment

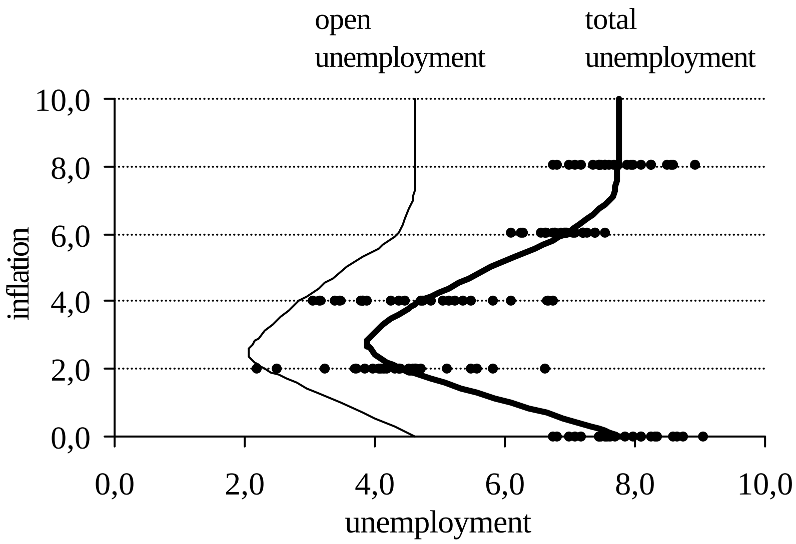


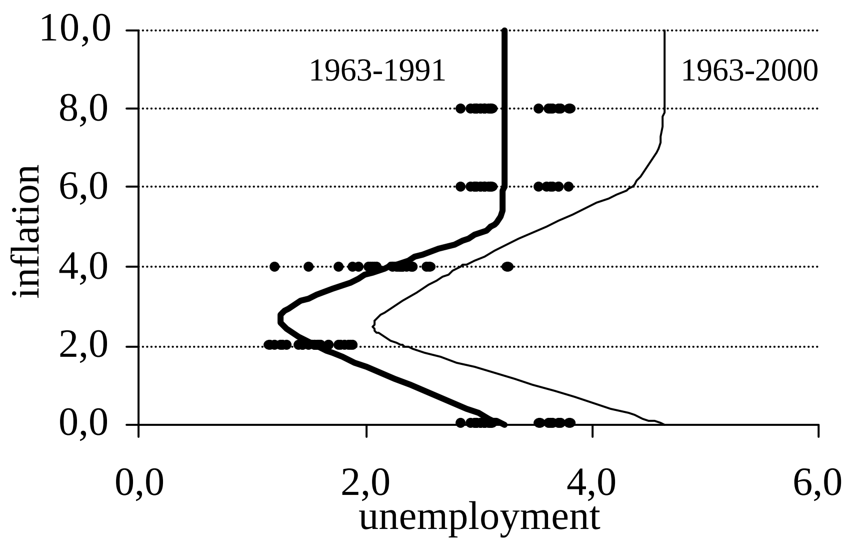
Table A1, models A1 and A2, in the appendix displays some selected results based on total unemployment. A comparison with the results in Table 1 above show that the LSURI estimates are similar. In Figure 5, we show the long run Phillips curve for total unemployment and, for comparison, we have reproduced the curve based on open unemployment (see Figure 3). If the purpose is to minimize the sustainable total unemployment, inflation should be at 2.83 percent, i.e. at approximately the same rate as previously obtained for open unemployment. The lowest sustainable total unemployment rate is 3.89 percent. While this figure is considerably closer to the LSURs estimated by ADP it still falls short of what appears to be the most common lowest unemployment rates in their study.[15] Many of their estimated LSURs exceed 4 percent.

[15] ADP never present an "average" estimate of their LSURs to which we may compare our estimates.

For sake of comparison with the results of ADP, we have also run some regressions based on prime aged males. The results based on open unemployment among males of ages 25-54 are presented in *Table A1* (models A3 and A4). As expected, this yielded considerably lower LSURs, but the corresponding inflation rates do not differ much from those previously obtained.

The turbulent Swedish labor market of the 1990s involved a major increase in unemployment and a drastic decrease in inflation. It seems reasonable to test if the exclusion of the 1990s yields very different results. In *Figure* 6 we show the Phillips curve for 1963:1-1991:2 and (again) the Phillips curve for the period 1963:1-2000:2 . Excluding the 1990s implies a leftward shift of the curve: at a just slightly higher inflation rate than for 1963-2000, the average lowest sustainable unemployment rate is now as low as 1.26 percent. This result therefore suggests that the inclusion of the turbulent 1990s in data has some effect on LSUR, while the inflation rate remains stable.[16] The observed change in *Figure 6* could indicate that some parameter shifts may have occurred during the 1990s, which our model is unable to capture accurately. However, re-estimating the model for the period 1963-2000 and adding a dummy shift variable for the 1990s did not yield a significantly different Phillips curve.

Figure 6. The Phillips curve: 1963-1991 and 1963-2000



[16] *Table A1*, models A5 and A6, reports some results based on the period up until the 1990s. In particular the latter model yields a very low sustainable unemployment rate only slightly exceeding the 1 percent level.

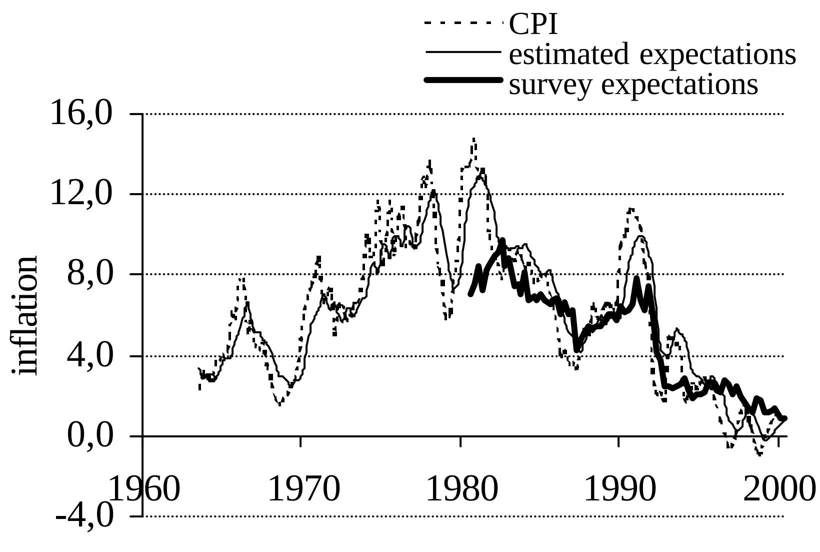
4.2 Direct measures of expected inflation

Since direct measures of expectations often are missing, the standard practice in macroeconomic studies is to estimate adaptive expectations. It is far from obvious that such estimations capture households' true expectations on inflation. To illustrate this point, *Figure 7* contrasts the estimated adaptive expectations based on model 5 in *Table 1* to survey data on households' expectations which is available for the period 1979:3-2000:2. The estimated series follow CPI quite closely, which should come as no surprise since past CPI determines the estimated adaptive expectations. Notable is that there are apparent deviations from the directly measured inflation expectations. Given that the survey data better reflect households' true inflation expectations, one might suspect that the results obtained above could be misleading.

Although, our survey data are restricted to the period 1979:3-2000:2, which precludes a perfect comparison of survey data and estimated expectations, we shall re-estimate the model using these data. Since the results suggest that the length of the sample period may matter for the results, we then proceed by imputing survey data for the period 1963:1-1979:2 and estimate the model on a full survey data series for 1963:1-2000:2.

The results of some of our regressions using survey data 1979:3-2000:2 are reported in *Table 2* as models 1, 2 and 3. In general, these data yield a LSUR that is higher than for estimated adaptive expectations. This can be seen in *Figure 8*, which plots the combinations of LSUR and LSURI

Figure 7. CPI and expected inflation



in our regressions. The average LSUR using survey data is 2.85 percent while estimated expectations yield 2.08 percent. Also the average LSURI has increased, from 2.61 percent to 4.01.[17]

Thus, not only is LSUR higher with survey data, but the corresponding LSURI is also considerably higher. There are several possible reasons for these differences. First, since the 1990s make up almost half of the sample period in the regressions based on survey data the differences could be the result of changes in the Swedish economy in this decade. Secondly, the short sample period could have introduced small sample bias. Finally, they could be the result of survey data yielding different results than estimated expectations. To shed further light on the issue we *imputed* survey data for the period 1963:1-1979:2 and added this series to the survey data 1979:3-200:2 to obtain a full series for 1963:1-2000:2.[18]

Table 2, models 4-6, show detailed results from some regressions based on our extended survey data set. As seen in *Figure 8*, the LSURs are now similar to those obtained with estimated expectations. The average LSUR is now 2.29. This suggests that the higher LSUR reported for our survey-based regressions may be the result of the sample period. We also see that the LSURIs are more in line with those obtained from the limited survey data. The average LSURI is now 4.24 percent.

To sum up, *Figure 9*, shows three representative Phillips curves for the three alternative assumptions of how expectations are formed. Regressions based on the two survey data sets suggest that inflation needs to be around 4 percent in order to be compatible with the lowest sustainable unemployment while adaptive expectations suggest a considerably lower LSURI. However, there are differences between the estimations based on survey data only and survey *cum* imputed data as the latter series, generates lower unemployment rates. This strongly suggests that the reason why survey data 1979:3-2000:2 yield considerably higher unemployment rates is the sample period.

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[17] This is the average of only six regressions.

[18] We fitted a regression model that determines our survey data as a non-linear function of lagged CPI and predicted a series for the 1963:1-1979:2 period. To study the effects of the small sample, an alternative approach would be to perform regressions based on estimated expectations for the same period, 1979:3-2000:2. However, the results of this approach did not come out well, presumably because the complexity of our non-linear model causes the estimates to suffer from small sample bias.

Table 2. Estimated parameters for the long run Phillips curve[a]

Independent variables and characteristics	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Constant	0.032 (6.17)	0.042 (8.48)	0.035 (6.25)	0.044 (10.0)	0.039 (9.49)	0.043 (9.90)
u_{t-1}	-0.595 (-1.40)	-0.896 (-1.66)	-0.223 (-0.53)	-0.904 (-1.54)	-0.405 (-0.79)	-0.952 (-1.59)
u_{t-2}	0.169 (0.39)	-0.870 (-0.85)	-0.249 (-0.59)	0.630 (0.66)	-0.111 (-0.22)	0.606 (0.52)
D (constant in coefficient on expectations)	-1.126 (-1.79)	-0.906 (2.03)	-0.509 (-1.58)	-1.306 (3.81)	-1.356 (3.54)	-1.318 (-3.59)
E (coeff. of p_L in coeff. on expectations)	578.51 (2.63)	451.83 (3.46)	373.20 (4.76)	442.75 (4.59)	688.38 (4.61)	451.61 (4.23)
Method for constructing p_L	Geometrically declining weights, eq. (16)	16-quarter MA with different weights for each year, eq. (18)	Geometrically declining weights, eq. (17)	Geometrically declining weights, eq. (16)	16-quarter MA with different weights for each year, eq. (18)	Geometrically declining weights, eq. (17)
Method for constructing p^e	Survey data	Survey data	Survey data	Survey data for 1979:3-2000:2, imputed survey data for 1963:1-1979:2.	Survey data for 1979:3-2000:2, imputed survey data for 1963:1-1979:2.	Survey data for 1979:3-2000:2, imputed survey data for 1963:1-1979:2.
Unemployment measure	Open unempl.	Open unempl.	Open unempl.	Open unempl.	Open unempl.	Open unempl.
No. of unempl. lags	2	12	2	12	2	12
Sample period	1979:3-2000:2	1979:3-2000:2	1979:3-2000:2	1963:1-2000:2	1963:1-2000:2	1963:1-2000:2
LSURI	**3.76**	**4.01**	**3.97**	**4.50**	**3.83**	**4.47**
LSUR	**2.09**	**2.96**	**3.52**	**2.31**	**2.35**	**2.26**
$\Phi(p=0.0)$	13.0	18.2	30.5	9.6	6.3	9.4
$\Phi(p=2.0)$	18.5	23.4	36.0	13.0	10.4	12.8
$\Phi(p=4.0)$	42.0	42.7	53.5	27.5	33.2	27.6
$\Phi(p=6.0)$	83.1	76.4	79.8	61.3	82.7	62.1
$u(p=0.0)$	7.57	6.52	7.45	7.26	7.55	7.22
$u(p=2.0)$	3.75	4.14	4.74	4.35	4.08	4.29
$u(p=4.0)$	2.13	2.96	3.52	2.42	2.37	2.35
$u(p=6.0)$	5.18	4.33	4.89	3.38	5.54	3.40
DW-statistic	1.002	1.150	1.056	1.544	1.283	1.432
R^2	0.933	0.948	0.931	0.876	0.847	0.872

[a] Asymptotic t-values in parentheses. Detailed results for all regressions are available on request.

Figure 8. Lowest sustainable unemployment rate

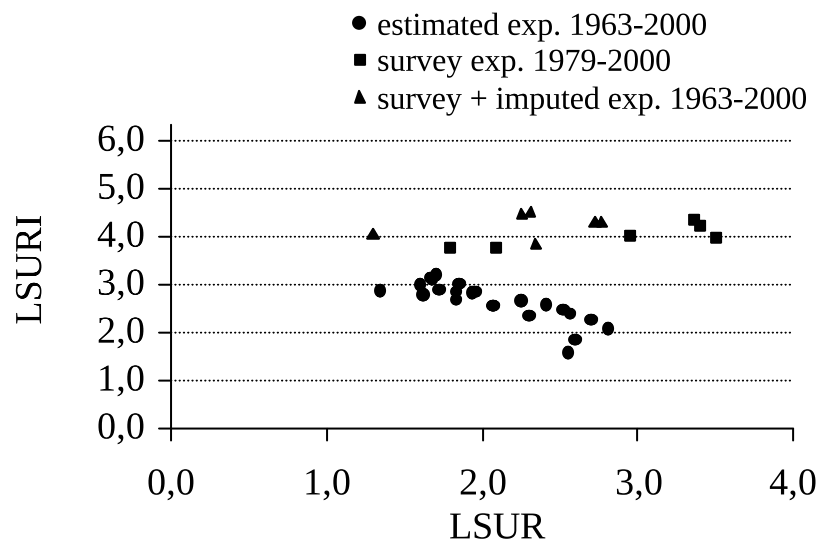
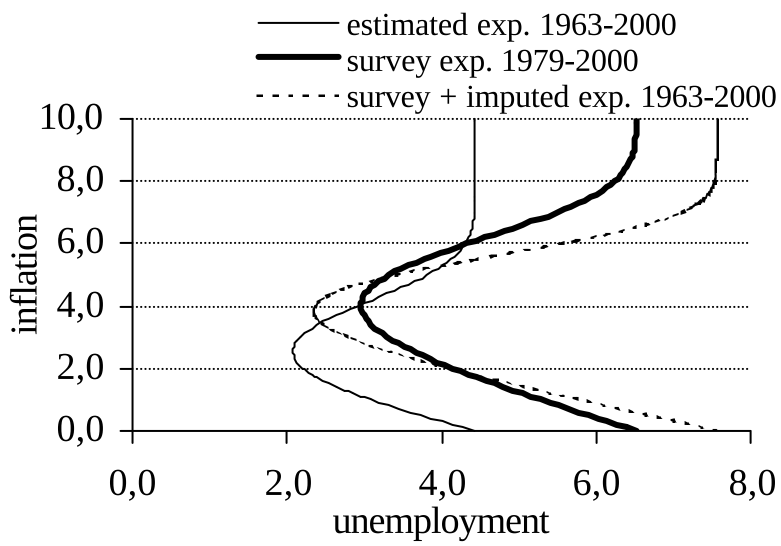


Figure 9. The Phillips Curve



Note also that the survey *cum* imputed data suggest a very high unemployment rate at price stability, i.e. at zero inflation. There appear to be extreme costs in terms of high unemployment, around 7.5 percent, by aiming at price stability. Comparing LSUR to the unemployment rate at zero inflation $u(p=0.0)$ in *Table 2* we see that there are very large potential gains by moving from price stability to the inflation rate that minimizes unemployment.

We have estimated *long run* Phillips curves and it is not obvious how they should be related to the present macroeconomic situation. As of today, the Riksbank has maintained the 2 percent inflation target for eight years. Unemployment has since 1997 come down from around 8 percent and appears to have stabilized at a level somewhat above 4 percent. A possible interpretation is that unemployment has stabilized at a rate consistent with the inflation target. At 2 percent inflation, estimations on survey *cum* imputed data suggest an unemployment rate almost exactly at the actual unemployment slightly exceeding four percent. Moreover, during the periods of price stability and deflation in Sweden, the unemployment rate was around 8 percent, also in line with the regression results based on these data.

Our results based on estimated expectations suggest that, on average, 2 percent inflation corresponds to 2.3 percent unemployment, which is way off the present situation. Thus, if one interprets the present macroeconomic situation as reflecting one of the long run, the survey *cum* imputed data appear consistent with actual data, while the results based on estimated expectations do not.

5. Concluding remarks

The ADP model suggests that the standard NAIRU model is not very robust with respect to alternative assumptions. Based on a range of evidence on decision-making, actual reactions to inflation, actual wage setting etc. and having shown that disregarding inflation is not costly to firms at low levels of inflation, a model is derived that yields a long run trade-off between inflation and unemployment at low levels of inflation. Only when inflation is high, and enters wage-and price setters' perceptions, will inflation be fully considered and unemployment will stabilize around a fixed level.

The derived shape of the long run Phillips curve suggests why it has been difficult to estimate a NAIRU point, particularly at low inflation rates. The empirical results presented in our paper for Sweden and in the ADP study for the US strongly suggest that different forces are at work at low inflation levels than at high inflation levels. The crucial aspect is the fairly general specification of the coefficient on expected inflation that in principle could capture anything that makes this coefficient contingent on the level of inflation. As such, one could see the estimated model as considerably more general and that it captures any reason for why the coefficient would depend on the inflation level.

The theory on which our estimations rely specifies the lowest sustainable unemployment rate and an inflation rate that yields this rate (LSURI). However, this rate is in general not the point that maximizes output, since productivity in the economy is not maximized at LSURI. GDP maximization would involve accepting an even higher inflation rate than LSURI, and also accepting a higher unemployment rate. Output will be higher on the positively sloped part of the Phillips curve than on the negatively sloped part.

Our estimations based on survey *cum* imputed data suggest that if the Swedish inflation target is raised from 2 percent to around 4, unemployment could in the long run settle at slightly above 2 percent. This point of a minimum unemployment is lower than the figure ADP estimate for the US, and we should in general find that these lowest long run unemployment rates differ across countries. Regressions based on different adaptive expectations schemes, suggest that inflation around 2.6 percent is consistent with unemployment around 2 percent. These data therefore suggest that the present inflation target is less off the one consistent with the lowest sustainable rate of unemployment.

There is not much in favor of the idea that the inflation rate that minimizes unemployment should be identical across the EMU member states.[19] This is of course an empirical issue but if this is the case, the single inflation rate that the European Central Bank targets could imply large differences in the long run unemployment rates across the member countries. Our results also suggest that if Sweden joins the EMU and the ECB continues to aim at an inflation rate less than 2 percent, long run unemployment will rise in Sweden and we would move further away from a point of maximum output.

[19] Cf. Wyplosz (2001).

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Appendix

CPI (Consumer Price Index):
1959:1-2000:2 from Statistics Sweden.
Our quarterly data are calculated as arithmetic averages of the monthly figures.
We use an annualized inflation rate, obtained by $(CPI_t\text{-}CPI_{t-1})/CPI_{t-1}$.

IPI (Import Price Index):
1963:1-2000:2 from Statistics Sweden.
This index reflects the prices of goods imported to Sweden. Our quarterly data are calculated as arithmetic averages of the monthly figures.

Import shares:
1963-2000 from Statistics Sweden.
For each year we calculate the value of goods and services imported to Sweden as a share of GDP at market prices. We then assign the same import share to each quarter.

Survey data on expected inflation:
1979:3-2000:2 from the National Institute of Economic Research. Quarterly data on households' expectations on CPI one year ahead, collected every quarter.

Unemployment:
1959:1-2000:2 from Statistics Sweden (AKU).
Seasonally adjusted data on open unemployment as a share of the labor force (aged 16-64).

Total unemployment:
1965:1-2000:2 from Statistics Sweden (AKU). Seasonally adjusted data on open unemployment plus workers in active labor market programs (aged 16-64).

Male unemployment:
1959:1-2000:2 from Statistics Sweden (AKU). Seasonally adjusted data on open unemployment for men aged 25-54

Dummy variables:

1. D1=1 for 1970:3-1970:4, zero otherwise.
2. D2=1 for 1973:1-1974:1, zero otherwise.
3. D3=1 for 1974:3, zero otherwise.
4. D4=1 for 1975:3, zero otherwise.
5. D5=1 for 1979:1-1980:1, zero otherwise.
6. D6=1 for 1980:2-1981:3, zero otherwise.
7. D7=1 for 1981:4-1983:3, zero otherwise.
8. D8=1 for 1986:1-1986:4, zero otherwise.
9. D9=1 for 1990:1-1991:2, zero otherwise.
10. D10=1 for 1995:3-1996:2, zero otherwise.

Table A1. Estimated parameters for the long run Phillips curve[a]

Independent variables and characteristics	***Model A1***	***Model A2***	***Model A3***	***Model A4***	***Model A5***	***Model A6***
Constant	0.016 (4.32)	0.012 (2.76)	0.013 (2.39)	0.012 (3.82)	0.036 (3.28)	0.028 (2.85)
u_{t-1}	-0.535 (-1.47)	-0.145 (-0.29)	-0.996 (-2.12)	-0.113 (-0.19)	-1.245 (-1.64)	-1.059 (-1.17)
u_{t-2}	0.322 (0.89)	0.029 (0.04)	0.700 (1.51)	-1.117 (-1.11)	0.012 (0.02)	1.106 (1.00)
D (constant in coefficient on expectations)	0.168 (0.40)	0.598 (1.07)	0.090 (0.16)	0.187 (0.41)	-1.746 (2.08)	-1.489 (1.79)
E (coeff. of p_L in coeff. on expectations)	541.04 (2.87)	400.03 (3.64)	668.45 (4.44)	587.17 (3.13)	1368.6 (3.36)	1351.2 (2.42)
Method for constructing p_L	Geometrically declining weights, eq. (16)	Geometrically declining weights, eq. (17)	Geometrically declining weights, eq. (16)	Geometrically declining weights, eq. (17)	16-quarter MA with different weights for each year, eq. (18)	Geometrically declining weights, eq. (16)
Method for constructing p^e	16-quarter lag with different weights for each quarter, eq. (18)	16-quarter lag with different weights for each quarter, eq. (18)	Geometrically declining weights, eq. (16)	16-quarter MA with different weights for each year, eq. (18)	16-quarter lag with different weights for each quarter, eq. (18)	Geometrically declining weights, eq. (17)
Unemployment measure	Total unempl.	Total unempl.	Male unempl.	Male unempl.	Open unempl.	Open unempl.
No. of unempl. lags	2	12	2	12	2	12
Sample period	1965:1-2000:2	1965:1-2000:2	1963:1-2000:2	1963:1-2000:2	1963:1-1991:2	1963:1-1991:2
LSURI	**2.77**	**2.91**	**2.54**	**2.65**	**2.86**	**2.70**
LSUR	**4.06**	**4.26**	**1.67**	**1.61**	**1.32**	**1.18**
$\Phi(p=0.0)$	56.7	72.5	53.6	57.4	4.0	6.8
$\Phi(p=2.0)$	65.0	77.6	63.9	66.4	11.5	17.1
$\Phi(p=4.0)$	84.3	89.2	87.7	87.0	67.1	74.9
$\Phi(p=6.0)$	98.3	97.9	99.4	98.9	99.9	100.0
$u(p=0.0)$	7.70	7.59	4.26	3.95	2.99	3.54
$u(p=2.0)$	4.41	4.65	1.82	1.79	1.58	1.45
$u(p=4.0)$	4.87	4.76	2.59	2.28	1.94	2.28
$u(p=6.0)$	7.21	6.78	4.14	3.75	2.98	3.53
DW-statistic	1.524	1.534	1.500	1.523	1.509	1.797
R^2	0.876	0.891	0.872	0.872	0.839	0.839

[a] Asymptotic t-values in parentheses. Detailed results for all regressions are available on request.

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