The Possible Unemployment Cost of Average Inflation below a Credible Target

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Issue

- Average inflation below target in Sweden 1997-2011
- Average inflation expectations (Prospera) close to target 1997-2011

Questions to be answered:

- If inflation expectations stuck at target when average inflation deviates from target, non-vertical long-run Phillips curve?
- If lower average inflation, higher average unemployment?
- If estimates of sustainable unemployment rate based on historical averages, bias?
- Policy conclusions for the future?
The data:
Unemployment, CPI inflation, and CPI inflation expectations (Prospera) 1996-2011

5-year moving averages:
CPI inflation expectations close to 2 %,
CPI inflation below 2 %
Before 1996: High CPI inflation expectations (Aragon)

Riksbank graph: "Inflation target crecible"
### Average inflation in some countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Target</th>
<th>Index</th>
<th>Period</th>
<th>Average</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>2 (1995-)</td>
<td>CPI</td>
<td>1997-2011</td>
<td>1.4</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>2 (1995-)</td>
<td>CPI</td>
<td>1997-2007</td>
<td>1.3</td>
<td>-0.7</td>
</tr>
<tr>
<td>Australia</td>
<td>2-3 (1993-)</td>
<td>CPI</td>
<td>1997-2011</td>
<td>2.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Canada</td>
<td>2 (1995-)</td>
<td>CPI</td>
<td>1997-2011</td>
<td>2.0</td>
<td>0.0</td>
</tr>
<tr>
<td>UK</td>
<td>2.5 (1992-2003)</td>
<td>RPIX</td>
<td>1997-2003</td>
<td>2.4</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>2 (2004-)</td>
<td>CPI</td>
<td>2004-2007</td>
<td>2.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>2 (2004-)</td>
<td>CPI</td>
<td>2008-2011</td>
<td>3.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Euro zone</td>
<td>(&lt; 2) (1999-)</td>
<td>HICP</td>
<td>2000-2011</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>(≤ 2) (2000-)</td>
<td>core CPI</td>
<td>2000-2011</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>core PCE</td>
<td>2000-2011</td>
<td>1.9</td>
<td></td>
</tr>
</tbody>
</table>

### Non-rational inflation expectations

- Prospera inflation expectations not rational (Jonsson and Österholm 2012)
- ”Near-rational” inflation expectations?
- Akerlof-Dickens-Perry (2000): For average inflation close to zero, a significant fraction of agents disregard inflation; behave as if inflation expectations are zero
Near-rational rational inflation expectations

Figure 1. A Hypothetical Long-Run Phillips Curve

Inflation (percent per year)

Unemployment (percent)

Source: Authors' calculations from calibration of the theoretical model.
Non-rational inflation expectations

- Here, for average inflation close to 2%, a significant fraction of agents disregard deviation from 2%; behave as if inflation expectations are 2%
- Non-vertical Phillips curve applies for average inflation not too far from 2% (±1%?)

Wage settlements: What inflation expectations?

- Central wage settlements guide wage setting in Sweden, more so from around 2000
- The Industrial Cooperation and Negotiation Agreement 1997: Wage setting in manufacturing industry guides other wage setting
- The Trade Union Confederation (LO)
  “During the years 1995-2008 the CPI has on average increased by 1.4 percent… That the price increase has fallen short of the inflation target should not be the starting point for a future assessment. Instead, the reference point for wage formation should be that the Riksbank will attain the inflation target of 2 percent… (Morin 2009, p. 15, translated from Swedish)
- Wage-setting with inflation expectations equal to 2 percent
Before 1996: Inflation target not credible, tight monetary policy, and high unemployment

1996: Inflation target gradually becomes credible
From 1997: Inflation expectations stuck at 2 %, but monetary policy still tight:
Inflation too low, and unemployment too high

\[ \pi^e = \pi^* = 2 \]
\[ \pi = 1.4 \]

Quarterly CPI inflation, annual rate, seasonally adjusted
Estimate (1) short-run Phillips curve

\[ \pi_t = \gamma_0 - \gamma_1 (u_t - u_{t-1}) - \gamma \pi_{t-1} + \epsilon_t \]

Sample 1997Q4-2011Q4

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma_0 )</td>
<td>7.19</td>
<td>1.36</td>
<td>5.29</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \gamma_1 )</td>
<td>2.70</td>
<td>0.72</td>
<td>3.73</td>
<td>0.0005</td>
</tr>
<tr>
<td>( \gamma' )</td>
<td>0.81</td>
<td>0.19</td>
<td>4.33</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Note: OLS, \( R^2 = 0.30 \), adjusted \( R^2 = 0.27 \), S.E. = 1.53, DW = 1.77.

Coefficients on lagged inflation not significant: “Level” Phillips curve instead of “acceleration” Phillips curve

(2) Long-run Phillips curve

\[ \pi = \gamma_0 - \gamma u \]

The long-run Phillips curve, 1997Q4-2011Q4
The long-run Phillips curve, 1997Q1-2011Q4

The slope of the long-run Phillips curve
Sample starts from 1997Q1 to 1999Q2
The unemployment cost of average inflation below a credible target

- 1997-2011 average CPI inflation 1.4%
- Average inflation expectations about 2%, at inflation target
- 0.6 p.p. lower inflation gives $0.6/\gamma = 0.6/0.75 = 0.8$ p.p.
  higher unemployment on average during 1997-2011

Excess average unemployment
Sample start from 1997Q1 to 199Q2
Near-rational rational inflation expectations

Figure 1. A Hypothetical Long-Run Phillips Curve

Inflation (percent per year)
Some robustness tests

Consider (1) CPIXF inflation instead of CPI inflation and (2) unemployment gap to Riksbank long-term unemployment
(1) With CPIXF inflation, 1997Q4-2011Q4
Flatter curve, higher unemployment cost, less precision

(2) With Riksbank unemployment gap, flatter curve, higher unemployment cost, bias of estimated long-term unemployment?
Revised Riksbank long-term unemployment gap,

Average unemployment as an estimate of long-run natural rate (long-run sustainable rate of unemployment, LSRU): Bias?

- Average unemployment biased estimate of LSRU?
- Bias:
  (Average inflation expectations - average inflation)/0.75
- Riksbank July 2012 estimate: 6.25% (midpoint)
- My correction: 5.5%, bias 0.75 p.p. (appendix July 2012 minutes)
Simultaneity? With lagged unemployment, flatter curve, higher unemployment cost (Also 2SLS estimation)

Long-run Phillips curve: Sample 1997Q4 - 2011Q4

US, unemployment and core CPI, Y/Y, 1970-2012
Average inflation 2000-2011  2 %
Long-run Phillips curve 2000Q1-2011Q2
US, unemployment and core CPI, Q/Q AR, 2000-2012
Long-run Phillips curve 2000Q1-2011Q2
Fuhrer (2011)

\[ \pi_t = 4.50 - 0.33 \pi_{t-4} - 0.30 u_{t-1} + \epsilon_t \]

(0.10) (0.04)

US, short-run Phillips curve 2000Q1-2012Q2:
Residuals and actual and fitted values
“Level” Phillips curve fits better than “acceleration” Phillips curve
(solves “puzzle” of Astrayuda, Ball, and Mazumder 2013)
Canada, unemployment and CPI, Y/Y, 1970-2012
Average inflation on target 1997-2011, 2 %

\[ \pi_t = 4.94 - 2.57 \Delta u_t - 0.42 u_{t-1} + \varepsilon_t \]
\[ (0.58) \quad (0.20) \]

\[ \pi = 4.94 - 0.42 u \]
Conclusions for the future?

- Swedish (Prospera) inflation expectations not rational
- "Near rational"? Stuck at target of 2% for average inflation not too far from target?
- Note that anchoring of inflation expectations at target is good: Easier to stabilize unemployment without too much variation in inflation

Policy conclusions for the future?

- Important to hold average inflation close to target
- Too low average inflation can entail large real economic costs
- Better with price-level targeting, average-inflation targeting over a longer period?
- Bias in estimates of long-run sustainable rate of unemployment (long-run natural rate)
Reasons for undershooting the target?

- Does not matter for average unemployment cost
- Asymmetric objective? (Ceiling?)
- Overestimated inflation pressure?
  - Overestimated long-run natural rate?
    (Mirror image of Orphanides)
  - Overestimated imported inflation?
  - Underestimated productivity growth?
- Different objective: Restricting household debt?
  - Tighter policy because of concerns about household debt
  - Giavazzi-Mishkin, since 2005?
  - Definitely now
A1. Wage-setting with inflation expectations equal to the inflation target

- Target real wage \( \tilde{w}^* \), for target employment,
- Nominal wage set in advance to achieve target real wage
  \[ w_t = \tilde{w}^* + p_t^e = \tilde{w}^* + p_{t-1} + \pi_t^e \]
- Actual real wage
  \[ \tilde{w}_t \equiv w_t - p_t = (\tilde{w}^* + p_{t-1} + \pi_t^e) - (p_{t-1} + \pi_t) = \tilde{w}^* + \pi_t^e - \pi_t \]
- Inflation below inflation expectations and target implies actual real wage above target real wage
  \[ \tilde{w}_t - \tilde{w}^* = \pi_t^e - \pi_t = \pi^* - \pi_t \]

A2. The average unemployment cost of average inflation below the target is independent of the reasons for missing the target

Short-run Phillips curve; assume structural:
\[ \pi_t = \gamma_0 - \gamma_1(u_t - u_{t-1}) - \gamma u_{t-1} + \epsilon_t \]
Sample averages:
\[ \bar{\pi} = \gamma_0 - \gamma \bar{u} + \bar{\epsilon} \]
Average unemployment consistent w/ average inflation on target:
\[ \pi^* = \gamma_0 - \gamma \bar{u}^0 + \bar{\epsilon} \]
Average unemployment cost of undershooting the target:
\[ \bar{u} - \bar{u}^0 = (\pi^* - \bar{\pi}) / \gamma \]
\( \bar{u} - \bar{u}^0 \) is independent of \( \bar{\epsilon} \), the sample average of the shocks
Natural rate:
\[ 0 = \gamma_0 - \gamma u^* \]
Note that \( \bar{u}^0 \neq u^* \) if \( \bar{\epsilon} \neq 0 \)
A3. Steady state: Ad hoc AD relation

Phillips curve: $\pi_t - \pi^e_t = -\gamma(u_t - u^*) + \epsilon_t$

SS: $\pi - \pi^e = -\gamma(u - u^*)$

AD relation: $u_t - u^* = \sigma(r_t - r^*)$

SS: $u - u^* = \sigma(r - r^*)$

Policy rule: $r_t - r^* = \alpha(\pi_t - \pi^0)$

SS: $r - r^* = \alpha(\pi - \pi^0)$

$$\pi - \pi^e = -\gamma \sigma \alpha (\pi - \pi^0) = -\gamma \sigma \alpha (\pi - \pi^e + \pi^e - \pi^0)$$

$$\pi - \pi^e = -\frac{\gamma \sigma \alpha}{1 + \gamma \sigma \alpha} (\pi^e - \pi^0)$$

$$\pi^0 < \pi^* = \pi^e \Rightarrow$$

$$\pi^0 < \pi < \pi^e = \pi^* \Rightarrow u > u^*, \ r > r^*$$

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Phillips curve: $\pi_t - \pi^e_t = -\gamma(u_t - u^*) + \epsilon_t$

SS: $\pi - \pi^e = -\gamma(u - u^*)$

AD relation: $u_t - u^* = E_t(u_{t+1} - u^*) + \sigma(r_t - r^*)$

SS: $r = r^*$

Policy rule: $r_t - r^* = \alpha(\pi_t - \pi^0)$

SS: $\pi = \pi^0$

$$\pi^0 < \pi^* = \pi^e \Rightarrow$$

$$\pi^0 = \pi < \pi^e = \pi^* \Rightarrow u > u^*, \ r = r^*$$
Example: A New-Classical Phillips curve

\[ w_t - p_t = -\gamma l_t \]
\[ w_t - p_t^* = -\gamma l^* \]
\[ p_t^* = p_{t-1} + \pi^* \]
\[ p_t = p_{t-1} + \pi_t \]
\[ p_t - p_t^* = \gamma (l_t - l^*) = -\gamma (u_t - u^*) \]
\[ \pi_t - \pi_t^* = -\gamma (u_t - u^*) \]
\[ \Delta w_t = \Delta p_t^* = \Delta p_{t-1} = \pi_{t-1} \]
\[ (w_t - p_t) - (w_t - p_t^*) = -(p_t - p_t^*) = -(\pi_t - \pi_t^*) = \gamma (u_t - u^*) \]

Riksbank’s mandate: Price stability and highest sustainable employment

- Riksbank Act (Ch. 1, art. 2): “The objective of the Riksbank activities shall be to maintain price stability.”
- Government bill (1997/98:40, p. 1): “without prejudice to the objective of price stability, [the Riksbank] should support the objectives of general economic policy with the purpose of achieving sustainable growth and high employment.”
- Mandate: Price stability and highest sustainable employment
- Without prejudice to the objective of price stability: Keep average inflation over longer period on target
- Highest sustainable employment = Lowest sustainable unemployment
NIER firm inflation expectations

NIER firm inflation expectations
5-yr moving averages
Wage settlements: What inflation expectations?

The Industrial Trade Unions (Facken inom industrin) (Dagens Nyheter Nov 12, 2012) (Also Facken inom industrin 2011):

“Riksbankens inflationsmål är i dag ankaret för den ekonomiska politiken och en självklar utgångspunkt för vårt agerande.


Parterna bör utgå från att Riksbanken gör sitt jobb och att inflationen hamnar runt två procent. Det bidrar till att inflationsförväntningarna håller sig i närheten av inflationsmålet.
Two interpretations

- The inflation target has been **credible**, the relevant inflation expectations are sticky (anchored) at the target, and there has been a **substantial average unemployment cost** of average inflation below the target

- The inflation target has **not been credible**, average inflation expectations are close to average inflation and **not anchored** at the target, and there has been **not been any average unemployment cost** of average inflation below the target

More robustness tests

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI Q/Q AR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP Q/Q AR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP deflator Q/Q AR</td>
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<tr>
<td>GDP deflator Q/Q AR</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>CPI Q/Q AR Revised</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Constant</td>
<td>7.344</td>
<td>8.255</td>
<td>5.665</td>
<td>6.812</td>
<td>7.278</td>
</tr>
<tr>
<td></td>
<td>(1.462)</td>
<td>(3.070)</td>
<td>(1.691)</td>
<td>(1.732)</td>
<td>(1.415)</td>
</tr>
<tr>
<td>$u_t - u_{t-1}$</td>
<td>-2.909</td>
<td>-3.533</td>
<td>-1.137</td>
<td>-1.621</td>
<td>-2.538</td>
</tr>
<tr>
<td></td>
<td>(1.030)</td>
<td>(1.071)</td>
<td>(0.899)</td>
<td>(0.854)</td>
<td>(0.753)</td>
</tr>
<tr>
<td>$u_{t-1}$</td>
<td>-0.829</td>
<td>-0.929</td>
<td>-0.579</td>
<td>-0.722</td>
<td>-0.830</td>
</tr>
<tr>
<td></td>
<td>(0.202)</td>
<td>(0.296)</td>
<td>(0.232)</td>
<td>(0.225)</td>
<td>(0.194)</td>
</tr>
<tr>
<td>$\pi_t^1$</td>
<td>-0.112</td>
<td>0.583</td>
<td>0.8483</td>
<td>0.349</td>
<td>(0.129)</td>
</tr>
<tr>
<td>$\pi_{t-1}^{GDP}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_{t-3}^{GDP}$</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.30</td>
<td>0.27</td>
<td>0.10</td>
<td>0.26</td>
<td>0.28</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.27</td>
<td>0.23</td>
<td>0.07</td>
<td>0.20</td>
<td>0.26</td>
</tr>
<tr>
<td>S.E.</td>
<td>1.54</td>
<td>1.38</td>
<td>1.91</td>
<td>1.77</td>
<td>1.60</td>
</tr>
<tr>
<td>DW</td>
<td>1.78</td>
<td>1.79</td>
<td>2.59</td>
<td>1.94</td>
<td>1.79</td>
</tr>
</tbody>
</table>

Note: $u_t$ denotes the unemployment rate in quarter $t$. $\pi_t^1$ denotes expectations in quarter $t$ of annual inflation 1 year ahead, and $\pi_{t}^{GDP}$ denotes quarterly GDP-deflator inflation at an annual rate. Column (1): 2SLS, instruments $u_{t-1}$, $u_{t-2}$, and $u_{t-3}$. Column (2): 2SLS, instruments $u_{t-1}$, $u_{t-2}$, $u_{t-3}$, $\pi_{t-1}^1$, and $\pi_{t-3}$ (quarterly CPI inflation at an annual rate). Column (3)-(5): OLS.