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**SWEDISH CORE INFLATION MEASURES\***

Submitted by Statistics Sweden

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**ABSTRACT**

This paper describes the method used by Statistics Sweden to calculate two official measures of underlying inflation, or core inflation, in Sweden. These measures, called UND1X and UNDINH, are published by Statistics Sweden together with the Swedish CPI each month. The national Swedish CPI uses an improved index construction based on a superlative index formula (Walsh index) since January 2005. In accordance with this new method practical calculations of underlying inflation were altered. The paper highlights the relationship between the national Swedish CPI, the NPI (Net Price Index) and these official measures of underlying inflation.

**Keywords:** Core inflation, underlying inflation, CPI, Net Price Index, Walsh index.

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\* This paper has been prepared by Mr. Peter Nilsson and Mr. Martin Ribe, Statistics Sweden, at the invitation of the Secretariat.

## **I. INTRODUCTION**

1. Usually concepts of underlying inflation are employed as an attempt to identify the underlying trend in CPI inflation by excluding certain components, which are subject to large relative price changes. A successful measure of underlying inflation, or core inflation, should provide as much information on the underlying trend as possible from each month's CPI data (Bryan, Cecchetti and Wiggins, 1997). The rationale of excluding temporary or transitory effects on CPI inflation is that such effects normally are unimportant for monetary policy. The Swedish Riksbank, that is, Sweden's central bank, has over the years used various measures of underlying inflation to distinguish transitory from permanent movements in the CPI. Such filtered measures of inflation have at times been considered more decisive for monetary policy than CPI forecasts (Heikensten and Vredin, 2002).

2. Statistics Sweden calculates and publishes two official measures of underlying inflation, called UND1X and UNDINHX, on the behalf of the Riksbank since august 1998. The Riksbank calculated these measures earlier in a somewhat different way. Rates of change in UND1X and UNDINHX are published by Statistics Sweden together with the CPI each month. The UND1X and UNDINHX are presented as rates of change only, not as index numbers.

3. This paper highlights the relationship between the national Swedish CPI, the NPI (Net Price Index) and these official measures of underlying inflation.

## **II. PRINCIPLES OF THE MEASURES**

4. A monthly calculation of UND1X begins after CPI inflation has been computed. In the UND1X, the interest costs for owner-occupied dwellings are excluded from the domain of CPI, and so are the direct effect from changes in indirect taxes and subsidies (except those that are related to wages/salaries). The same holds for the UNDINHX, but there the domain of CPI is further modified to exclude products that are mainly imported.

5. The rationale of excluding owner-occupiers' interest costs from the UND1X emerged from the Riksbank's experience in 1997 and 1998. The CPI inflation was continuously below the target of monetary policy during this time, despite large cuts in the repo rate in 1996. It gradually became apparent that one property of the CPI can give rise to "perverse" short-run effects of monetary policy. When the Riksbank lowers the repo rate as inflation prospects improve, this lowers mortgage interests and thereby automatically also CPI inflation (Heikensten and Vredin, 2002).

6. The motivation of excluding the direct effect from indirect taxes and subsidies from the UND1X is that they are an effect of government policy and only loosely related to demand pressures in the economy. Since monetary policy can do little to counteract changes in the price level due to these changes, it has been argued that monetary policy should aim to stabilize inflation adjusted for those factors (Heikensten and Vredin, 2002).

7. However, the method used by Statistics Sweden to compute this underlying trend in CPI inflation differs in three ways from earlier methods (before August 1998) used by the Riksbank:

- (a) Rates of change are calculated according to the method used for CPI. This means that calculation of the underlying inflation follows the index construction used for CPI.
- (b) Only those indirect taxes and subsidies considered in the NPI are used in the calculations. Also, the information set regarding taxes and subsidies in NPI underlie calculated direct effects on CPI from indirect taxes and subsidies in UND1X and UNDINHX.
- (c) Statistics Sweden's method involves the implicit assumption that changes in indirect taxes and subsidies have full and immediate effects on consumer prices.

### III. CALCULATIONS

8. From 2005, the national Swedish CPI is based on a superlative index formula (Walsh index) for macro-level aggregation in annual links of years past, and the Jevons index formula for elementary aggregation. These features should serve to prevent a cumulating “Laspeyres bias” and make the CPI perform reasonably as a cost-of-living index (coli), as is considered appropriate in view of the uses of the CPI for compensation purposes. In accordance with this new method, practical calculations of NPI as well as the measures of underlying calculation were also altered, as will here be described.

#### CPI

9. From January 2005 CPI inflation is computed as the relative change of the CPI numbers (se below) – as in most countries but not exactly as previous Swedish practice. For instance, the annual inflation rate in per cent in May 2006 is computed from CPI numbers as

$$\left( \frac{I_{1980}^{2006, \text{May}}}{I_{1980}^{2005, \text{May}}} - 1 \right) \times 100 \quad (1)$$

10. The CPI is still presented as index numbers with the index reference year 1980 = 100 – as before. The index numbers remain well comparable over time, in spite of the change in the index construction. The new index construction was linked on to the old one through average prices during 2004. For example in order to calculate the CPI-number in May 2006 i.e.  $I_{1980}^{2006, \text{May}}$  the following expression is computed (Ribe, 2005):

$$I_{1980}^{2006, \text{May}} = I_{1980}^{1980, \text{Dec}} \times I_{1980, \text{Dec}}^{1981, \text{Dec}} \times I_{1981, \text{Dec}}^{1982, \text{Dec}} \times \dots \times I_{2002, \text{Dec}}^{2003, \text{Dec}} \times I_{2003, \text{Dec}}^{2004} \times I_{2004}^{2006, \text{May}} \quad (2)$$

11. The CPI is a chain index with annual links – as before but the annual links are now chained over the full year according to a Walsh formula and not over December. The particular link  $I_{2003,Dec}^{2004}$  in this expression serves to give a transition between the previous index construction and the new one. This link is computed as:

$$I_{2003,Dec}^{2004} = \left( \frac{1}{12} \sum_{m=1}^{12} I_{2003,Dec}^{2004,m} \right) \times \frac{I_{2002}^{2003} \times I_{2003}^{2004}}{\frac{1}{12} \sum_{m=1}^{12} I_{2002}^{2004,m}} \quad (3)$$

where the summations run over all months of the year. The monthly index numbers in the left-hand main factor are computed according to the previous CPI construction, while the index numbers in the right-hand main factor are computed by formulas of the new CPI construction.

12. The links  $I_{2002}^{2003}$  and  $I_{2003}^{2004}$  which are used in the chain above are annual links, called year-to-year links in the following. They are calculated according to the Walsh index formula (Ribe, 2005), as:

$$I_{2003}^{2004} = \frac{\sum_i P_i^{2004} \times \sqrt{Q_i^{2003} \times Q_i^{2004}}}{\sum_i P_i^{2003} \times \sqrt{Q_i^{2003} \times Q_i^{2004}}} \quad (4)$$

13. Take one of the links,  $I_{2003}^{2004}$ , as an example. The summations in the numerator and the denominator run over the various consumer products,  $i$ , with annual mean prices,  $P_i$ , and consumed volumes (quantities),  $Q_i$ , for each year. The Walsh index according to (4) above follows the development of prices in a basket of consumer products where the volume of products,  $i$ , is  $\sqrt{Q_i^{2003} \times Q_i^{2004}}$ . That is, the geometric mean of consumption volumes for the two years respectively (Ribe, 2005).

14. The final link in the chain (2), above, i.e.  $I_{2004}^{2006,May}$  (called year-to-month link in the following) is instead calculated by a formula according to Laspeyres, which by corresponding notation in principle can be written as:

$$I_{2004}^{2006,May} = \frac{\sum_i P_i^{2006,May} \times Q_i^{2004}}{\sum_i P_i^{2004} \times Q_i^{2004}} \quad (5)$$

15. This is an index that expresses the price development up to May 2006, from the average level of prices during 2004. However, in order to calculate the expressions (4) and (5) above, in practice we can't use the volumes of consumption, as these are not given. Instead the CPI is built up, as before, from consumption values (cost of consumption). So for the practical computation, the index is re-written in a different form, along the lines of traditional practice for almost all index computations. So the index links are still computed by weighting together sub-indices for the product groups covered by the CPI.

16. Basic data needed to calculate weights in the CPI make use of, as well as before, National Accounts data regarding private consumption. However in the new CPI construction no information regarding consumption values during the previous year is needed. Instead the year-to-month link, above, involves consumption values for 2004 when computing CPI numbers in 2006. Of course, this new situation has the advantage of more accurate information regarding the material used, as well as more time available to make accurate calculations of weights.

#### Net Price Index (NPI)

17. NPI (Net Price Index) measures the relative change in business prices after indirect taxes and subsidies for an unchanged production level of products and services. NPI is calculated from the estimated consumption values in CPI during the reference year and the comparison year respectively. This domain is then reduced by the tax amounts calculated according to rules that apply for the years in question. Subsidies are treated as negative indirect taxes (SOU, 1999).

18. All indirect taxes, which are identified as costs in the manufacturing or distributing process of products included in private consumption, are to be treated in the NPI. This also includes indirect taxes paid in earlier stages which means indirect taxes paid on raw materials, semi-manufactured products etc. Monthly, Statistics Sweden publishes a table consisting of effects on total CPI from net prices, indirect taxes, and subsidies.

19. Estimation of these effects on CPI from indirect taxes and subsidies consists in index calculations of either of two types. If the indirect tax/subsidy is paid as a percentage of the quantity of the product this index simply becomes the ratio expressed as (Johansson and Sjögren, 1999):

$$I_{S_j^{1:1}}^1 = \frac{t_j^1 \times (1 + K^1)}{t_j^0 \times (1 + K^0)} \quad (6)$$

20. Here  $t_j^1$  and  $t_j^0$  are tax rates in periods 0 and 1 respectively and  $K^1, K^0$  are the value-added tax rate, expressed as a proportion of the consumer price exclusive of value-added taxes in periods 0 and 1 respectively. An index  $I_{S_j^{1:0}}^1$  expressing the change in the tax in question at unchanged tax rate  $t_j^0$  is calculated as (Johansson and Sjögren, 1999):

$$I_{S_j^{1:0}}^1 = \frac{t_j^0 \times (1 + K^1)}{t_j^0 \times (1 + K^0)} = \frac{(1 + K^1)}{(1 + K^0)} \quad (7)$$

21. If the indirect tax or subsidy is constructed to be paid as a percentage of the value of the product consumed ( $p_i \times q_i$ ), a different formula is used, where the index for the indirect tax/subsidy equals a price index multiplied by the quotient between the tax rates in the comparison period and the reference period according to (Johansson and Sjögren, 1999):

$$I_{S_j^{1:1}}^1 = I_j^{01} \times \frac{K^1}{K^0} \quad (8)$$

and

$$I_{S_j^{1:0}}^1 = I_j^{01} \times \frac{K^0}{K^0} = I_j^{01} \quad (9)$$

### UND1X and UNDINHX

22. UND1X and UNDINHX follow the calculations used in the new index construction described in the subsection above. The domain of CPI is then modified for all indexes in the chain (2). The calculation of underlying inflation according to UND1X and UNDINHX is thereby based on modified CPI numbers.

23. In both UND1X and UNDINHX the domain of CPI is modified to exclude interest costs of owner-occupiers. In UNDINHX the domain is further modified to also exclude mainly imported products. Interest costs of owner-occupiers included in the CPI are interest costs on all capital invested in owner-occupied houses, including both interest paid on different types of mortgages, and interest on equity (opportunity cost). The amount of invested capital is valued at the acquisition price for the present owner plus the present owner's costs for improvements.

24. In the calculations of the year-to-month link during 2006 the total weight for this product in the CPI is approximately 4.95 %, thus making the domain of UND1X approximately 95.05% of the total CPI coverage this year. The set of mainly imported products, measured in the CPI but excluded in UNDINHX is defined by the Riksbank in a memorandum to Statistics Sweden in 1999 (Sveriges Riksbank, 1998). The weight of this set for 2006, used in the calculations of the year-to-month link is approximately 35.86, thus making the domain of UNDINHX approximately 64.14 % of the total CPI.

25. If we would disregard the adjustment for taxes and subsidies, the measures could be expressed according to Eq. (5) as:

$$\text{UND1X}_{2004}^{2006, \text{May}} = \frac{\sum_{i \in U_{\text{UND1X}}} P_i^{2006, \text{May}} \times Q_i^{2004}}{\sum_{i \in U_{\text{UND1X}}} P_i^{2004} \times Q_i^{2004}} \quad (10)$$

$$\text{UNDINHX}_{2004}^{2006, \text{May}} = \frac{\sum_{i \in U_{\text{UNDINHX}}} P_i^{2006, \text{May}} \times Q_i^{2004}}{\sum_{i \in U_{\text{UNDINHX}}} P_i^{2004} \times Q_i^{2004}} \quad (11)$$

where  $U_{\text{UND1X}}$  denotes the set “all goods and services in total private consumption minus owner-occupiers' interest costs”, and  $U_{\text{UNDINHX}}$  denotes the set “all goods and services in total private consumption minus owner-occupiers' interest costs minus mainly imported products”.

26. However after this modification of the CPI domain, work with modification of prices still remains to complete the calculation. Namely, changes in the direct effects from indirect taxes and subsidies are also to be excluded.

27. In practice subsidies are relatively rarely considered, as these usually are not directly connected to consumption products. Also, only those indirect taxes/subsidies calculated in NPI are considered, except those that are related to wages/salaries. Statistics Sweden's method involves the implicit assumption that these changes have full and immediate effect on consumer prices.

28. In the practical calculation here we focus on the various kinds of taxes and subsidies, rather than on each of the particular goods and services concerned. This means that we estimate the total impact on the modified CPI domains from alteration in the indirect tax or subsidy.

#### The year-to-year link

29. The method used for excluding indirect taxes and subsidies is the same for both UND1X and UNDINHX, and it is here described for UND1X. We let the year-to-year link in the following presentation be the particular link of  $\text{UND1X}_{2003}^{2004}$ .

30. In order to estimate the effect from each tax and subsidy to the modified domain corresponding to UND1X we have to estimate weights according to the Walsh index in (4). Namely, we have to compute:

$$\text{UND1X}_{2003}^{2004} = \text{CPI}_{2003; \text{excl.i.c.}}^{2004} - \sum_{k \in T \& S} W_k^{2004} \times I_{2003; k}^{2004} \quad (12)$$

where  $CPI_{2003;excl.i.c.}^{2004}$  is the year-to-year link computed as for the usual CPI (according to Eq. (4)), but only over the restricted domain where owner-occupiers' interest costs are excluded. Furthermore  $k$  is a tax or subsidy,  $T$  &  $S$  is the set of taxes and subsidies to be considered, and  $I_{2003;k}^{2004}$  is an index that expresses a change in that specific tax or subsidy (up to the full year 2004 from the reference year 2003). The latter index is in turn calculated as:

$$I_{2003;k}^{2004} = \frac{I_{2002,Dec;k}^{2003,Dec} \times \frac{1}{12} \sum_{m=1}^{12} I_{2003,Dec;k}^{2004,m}}{\frac{1}{12} \sum_{m=1}^{12} I_{2002,Dec;k}^{2003,m}} \quad (13)$$

where the summations run over all month during the specified year. The December-based index numbers  $I_{2003,Dec;k}^{2004,m}$  etc. used in this computation are obtained according to the procedures indicated in Section "Net Price Index (NPI)" above, to express the change in the tax  $k$  that is due to change in tax rate.

31. The weight  $W_k^{2004}$  for a tax  $k$  used in Eq. (10) is calculated according to:

$$W_k^{2004} = \frac{\sqrt{U_k^{2003} \times U_k^{2004} / I_{2003;k}^{2004}}}{\sum_{g \neq i.c.} \sqrt{U_g^{2003} \times U_g^{2004} / CPI_{2003;g}^{2004}}} \quad (14)$$

where  $U_k^{2004}$  and  $U_k^{2003}$  are estimated government revenues from the tax  $k$  in the years indicated. Likewise  $U_g^{2004}$  and  $U_g^{2003}$  in the denominator denote estimated values of consumption for CPI product groups  $g$  during the years indicated. The summation in the denominator of Eq. (14) runs over all product groups  $g$  in the CPI domain, except owner-occupiers' interest costs (denoted "i.c.").

32. For a subsidy  $k$  the weight  $W_k^{2004}$  is computed in the same way as just described for taxes, but the weight is then taken as negative (i.e., multiplied by  $-1$ ).

33. Proper weights corresponding to each tax/subsidy are thus calculated. In order to withhold effects from specified taxes/subsidies in the domain of UNDI<sub>X</sub>, we simply multiply these weights to the corresponding yearly change in every indirect tax and subsidy. The final step in order to modify this domain with the effects from altered taxes and subsidies is now to sum up

a total net effect from altered taxes and subsidies. This sum is then subtracted, as is shown by Eq. (12), and the year-to-year link for the UNDI<sub>X</sub> results.

The year-to-month link

34. The modification of the domain and prices in the year-to-month link, i.e. the final Laspeyres link in the chain (2), follows the same procedure as in the year-to-year link. However as this link is calculated according to Laspeyres no geometric means have to be calculated. Estimated weights are therefore calculated simply by dividing the government revenue/expenditure value for each tax/subsidy by the total value of this domain. The sum of the direct effects on the domain of UNDI<sub>X</sub> is then given after multiplying the weights to an index corresponding to changes in each specific tax/subsidy between the reference period 2004 and each month during 2006 (see Appendix 1 for an example of a table of effects).

35. The year-to-month link can now be expressed as:

$$\text{UNDI}_X^{2006,\text{May}}_{2004} = \text{CPI}_{2004;\text{excl.i.c.}}^{2006,\text{May}} - \sum_{k \in T \& S} W_k^{2006} \times I_{2004;k}^{2006,\text{May}} \quad (15)$$

where  $\text{CPI}_{2004;\text{excl.i.c.}}^{2006,\text{May}}$  is the year-to-month link computed as for the usual CPI (according to Eq. (5)), but only over the restricted domain where owner-occupiers' interest costs are excluded. Furthermore  $k$  is a tax or subsidy,  $T \& S$  is the set of taxes and subsidies, and  $I_{2004;k}^{2006,\text{May}}$  is an index that expresses the relevant change in the tax or subsidy  $k$  between the reference year 2004 and May 2006. The latter index is obtained according to the procedures indicated in Section "Net Price Index (NPI)" above, to show the change in the tax  $k$  that is due to change in tax rate.

36. This final link needed to calculate UNDI<sub>X</sub> inflation is then chained on to Eq. (2), and rates of change corresponding to underlying inflation are computed according to Eq. (1).

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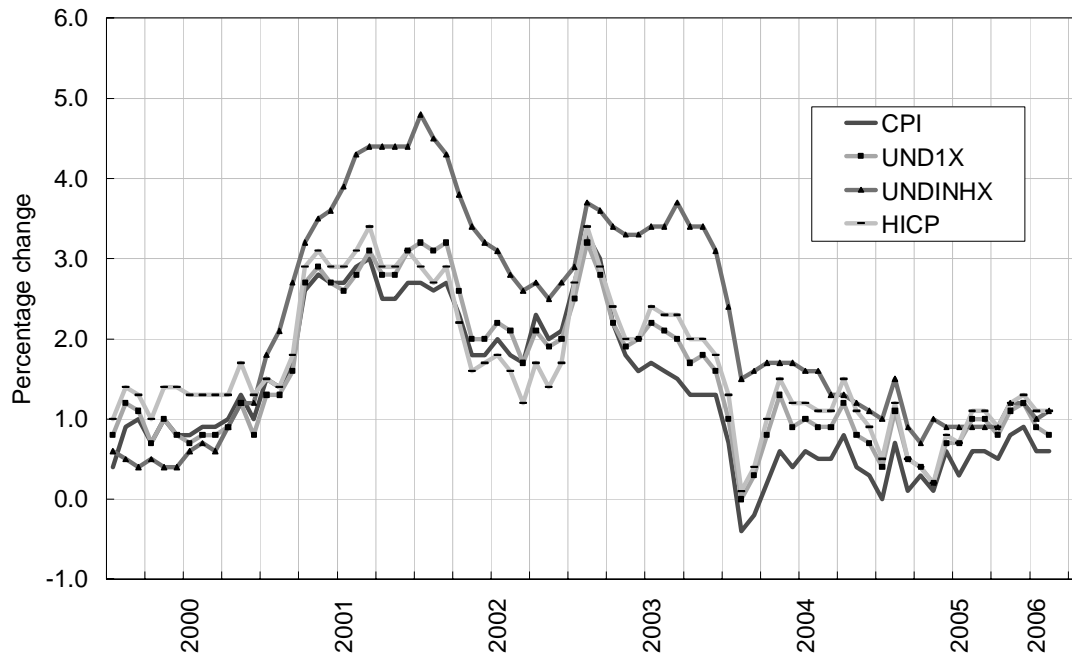
### Appendix 1

The table below shows the direct effects from indirect taxes and subsidies (however no subsidies enter the calculation this month) on the domain of UNDI<sub>X</sub> (CPI exclusive owner-occupiers interest costs).

STATISTICS SWEDEN		Table Of Effects, UNDI <sub>X</sub> 2006			
Underlying Inflation		<i>Year-To-Month 2006</i>			
Total privat cons. - Interest Costs MSEK = 1048419,4 <sup>↑</sup>	Tax MSEK 2004	Weights	Per cent change	Effects on UNDI <sub>X</sub> . Percentage points	
<b><u>Indirect taxes, subsidies</u></b>					
<b>JANUARY</b>					
<b>Taxes on alcohol and tobacco:</b>					
Tax on Tobacco	8181,0	0,007803	3,95300	0,03856	
<b>Taxes on Energy:</b>					
Gasoline	11506,2	0,010975	6,71640	0,09214	
Gasoline (alkylat)	11,7	0,000011	14,28570	0,00020	
Diesel fuel	234,3	0,000223	41,26430	0,01153	
Other fuels	551,8	0,000526	0,95630	0,00063	
Electric power	8234,0	0,007854	8,69280	0,08534	
<b>Tax on Carbon Dioxide:</b>					
Gasoline	9084,3	0,008665	0,94790	0,01027	
Diesel	830,4	0,000792	0,95170	0,00094	
Other fuels	1958,3	0,001868	0,96230	0,00225	
<b>Environment taxes</b>	91,8	0,000088	17,56760	0,00192	
<b>Taxes on trafic:</b>					
Congestion Charges	705,0	0,000672		0,05738	
<b>Real estate tax</b>					
Owner-occupied houses	12458,0	0,011883		-0,01170	
<b>SUM OF INDIRECT TAXES AND SUBSIDIES 2004 TO 2006</b>				<b>0,2894</b>	

### Appendix 2

The figure below illustrates Swedish inflation rates according to CPI, UND1X, UNDINHX and HICP since January 2000.



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