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Working Paper

Inflation targeting: analyzing indicators of inflation in Finland

Bank of Finland Discussion Papers, No. 19/1995

Provided in Cooperation with:
Bank of Finland, Helsinki

Suggested Citation: Andersen, Kaare G. (1995) : Inflation targeting: analyzing indicators of inflation in Finland, Bank of Finland Discussion Papers, No. 19/1995, ISBN 951-686-461-9, Bank of Finland, Helsinki,
https://nbn-resolving.de/urn:nbn:fi:bof-20140807378

This Version is available at:
https://hdl.handle.net/10419/211732

BANK OF FINLAND
DISCUSSION PAPERS

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ISBN 951-686-461-9
ISSN 0785-3572

Suomen Pankin monistuskeskus
Helsinki 1995

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Abstract

This paper considers different indicators of inflation that are recorded in Finland. Initially, we define inflation as an irreversible rise in the general price level. We then go on to describe different indicators of inflation, focusing on problems related to their construction. Since it is not possible to monitor the general price level, we have to target a subset of this. The different indicators each measure representative parts of the economy. However, we found that they all have strengths and weaknesses and the choice of an indicator is thus a balance between different priorities.

We then conducted an empirical analysis of these indicators of inflation with respect to stationarity and cointegration using data for Finland. Empirical evidence supports the assumption of cointegration between different indicators of inflation, but we also found that price levels are non-stationary.

Finally, this paper discusses special issues that should be borne in mind when choosing an inflation indicator as a target objective for monetary policy.

Tiivistelmä

Tämä keskustelualoite tutkii eri Suomessa käytössä olevia inflaatioindikaattoreita. Aluksi määrittelemme inflaation yleisen hintatason peruuttamattomana nousuna. Sen jälkeen kuvailemme eri inflaatioindikaattoreita keskittyen niiden muodostamisessa esiintyviin ongelmiin. Koska ei ole mahdollista mitata yleistä hintatasoa kokonaisuudessaan, meidän täytyy muodostaa edustava otos siitä. Eri indikaattorit mittaavat eri talouden alueita, eri otoksia. Havaitsemme, että kaikilla indikaattoreilla on vahvuutensa ja heikkoutensa, joten indikaattorin valinta on painotuskysymys.

Tämän jälkeen tutkimme indikaattoreita empiirisesti stationaarisuuden ja kointegraation suhteen Suomen talouden tunnuslukujen avulla. Empiirisesti havaitsemme, että eri indikaattoreiden välillä on kointegraatiota, mutta toisaalta että hintatasot eivät ole stationaarisia.

Lopuksi tämä keskustelualoite tutkii erityisiä kysymyksiä, jotka tulisi pitää mielessä kun rahapolitiikan tavoitteeksi valitaan inflaatioindikaattoria.

Contents

1 Introduction

Recently, several countries have adopted a direct inflation targeting approach for their monetary policy. In practice, countries have implemented inflation targets in various ways. In this connection, inflation targeting has been the subject of much debate among central banks. The discussion has partly focused on the choice of inflation indicator and partly on historical experiences. In Finland, the Bank of Finland committed itself to an explicit inflation target in early 1993, adopting the Indicator of Underlying Inflation as the target measure.

The purpose of this paper is to examine various measures of inflation in the context of inflation targeting as carried on by the Bank of Finland. Specifically, we focus on the strengths and weaknesses of these various measures of inflation. The aim of this analysis is to reveal any systematic differences in the response of different measures of inflation to shocks or changes in the economy.

In section 2, we define inflation. Section 3 presents different measures of inflation and discusses the construction of these and their strengths and weaknesses. In section 4 we present an empirical analysis of the inflation indicators used in Finland. Section 5 discusses the indicators of inflation described in the previous sections, the purpose being to evaluate these different indicators of inflation in the context of the inflation target applied by the Bank of Finland. Section 5 concludes by addressing some issues worth keeping in mind in connection with choosing an indicator of inflation.

2 Defining inflation

Before we turn to the description of the different indicators of inflation, it is worth define inflation. In the literature, there is no generally accepted definition of inflation. However, one pragmatic definition by Laidler and Parkin (1975) is widely acknowledged: "Inflation is a process of continuous rising prices, or equivalently, of a continuously falling value of money". They use this definition to describe the consequences of inflation but not its causes. Nevertheless, the definition generally states that inflation is the continuous increase in the *general price level* or, the continuous fall in the value of money. Furthermore, inflation is not a one-time (short-run) increase in prices, rather it is an irreversible increase in the general price level. Bronfenbrenner and Holzman[1] describe the consequences of inflation with the following four statements:

1. Inflation is a condition of generalized excess demand, in which "too much money chases too few goods."
2. Inflation is a rise of the money stock or money income, either total or per capita.
3. Inflation is a rise in the price level with additional characteristics or conditions: it is incompletely anticipated; it leads (via cost increases) to

[1] Bronfenbrenner, M. and Holzmann, F.D. (1963).

further rises; it does not increase employment and real output; it is faster than some "safe" rate; it arises "from the side of money"; it is measured by prices net of indirect taxes and subsidies; and/or it is irreversible.

4. Inflation is a fall in the external value of money as measured by foreign exchange rates, by the price of gold, or indicated by excess demand for gold or foreign exchange at official rates.

The first two definitions describe the causal relationship between the money stock and inflation, the first using the equilibrium in the goods market and the second a change in the money supply. The third definition simply adds some required characteristics to the consequence-based definition. Finally, the fourth definition describes inflation in terms of the external balance.

Generally, we can speak of inflation as a permanent reduction in the purchasing power of a given nominal amount of money, which is caused by an increase in the *general price level.* By the *general price level* we mean the aggregation of the money prices of all tangible and intangible goods and services traded in the economy. Here, money acts as a store of value, in the sense that it gives the owner some purchasing power in the future. On the other hand, many *goods* have the same characteristics and can according to this definition, be regarded as money, the main difference, however, being that these goods provide services to the owner over time. For instance, a house can be regarded a store of value but at the same time it also provides a service to the owner as a residence.

In practice, however, the general price index does not exist. None of the indices produced covers all prices in the economy. Hence, no existing index corresponds exactly to the general price index. Instead, we monitor a range of different indicators, which are subcomponents of the general price index.

3 Indicators of inflation

Since it is not possible to observe the general price level on a regular basis, because of the overwhelming research and data collection that would require, it is necessary to accept targeting "the second best", i.e. some representative subcomponent of the general price level. This requires that we construct an alternative indicator which we can use to measure inflation. In addition, it should be possible to monitor this indicator fairly simply, and moreover, it should be reliable and consistent. In this section, we briefly present several indicators of inflation. Many of them are monitored on a regular basis in Finland[2]. These measures of inflation can be divided into three types; (1) deflators, (2) indices, (3) labour cost measures[3].

[2] For Canada see Selody, J. (1995).

[3] Appendix A provides a more detailed discussion on the construction of these indicators of inflation in Finland.

3.1 GDP deflators

The gross domestic product (GDP) deflator measures the price of the total value-added domestic production of goods and services. The deflator consists of both public and private sector consumption of domestically produced goods and services, as well as investment goods and services and exported goods and services but excludes import prices. The GDP deflator is thus the aggregated market price of overall domestic production. Consequently, the GDP deflator can be considered the natural choice for a price index substituting the general price index. The GDP deflator is measured at market prices and thus also includes indirect taxes. However, a GDP deflator with an even broader coverage has been suggested by Alchian and Klein[4]. They propose that assets prices should also be included in the inflation measure.

In practice, however, the GDP deflator is constructed as the ratio of spending on Finnish goods and services in the current period to spending on the same basket of goods and services in the base period. The basket is composed of goods and services which are weighted according to their share of total expenditure. The construction of the deflator therefore depends on the choice of base period. Thus, there exist several different GDP deflators.

The variable-weight GDP deflator uses current period weights as the base. It thus reflects the true expenditure cost of the current period. However, as a consequence, it is not possible to use the variable-weight GDP deflator in year-to-year comparisons of price changes, because of the yearly rebasing.

Another possible deflator is the fixed-weight GDP deflator. This deflator uses weights obtained from the base year. The base year is fixed for several years and it is therefore possible to make comparisons between different years. However, since the weights are fixed for a longer period, they may not reflect the true structure of the consumption pattern.

Finally, there is the chain-linked GDP deflator, which is a compromise between the variable- and the fixed-weight GDP deflator. This indicator overcomes many of the problems that are present in the deflators described above but its calculation involves major problems with regard to collecting data.

3.2 Indices

Different kinds of indices have become popular among the general public around the world as reliable indicators of inflation. Basically, these indices measure price movements in different parts of the economy. In Finland, several different price indices are regularly recorded. The basic idea is to choose a reference year and then to calculate developments in accordance with this reference year.

The consumer price index (CPI) is probably the best known index. It measures movements in prices of goods and services in a representative consumer basket. The CPI covers a broad range of goods and services that are purchased by consumers. In other words, the CPI measures developments in the prices that the consumer faces.

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[4] Alchian, A.A. and B. Klein (1973).

The net-price index (NPI) is a subcomponent of the CPI. It is the CPI net of indirect taxes and to which has been added the effect of subsidies. Therefore, the index measures developments in prices charged by producers and sellers. However, the NPI is constructed on the basis of the CPI, but unlike the CPI, it is not subject to effects deriving from changes in fiscal policy.

Another subcomponent of the CPI is the indicator of underlying inflation (IUI). This index is constructed so that it is not directly affected by changes in fiscal or monetary policy. However, since this index is also constructed on the basis of the CPI, it suffers from some of the same basic weaknesses.

On the producer side, the producer price index (PPI) measures movements in prices charged by national producers. Unlike the NPI, the PPI measures only movements in the prices of products produced in Finland, but both sold in Finland and exported. The index is constructed on the basis of the composition of national output statistics.

Finally, the wholesale price index (WPI) measures developments in procurement prices of goods used in Finland. The index is composed of indices for both imported goods and domestically produced goods, weighted according to their share of the market. Basically, the index measures developments in the prices that shops and other retail outlets face.

3.3 Labour cost indices

Labour cost can be measured by different indices. However, problems arise because data collected on labour costs are often biased in a upward direction. In some sectors, large part of the worker's earned income is not included in the generally published statistics because of problems related to calculating wages and salaries in these sectors. This is a particularly serious problem with regard to agriculture and fishing. In Finland, two indices are regularly recorded.

The index of wages and salary earnings (WSE) measures developments in average earnings for regular working time of wage and salary earners. It is used as reference material by the labour market parties in collective bargaining agreements. However, this index suffers from problems connected with construction as well as from problems caused by data collection.

3.4 The best indicator for inflation targeting

Above we briefly described various price and wage measures and found that they all have strengths and weaknesses. However, the choice of inflation indicator also depends on other factors. First of all, the choice of the inflation indicator to target depends on which part of the economy is considered to be the main target. Consequently, the choice of target depends on the types of shocks that are likely to occur in the economy and to which degree the indicator is reliable and controllable at present. Secondly, the choice of the inflation measure to target depends on how a particular indicator reflects changes in the economy and especially on how large a part of the economy is captured by it. Finally, the controllability of the measure also enters as a significant factor in the choice of an inflation measure.

4 Empirical analysis of inflation indicators

Before continuing with the discussion of the different inflation indicators, we take a closer look at the characteristics of the indicators of inflation in an empirical perspective. This is done in order to reveal whether any of the measures contain superior information that might be of value. Because all the indicators are subsets of the general price level, and they measure the developments in prices in different parts of the economy. By analyzing to what extent the different indicators cointegrate with each other, we can gain a fairly good idea about what we are targeting, and more important, what we are not targeting.

Analysis of the cointegration of different potential inflation indicators has been carried out for the US by Lebow et al.[5] and for the UK by Yates[6]. Lebow et al. conducted pairwise cointegration tests between the CPI and some of its subcomponents, the PPI and some of its subcomponents[7]. They found that none of the price measures cointegrated with the overall CPI, and furthermore, not with the GDP deflator either. In the UK, however, Yates (1995) conducted pairwise cointegration tests for the RPI and some of its subcomponents[8]. He found that all inflation rates cointegrated with each other and for most of them the hypothesis of substitutability was accepted. For price levels without trends, almost all pairs co-integrated. However, the tests for substitutability of price levels was rejected for all pairs.

In the following empirical analysis we test for stationarity and cointegration between IUI, which is the target indicator of the Bank of Finland, the overall CPI, the NPI, the PPI, the fixed-weight GDP deflator and the index of wage and salary earnings. The data for the IUI, the CPI, the NPI and the PPI are recorded monthly, whereas the data for the GDP deflator and the index of wage and salary and earnings (WSE) are recorded quarterly.

4.1 Testing for stationarity

First, we test whether the different indicators of inflation follow a random walk. This is mainly because regression of variables that follow random walks can lead to spurious results. Secondly, random walks affect our way of understanding the economy, since for instance a change in the price level as the results of temporary shocks will not dissipate after some time, but will instead persist. It is therefore

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[5] Lebow, D.E.,J.M. Roberts and D.J. Stockton (1992).

[6] Yates, A. (1995).

[7] The subcomponents of the CPI that were used by Lebow et al. were the CPI excluding food and energy, and the CPI commodies index. Furthermore, they also tested against the PPI finished goods index, the intermediate PPI excluding food and energy, and the crude PPI.

[8] Yates (1995) tests for cointegration between the Retail Price Index (RPI) and the RPIX, RPIY as well as RPIY excluding energy (RPIYE), excluding food (RPIYF) and finally RPIY excluding food and energy (RPIYFE). For further details on how these price measures are constructed, see Yates, A. (1995).

important that variables are stationary, and hence, that they have no unit root or explosive roots. In other words, the variables should be I(0). To test for the order of integration of the series, we use the augmented Dickey-Fuller test[9].

We use this to test the hypothesis of a unit root (ß = 1). Accepting the hypothesis implies that the variable is non-stationary

$$Y_t = \mu + \beta Y_{t-1} + \varepsilon_t .$$

Consequently, finding that a price level has a unit root means that it is integrated of the order I(1), correspondingly, the differences of the variable being of the order I(0). The results of the augmented Dickey-Fuller test are shown in table 4.1. The test is conducted for levels of the variables, the one-month change and the 12-month change.

Table 4.1 **Augmented Dickey-Fuller test for stationarity**

	Levels		1 month change		12 month change	
	No trend	Trend	No trend	Trend	No trend	Trend
CPI	–1.8	–2.4	–1.0	–2.9	–1.5	–3.5**
IUI	–1.8	–1.2	–1.5	–2.8	–0.6	–2.6
NPI	–1.6	–1.9	–1.3	–2.4	–0.5	–2.4
PPI	–1.8	–1.7	–2.1	–3.1	–2.1	–3.7
WPI	–1.8	–2.9	–1.7	–2.1	–2.8	–2.2
GDP	–1.1	–2.7	–1.1	–3.0	–2.1	–4.6**
WSE	–1.0	–2.6	–1.2	–2.7	–2.6	–6.2**

Note: Stationary series are marked with * (5 % significance) and ** (1 % significance)

The ADF test statistic depends on the number of lags used in the regression. In this analysis the ADF statistic was obtained from regressions including a constant and using twelve lags of the dependent variable. The negative number is given, because the interesting alternative hypothesis is that of ß < 1. The other alternative hypothesis, ß > 1, is not very likely for economic variables, since it implies that the variable would be undergoing an exploding process. From table 4.1, we see, that we cannot reject the null hypothesis for unit root, i.e. ß – 1 = 0. However, some of the 12-month price differences were accepted at the 1 % level of significance. However, the use of trends in the regression has a rather large effect on the results; only in three cases are the variables proven to be stationary. Therefore, price levels and differences appear to have a unit root, and hence, they are either I(1) or I(2). Having rejected the hypothesis of stationarity, we might continue with pairwise cointegration tests, since these can also give us some indication about stationarity.

[9] For details of the augmented Dickey-Fuller test, see Dickey, A.D. and W.A. Fuller (1979), Distribution of the Estimations for Autoregressive Time Series With a Unit Root, Journal of the American Statistical Association, vol. 74, no 366 (June 1979), pp. 427–431. Dickey, A.D. and W.A. Fuller (1981), Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica, vol. 49, no 4 (July, 1981).

4.2 Test for cointegrating vectors

The first question is now — what can cointegration analysis actually tell us? The answer to that question is straightforward; cointegration analysis can tell us whether two indices cointegrate or not. Assuming, that two indices that cointegrate over time follow the same path, any divergence between them is only of a temporary character. Thus with knowledge about one index, it is possible to predict the other, and moreover, stabilizing one index should automatically result in stabilization of the other. Therefore, cointegration and the possible cointegrating vector(s) between indices are of vital importance for central banks that focus on a single index rather than a range of different indices.

Since the credibility of a central bank with a publicly announced inflation target depends on the outcome of this policy, in other words, the *ex post* rate of inflation observed by the general public it is of relevance to a central bank to be aware of any cointegration between different indices — if these exist — and to monitor them.

In Finland, the Bank of Finland targets the indicator of underlying inflation (IUI), which is a subset of the overall consumer price index (CPI). Both are measured in terms of the IUI as well as the CPI and other indices. Suppose that these two indices are cointegrated, then targeting and controlling one of the indices would automatically result in control over the other index too. We might write cointegration between two different indices as follows:

$$Y_1 = \alpha + \beta Y_2 \, .$$

Here Y_1 and Y_2 are different price indices. The above equation shows that the price Y_1 can be expressed in terms of Y_2 if both $\alpha = 0$ and $\beta = 1$. If these conditions not satisfied, then stabilizing one index does not necessarily correspond with stabilization of the other index.

We use the maximum likelihood estimator of the cointegration space developed by Johansen[10] to determine the cointegration rank and the associated cointegrating vectors. The results of the cointegration tests are presented in table 4.3.

Table 4.2 **Hypothesis of cointegration**

	H_0:	H_1:
ME test	$p = 0$	$p = 1$
Trace test	$p = 0$	$p > 0$
Alternative hypothesis	$p = 1$	$p > 1$

Table 4.2 should be interpreted as follow: the top left row of each block is the maximal eigenvalues of the stochastic matrix; the bottom left row is the trace of the stochastic matrix; and finally, the top right row is the hypothesis that there is one cointegrating vector against the alternative hypothesis that there is more than

[10] Johansen, S. (1988).

one. Under the null hypothesis of the maximum eigenvalue test (ME) we assume that there are no cointegrating vectors against the alternative hypothesis of one cointegrating vector. In the trace test the null hypothesis is that of no cointegrating vectors against the alternative hypothesis of more than one cointegrating vector.

The cointegration tests are carried out between the price levels and differences that are also used in the unit root test (see section 4.1). However, the cointegration test was not preformed for the GDP deflator or the index of wage and salary earnings, because they are recorded according to another time frequency (quarterly). Throughout the analysis below, we have used 8 lags of the variables. However, the test has also been conducted with 4 and 6 lags. The results of these tests show that the number of lags has a significant influence on the results of the cointegration tests. Nevertheless, when 8 lags were used, most of the inflation indicators cointegrated with each other. This was not the case when 4 or 6 lags of the variables were used.

Table 4.3 **Cointegration test, levels, no trend and 8 lags**

	CPI		PPI		WPI		NPI	
IUI	22.5*	3.9	30.7*	7.6	45.7*	7.1	36.0*	5.2
	26.5*		38.3*		52.8*		31.3*	
CPI			31.0*	5.5	32.8*	4.3	26.6*	5.1
			36.5*		37.2*		31.7*	
PPI					29.0*	11.2*	21.3*	6.8
					40.3*		28.2*	
WPI							35.6*	5.1
							40.7*	

Note: Rejection of the null hypothesis at the 95 % confidence level is marked with *.

Critical values: 95 % level		
	ME test	15.67
	Trace test	19.95
	Alt. hypothesis	9.24

Assuming that our inflation indicators are of the order I(1), in other words, that they are stationary, implies that we can proceed with the testing for cointegration of the price levels.

In table 4.3 we test for cointegration of price levels under the assumption that there is no time trend in the series. The results of these tests are very convincing, in all tests we reject the null hypothesis of no cointegrating vectors at the 95 % level of significance – both for results of the maximum eigenvalues test and the trace test.However, only in one case can we clearly reject the null hypothesis of one or fewer cointegrating vectors, even if we use the 90 % level of significance. Hence, with only one cointegrating vector between two price levels, it means that the price levels are non-stationary, and hence, price levels are possibly of the order I(2).

In table 4.4 we assume, as in table 4.3, that price levels are of the order I(0). Therefore, we test for cointegration of levels, and assume that the series *in fact* contain linear time trends. The results of these tests are somewhat disappointing: only two tests provide convincing support for rejection of the null hypothesis and thereby the basis for accepting the alternative hypothesis that there exists at least

one cointegrating vector. Compared with the analysis without linear time trends, we find that including time trends has a negative effect on the cointegration of the price levels. We might therefore expect that the series do not contain linear time trends. Moreover, adding a linear time trend did not provide any evidence of stationarity of the variables. Hence, price levels are I(2).

This indicates that there might be a unit root in the seasonal component of the price levels, implying that the series are non-stationary. Furthermore, the seasonal components could also be cointegrating. However, we preformed the cointegration test again using seasonally adjusted data and found that this did not change the results significantly.

Table 4.4 **Cointegration test, levels, trend and 8 lags**

	CPI		PPI		WPI		NPI	
IUI	4.0	3.2	10.3	3.8	24.8*	5.0	5.5	1.0
	7.2		14.1		29.8*		6.4	
CPI			16.1*	1.1	18.4*	0.6	7.2	3.7
			17.1		19.0*		10.8	
PPI					11.3	7.2	8.4	3.2
					18.6*		11.6	
WPI							10.6	3.8
							14.1	

Note: Rejection of the null hypothesis at the 95 % confidence level is marked with *.

Critical values: 95 % level		
	ME test	14.90
	Trace test	17.95
	Alt. hypothesis	8.18

Assuming that price levels are non-stationary or of order I(1) corresponds to saying that price changes are stationary. If this is the case, we would rather use price differences in our analysis than price levels. We use 12-month price differences, but we could also use one-month price changes. But, by using year-to-year differences, we overcome some of the problems connected with seasonal variations. In this analysis, we have not included a linear time trend in the variables.

Table 4.5 presents the results of the pairwise cointegration tests of 12-month price differences. Surprisingly few tests are significant at the 95 % level. Thus, we can not generally reject the null hypothesis and say that all the price differences cointegrate with each other. Furthermore, in all cases, we clearly accept the null hypothesis that of one or fewer cointegrating vectors, and thus we have strong support for the assumption that differences are indeed I(1) or even I(2). This implies, that price levels are of somewhat higher order.

The test was also done for price differences including linear time trends. It was found to have no effect on the cointegration of the 12-month price differences, and moreover, there was clear rejection of the assumption that 12-month price differences were stationary. This only confirms our prior assumptions that the series presumably does not contain time trends.

Table 4.5 **Cointegration test, 12 month differences, no trend and 8 lags**

	CPI		PPI		WPI		NPI	
IUI	10.6	1.2	15.8*	1.4	17.4*	5.9	10.1	4.5
	11.8		17.2*		23.3*		14.6	
CPI			23.7*	1.6	13.5	5.0	12.3	1.4
			25.3*		18.5		13.7	
PPI					15.6	4.9	11.8	1.5
					20.4*		13.3	
WPI							12.9	4.0
							16.8	

Note: Rejection of the null hypothesis at the 95 % confidence level is marked with *.

Critical values: 95 % level	ME test	14.90	90 % level	ME test	13.75
	Trace test	17.95		Trace test	17.85
	Alt. hypothesis	8.18		Alt. hypothesis	7.53

The results obtained, using 12-month price differences were somewhat disappointing. The lack of cointegration between 12-month price differences might, however, be due to the fact that we obtained a seasonal adjustment by taking 12-month differences of the variables (Phillips and Perron (1988) and Yates (1995)).

Therefore, we redid the analysis using one-month price differences and omitting linear time trends. The results presented in table 4.6 are striking. All one-month price differences cointegrate with each other at the 95 % confidence level, and more important, using 90 % levels of significance, we found that in seven out of ten pairwise cointegration test there exists more than one cointegrating vector. The interpretation of this result is the following: two cointegrating vectors between two variables imply that the two variables are indeed stationary.

It appears that not only is the cointegration of one-month price differences significant, but that the test also provides evidence for the assumption that price differences are stationary. We have then confirmed what we also found above when we tested for unit root in price levels and the cointegration between them.

Table 4.6 **Cointegration test, 1 month differences, no trend and 8 lags**

	CPI		PPI		WPI		NPI	
IUI	48.1*	8.1**	42.2*	8.02**	23.7*	9.1*	30.6*	1.9
	56.2*		50.2*		32.8*		32.0*	
CPI			28.6*	6.6**	22.6*	8.5*	53.1*	8.8*
			35.6*		31.1*		61.9*	
PPI					19.5*	5.6	38.1*	8.1**
					25.1*		46.2*	
WPI							15.8*	8.4*
							24.3*	

Note: Rejection of the null hypothesis at the 95 % confidence level is marked with *.

Critical values: 95 % level	ME test	14.90	90 % level	ME test	12.91
	Trace test	17.95		Trace test	15.66
	Alt. Hypothesis	8.18		Alt. hypothesis	6.50

4.3 Results

To sum up the basic findings of this empirical analysis, we have found that both price levels and price differences cointegrate with each other, respectively. However, for price levels, we found that they only cointegrate with one vector and thus are non-stationary. Intuitively, this implies that, in contrast to price levels, price differences should be stationary. Analyzing first the 12-month price differences did not confirm this assumption, however, and moreover, it raised doubts as to whether or not price differences cointegrated at all. When, instead, we analyzed cointegration of one-month price differences, the results were completely overturned, confirming our prior intuition. Thus all one-month price differences cointegrated with one another, and furthermore, the analysis provided strong evidence that price differences are indeed I(1).

However, we must be cautions about drawing any firm conclusion based on these analyses, since, they are strongly affected by the choice of lags used in the cointegration tests. The results can be somewhat reversed by choosing another lag length.

5 Optimal inflation indicator

In connection with discussing different potential indicators of inflation which can be used as a target for monetary policy in Finland, it is worth to bearing in mind, that the choice of an indicator to target is determined by which part of the economy we wish to target. Additionally, the question is whether it is possible to control the indicator with the monetary policy instruments available. Moreover, discussing possible indicator targets for Finland, it is necessary to examine what types of shocks are likely to hit the Finnish economy and affect the indicators. Finally, what should actually be the target – the price level or the inflation?

5.1 Shocks affecting the indicators

Temporary shocks of different types are likely to hit the economy from time to time. The effect and length of these vary according to the type and strength of the shocks concerned. Inflation indicators tend to behave slightly differently in response to a shock depending on which part of the economy they monitor. Some prices are especially sensitive to exogenous changes. Hence, it is important to know exactly which part of the economy is being targeted; and further, what types of shocks are likely to have a direct effect on the indicators of inflation.

When pursuing monetary stability, it is not desirable that the central bank has to respond to various temporary shocks affecting the target indicator. In this case, policy makers have two options – either they can exclude extremely volatile prices from the index; or, they can exempt themselves from the effects of these price shocks by introducing various caveats.

5.1.1 Terms-of-trade shocks

The external shocks which are most likely to hit Finland is here considered to be "big" changes in oil prices or exchange rates. The interesting scenario – from our point of view – is that of rising oil prices or depreciation of the currency as a result of, for instance, speculative attacks.

A surprise oil price increase will have a different short-term effect on the possible inflation indicators. The consumer price index will immediately reflect an increase in domestic oil product prices. Likewise, the IUI and NPI, which are subcomponents of the all-item CPI but include the energy component, will also reflect the change in energy prices. On the other hand, indicators like the PPI, the GDP deflator and the Index of Wage and Salary Earning do not directly reflect changes in oil prices, since they measure price changes of domestic production and labour cost.

A currency crisis, like e.g. the one the Finnish Markka experienced in November 1991, is directly reflected in the consumption indices. For the CPI and its subcomponents as too for the WPI, the lag length between the devaluation and its impact on these indices was only one month. The effect was, however, a sharp increase in these indices. In contrast, the impact of exchange rate shocks are less pronounced in the PPI, the GDP deflator and the Index of Wage and Salary Earning. Furthermore, the time lag between the exchange rate shock and the impact of this on the indicators are longer than for the consumption indices.

5.1.2 Internal shocks

Fiscal or monetary policy changes represent two major internal shocks to the economy that are likely to affect inflation indicators. These are perhaps also the most likely to affect the Finnish economy in the present circumstances. Changes in either taxation or the rate of interest both have large impacts on the domestic economy. The results of internal shocks might be deviation from the target, thus forcing the monetary authorities to deal with effects caused by themselves or the government.

Monetary policy in the form of a rise in the interest rate affects the CPI and the NPI immediately, because interest rate changes are transmitted directly to housing prices and mortgage interest payments, which are included in these indices. However, the IUI, the WPI, the GDP deflator and the WSE are not affected directly by monetary policy, since the housing sector is not covered by these indicators. Thus, monetary policy responses that were intended to fight inflation might initially have the opposite effect – increasing the measured rate of inflation[11]. By selecting a target indicator which is not directly affected by monetary policy, the central bank is not placed in the absurd situation of being forced to take perverse policy responses.

Fiscal policy is here thought to involve changes in the government reallocation of resources through taxation or spending. For example, an increase in indirect taxes or cuts in subsidies will have direct effects on price setting in the economy.

[11] Åkerholm, J. and Brunila, A. (1994).

In Finland, indicators that are measured at market prices are affected by changes in indirect taxes; this is, for instance, the case with the CPI, the GDP deflator and the WPI. On the other hand, indicators like the IUI, the NPI, the PPI and the index of wage and salary earnings are measured at tax-free prices or factory gate prices including subsidies. However, because subsidies are also considered to be fiscal policy instruments, the PPI can cause problems for the monetary authorities.

Internal shocks caused by policy changes cannot be ruled out as implausible, since the authorities would thereby dismantle their policy instruments. However, having to explain many disturbances or reacting to self-created shocks would probably erode the credibility of the authorities or have effects on basic causalities.

5.2 Price-level or price differences

The choice between a price-level target and an inflation target has been subject to much attention, notably by Goodhart (1994), Haldane et al. (1995), Andersson et al. (1995) and Yates (1995). Overall, however, the arguments presented in the literature tend to support an inflation target. Targeting the price level, however, simply implies targeting a given set of prices in the future. On the other hand, targeting inflation corresponds to targeting the rise in prices. In practice, this means that we actually monitor the curve of price developments and then target the slope. Nevertheless, the main difference between the targets is that, when inflation is target, there exists room for *drift* in the price level. Hence, the preceding target does not inherit past failures. On the other hand, price level targeting implies that if the target is exceeded one period, the authorities will have to fight this in the next period in order to stay within the price level target – even if that means deflating the economy (Haldane et al. (1995)).

On the other hand, Gerlach (1993) and Yates (1995) argue that inflation targeting affects the price level in a way that makes it non-stationary with increasing variance over time. Moreover, targeting inflation instead of a the price level results in substantially more uncertainty about future prices (Lebow et al. (1992)). However, targeting the price level would require the authorities to act upon changes in the price level, resulting in increased instrument instability. Uncertainty about effect of the monetary policy instruments will thus be the result of targeting the price level rather than inflation.

Fillion and Tetlow (1994) argue that price-level targets increase variability in output, implying that supply shocks will be more prevalent, while inflation targeting has no significant effect on output variability.

In Finland, however, targeting inflation seems more realistic from an empirical point of view, because our empirical analysis of different inflation indicators provided some arguments for targeting inflation. Inflation rates are both stationary and cointegrate, whereas, price levels were found to be cointegrating but non-stationary – which corresponds with inflation rates being stationary. From an empirical viewpoint, an inflation target therefore seems more appropriate, since the analysis is not sample-dependent, as is the case for non-stationary variables. Besides, the pairwise cointegration between inflation rates was much more

significant than cointegration between price levels, indicating that controlling one inflation rate means controlling them all.

The choice between a price-level target and an inflation target is a trade-off between uncertainty in the price level or in the instruments. However, the costs involved with targeting a price level are somewhat larger than with targeting inflation in the case of a missed target. Re-establishing a price-level target *ex post* to a shock might involve real costs, in terms of higher unemployment and a reduction in output.

In addition, the lack of practical experience with price-level targets makes the outcome of such a target somewhat uncertain. Sweden is the only country where a price-level target has been pursued, in the 1930s (Jonung)[12].

5.3 Target measure and expectation formation

The fact that there exist different measures of inflation suggests that the decision on a target measure should be consistent with what the general public considers to be the inflation indicator. If, for instance, the central bank chooses to target a subset of a broader measure or exempt itself from prices that are especially volatile or affected by policy measures, then the target should vary in the same way as the inflation measure monitored by the public. Suppose that the general public forms its expectations on the basis of experiences and forecasts of one index while the central bank targets another. If, then, developments in these two indices differ from each other, we might expect the public to form expectations that are not consistent with the central bank policy. This may be because the forecast monitored by the public is somewhat higher than the target published by the central bank. There are then two possible outcomes: on the one hand, the public forms expectations about higher interest rates, because it expects the central bank to fight inflation, and acts on the basis of this – resulting in decreasing inflationary pressure; on the other hand, if the public forms expectations on the basis of the forecasts monitored publicly, then higher inflation than the target published by the central bank might result. This is especially the case, if the credibility of the central bank is low or the reputation based on past experiences is short. The letter might also be one argument for the emergence of this *target inconsistency problem*, since the public would be confident about the central bank target, if inflation target policy had been pursued for a longer period of time.

One solution to the problem, however, could be to choose a target that is consistent with the inflation measure monitored by the general public. Further, differences between the target measure and other generally used inflation indicators should be clearly pointed out, so that results are evaluated correctly by the public. Moreover, "advertising" the indicator of inflation used by the central bank might be one way to change the expectation formation of the general public. In addition, information about the target, the target measure and the forecasts made by central banks might also help the general public to understand the target and thereby decrease uncertainty about future inflation. Finally, the central bank

[12] For more details on the Swedish price-level target, see Jonung, L. (1992), Swedish price-stabilization policy, 1931-1939, The Riksbank and Knut Wicksll's Norm, in *Monetary Policy with a Flexible Exchange rate*, Sveriges Riksbank, pp. 25-39, Dec.

should not only focus on one measure, but monitor a range of inflation measures. In this way, the central bank would also have indications about possible future changes in the target indicator.

6 Conclusions

This paper has evaluated measures of inflation in Finland. The choice between different indicators is a trade-off between several important factors. However, it is not the purpose of this paper to make a choice between the different indicators presented, but rather to point out some general guidelines policy makers should to bear in mind when choosing an indicator. First, it should be realized that we cannot target the general price level. Hence, it must be decided which part of the economy is subject to targeting. Secondly, it should be possible to use the chosen inflation indicator in economic forecasts; in other words, it should be stationary and consistent with other indicators monitored by the public. Thirdly, the target measure should be chosen so that it is not unduly affected by shocks deriving from changes in monetary or fiscal policy, because that would result in perverse policy. Fourthly, the target measure should be chosen so that shocks that are likely to hit the economy do not affect the indicator directly. This is so because caveats or continuous explanations — whenever the target is missed — might erode confidence in the central bank monetary policy. The choice between level or inflation targets depends on how these behave in an empirical sense. However, much evidence speaks for the inflation target, since there are considerable real costs involved in missing a price-level target. Furthermore, targeting a price level is much a harder restriction on monetary policy. Finally, it should be possible to control the chosen target indicator with the monetary policy instruments available.

In Finland, several indicators are regularly monitored, and thus they are alternative measures of inflation for the target chosen by the Bank of Finland. The Bank of Finland has committed itself to targeting the indicator of underlying inflation. However, this measure, like the other measures described in this paper, has its own strengths and weaknesses. Nevertheless, the IUI satisfies many of the criteria mentioned above. In the empirical analysis we found that the one-month differences of the IUI cointegrated very well with the alternative inflation rates, and hence, it is a good substitute for the alternative inflation measures. Furthermore, we also found evidence that this indicator was stationary. However, it does not fall within the scope of this paper to estimate the vectors between the alternative measures. Efforts should, however, be devoted to this task, because then the stabilization of one index would not necessarily result in stabilization of the other index.

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Appendix

The aim of this appendix is to provide a comprehensive description and discussion of the construction of the different inflation indicators mentioned in chapter 3. However, some of these indicators are not monitored on a regular basis in Finland. Graphical illustrations of how these indicators have behaved in Finland is provided in Appendix B.

Variable-weight GDP deflator

The variable-weight GDP deflator is normally constructed on the principle of the *Paasche index*, using current- (nonbase-) period weights for the calculation of the aggregate. Here the weights reflect the quantities of the items bought during the current period. The variable-weight GDP deflator thus has the advantage that it captures changes in prices as well as in the expenditure weights. On the other hand, this makes the variable-weight deflator more volatile than the traditional GDP deflator.

In practice, the variable-weight GDP deflator is constructed using the current period's expenditure weights, by which the expenditure shares of GDP are applied. In this way, the variable-weight GDP deflator is adjusted every period for the composition of the current expenditure share. Accordingly, it reflects the true expenditure cost of the current period. As a consequence, the variable-weight GDP deflator is not widely used, because the difficulties involved in the gathering of data on current purchase habits for every period are overwhelming.

In Finland, the variable-weight GDP deflator is not calculated or recorded, since calculating the deflator regularly would imply calculating the weights every year. However, the variable-weight GDP deflator has several disadvantages, one of them being that it cannot be used in year-over-year comparisons of price changes because of the yearly rebasing. This is due to continuous changes in expenditure weights, which are reflected in the deflator. Another problem of the variable-weight GDP deflator is that it tends to overestimate the expenditure in the base period. As a result it generally underestimates the rise in the price level in later periods, because some part of the changes are captured due to the substitution in consumption behaviour.

Fixed-weight GDP deflator

An alternative deflator is the fixed-weight GDP deflator that is obtained by employing the same technic of calculation as in the *Laspeyres index*, using expenditure weights obtained from the base year. Hence, the fixed-weight GDP deflator measures the changes in total cost of a fixed basket of goods and services.

Basically, the fixed-weight GDP deflator is constructed using the same method as the variable-weight GDP deflator, but the fixed-weight deflator uses fixed weights to aggregate the subcomponent deflators. These weights are

calculated from the expenditure survey in the base year[13]. The limitation of the fixed-weight GDP deflator is that it assumes fixed expenditure behaviour over time. I.e. that the basket of items bought in the current period is the same as in the base period. This is unrealistic if the time interval between the base period and the current period is large. Nevertheless, this index is close to measure the pure price changes, since it only measures the changes in prices and not in expenditure behaviour.

Another disadvantage of the fixed-weight GDP deflator is that it tends to overestimate price changes, as the interval between the base period and current-period growth. This is due to the substitution bias, i.e. as the prices of some goods increase, consumers tend to substitute them with less expensive products. Revision and rebasing of the GDP deflator is normally quarterly and periodic. At present, the base year of the GDP deflator is 1990[14].

However, in Finland the GDP deflator is only calculated and recorded quarterly. It is not therefore optimal as a target indicator, because it is only available after a long time lag. The deflator reflects developments in the prices of domestic production. The implication of this is that the indicator is subject to shocks. These shocks can have a large direct effect on the indicator's behaviour. There can be fiscal or monetary shocks, i.e. changes in the indirect taxes or interest rates.

Chain-linked GDP deflator

Finally, the chain-linked GDP deflator is constructed as a compromise between the variable- and the fixed-weight GDP deflator. Hence, it comes closest to reflecting true price movements. The chain-linked GDP deflator uses the past period expenditure weights as the base which, in turn, is applied to the current period prices. In this way, the chain-linked GDP deflator measures the current price on the basis of the previous period's expenditure habits, and is therefore comparable with the previous period's price of the same basket.

The chain-linked GDP deflator overcomes the problems of changing purchasing habits by adopting expenditure weights lagged by one period. At the same time, it is still possible to make year-over-year comparisons within a narrow time interval.

The practical problem of the chain-linked GDP deflator – like the variable-weight GDP deflator – is that it needs an updated expenditure pattern every period. This means continuously updating, and hence overwhelming demands as regards data collection.

The chain-linked GDP deflator is not calculated or recorded in Finland, for the same reasons as mentioned for the variable-weight GDP deflator.

[13] The current base year in Finland is 1990, but the base year is subject to periodic revision.

[14] Before 1991, the base year of the GDP deflator was 1985.

Consumer price index

The headline consumer price index (CPI) is probably the most used index as an indicator of inflation, and one of the most important economic indicators. The CPI is constructed to measure movements in the prices of goods and services in the consumer basket. It is reliably calculated and commonly understood. The purpose of the CPI is to measure the cost of living. The CPI is calculated and published monthly by Statistics Finland.

In Finland, the consumer price index is calculated using the Laspeyres index formula. In practice, however, this implies that the index has the same base-weight structure for several years. The CPI is thus the weighted average of household expenditure on goods and services excluding consumption of own goods. At present, the base year for the CPI is 1990, but the index is subject to frequent rebasing[15].

Goods and services are divided into nine main groups, each of which is divided into subcomponents. These groups are each assigned a weight according to their relative share of total consumption. A representative commodity basket is formed on the basis of the Household Survey, and it comprises of 401 goods and services[16].

Consumer prices are collected monthly from retail stores throughout the country by Statistics Finland. Since data for the CPI is collected in retail stores, it includes indirect taxes as well as commodity taxes, whereas direct taxes are left out of the measure.

The consumer price index suffers from several weaknesses. First, the index is, like the fixed-weight GDP deflator, based on the fixed-weight system, and consequently it does not capture substitution between commodies in response to price changes. This is what Yates (1995) calls the *substitution bias*[17]. In other words, the index is biased in that it overestimates the cost of living. Secondly, the consumer price index is biased with regard to quality changes in the products, a problem which arises as a result of either the termination of production or improvement in the quality of existing products. The problem is generally referred to as the *quality adjustment bias*. Thirdly, introduction of new goods also constitutes a bias problem, in the way, that there is a delay in the introduction of these new goods in the CPI. This is called the *new goods bias*. Finally, the consumer price index reflects price movements in domestic markets. However, shocks affecting the price index can also be of external origin. Changes in prices of imported goods and especially raw materials — e.g. oil — constitute a significant factor. But internal shocks in the form of fiscal and monetary policy also changes have a direct effect on the consumer price index.

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[15] The previous consumer price index was based on consumption structure in 1985.

[16] For further details, see Consumer Price Index 1990=100, methodology and practice, Statistics Finland, Studies 200, Helsinki 1993.

[17] For details, see Yates, A. (1995).

Net-price index

The net-price index is consumer prices net of indirect taxes but including the effect of subsidies. The index measures developments in the income obtained by producers and sellers of goods and services. These are measured by a commodity basket produced using the technology of the base year and having a fixed structure and amount.

The net-price index is not used as a basis for any adjustments in Finland, but it shows, together with the consumer price index, the composition of price developments. In practice, the net-price index is the CPI less the tax rate index (TRI), which includes both taxes and subsidies[18]. Since the index is constructed on the basis of the consumer price index, it has the same structure and coverage and is thus subject to the same biases as the CPI.

The index is reversed whenever the indirect tax system is changed or the CPI is revised. The advantage of the net-price index is that it is not affected by changes in indirect taxes. In other words, fiscal policy does not directly affect the index, and hence, the index is not subject to perverse policy effects.

Indicator of underlying inflation

The Indicator of Underlying Inflation (IUI) can be characterized as a "peeled" price index, calculated on the basis of the consumer price index excluding the effects of indirect taxes, subsidies, dwelling prices and mortgage interest payments. In practice, however, the index is calculated as the CPI less the housing cost and tax rate index[19]. The index is calculated on a monthly basis like the CPI by Statistics Finland.

In Finland, the IUI is a rather new inflation measure, and hence it has not been recorded for a very long time. However, the Bank of Finland uses the indicator as its inflation target. Since the IUI is also constructed on the basis of the CPI, it is also affected by weaknesses concerning substitution bias, quality adjustment bias and new goods bias. Finally, the IUI does not capture movements in dwelling cost and mortgage interest payments, which account for approximately 10 % of total household expenditure. On the other hand, the IUI is not directly affected by changes in fiscal or monetary policy. Hence, there is no need for explaining temporary deviations from the inflation target resulting from policy changes.

As mentioned, the IUI is deducted from the consumer price index, and hence, it is also considered reliable and widely understood. Furthermore, the indicator of underlying inflation does not include changes in housing prices or indirect taxes which can obscure the general trend. Hence, it is a better indicator of price movements, since changes in fiscal or monetary policy are not reflected directly in the indicator.

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[18] The tax rate index (TRI) is calculated monthly by the Statistic Finland, in addition to the consumer price index. See Consumer Price Index 1990 = 100, Methodology and Practice, Statistics Finland 200, Helsinki 1993.

[19] For further details, see Spolander (1994).

Producer price indices

The producer price indices (PPI) measure price changes of 1333 goods manufactured in Finland including electricity, gas, heat and water. The index includes both products sold in Finland and exported. The measured price for goods sold in the domestic market is the price received by the producer including commodity subsidies. The price of exported products is the price obtained by the exporter, which is normally the f.o.b. price. In cases where exported goods are subject to subsidies or levies, these are included in the price measure[20]. Furthermore, the PPI does not include turnover tax or other indirect taxes, and thus fiscal policy does not affect the indicator directly.

Producer prices are weighted according to the markka values of domestic production in 1990. The indices are thus fixed-weight Laspeyres price indices obtained from industrial statistics and national accounts for 1990. By combining the weights of home-market production and export, we end up with the value weights of the producer price index for manufactured products.

Quality changes in the fixed commodity basket are likely to occur, but this should not affect the producer price indices. Therefore, developments in the average price of a product group are monitored. Moreover, the effects of quality changes in products on prices are estimated by contact persons in the companies[21].

The producer price indices are constructed in the same way as the CPI, and hence, it shares some of the same fundamental problems as the consumer price index. These problems are especially related to quality bias and new goods bias. Moreover, the PPIs are measured at factory gate or f.o.b prices, thus i.e. transportation cost and value added in distribution and sales are not included. Finally, the producer price index does not include services or non-manufactured goods. On the other hand, substitution bias does not affect the producer price indices.

Index of Wage and Salary earnings

The *index of wage and salary earnings* (WSE) measures developments in average earnings for regular working time of wage and salary earners. The index is calculated quarterly by Statistics Finland. The data are collected from 389 base series and include both public and private employment statistics. The basis for the index is the official index, which are composed of the **employer sector, industry and wage earner group**. There are 127 of these groups in the new index, for which average earnings are determined using the 389 base series and changing the numerical weights of wage and salary earners[22]. The index is then calculated by

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[20] For further details, see Producer Price Indices 1990 = 100, Handbook 31, Statistics Finland, Helsinki 1993.

[21] Op.cit.

[22] For Further details, see The Index of Wage and Salary Earnings 1990=100, Handbook 33, Statistics Finland, Helsinki 1994.

dividing these average earnings by the average earnings of the corresponding group in 1990 and multiplying by a hundred. Salary and wage earner groups indices are combined by weighting each group index with the group's total earnings weight. The total index of wage and salary earnings is calculated as a Laspeyres index, with 1990 as the base year in Finland.

In Finland, the index of wage and salary earnings is mainly used as background material in collective bargaining agreements by both employees and employers. However, the index is also used as a guideline for the pension system, where it is of significant importance. Finally, the index is also used by insurance companies for calculation of reimbursement.

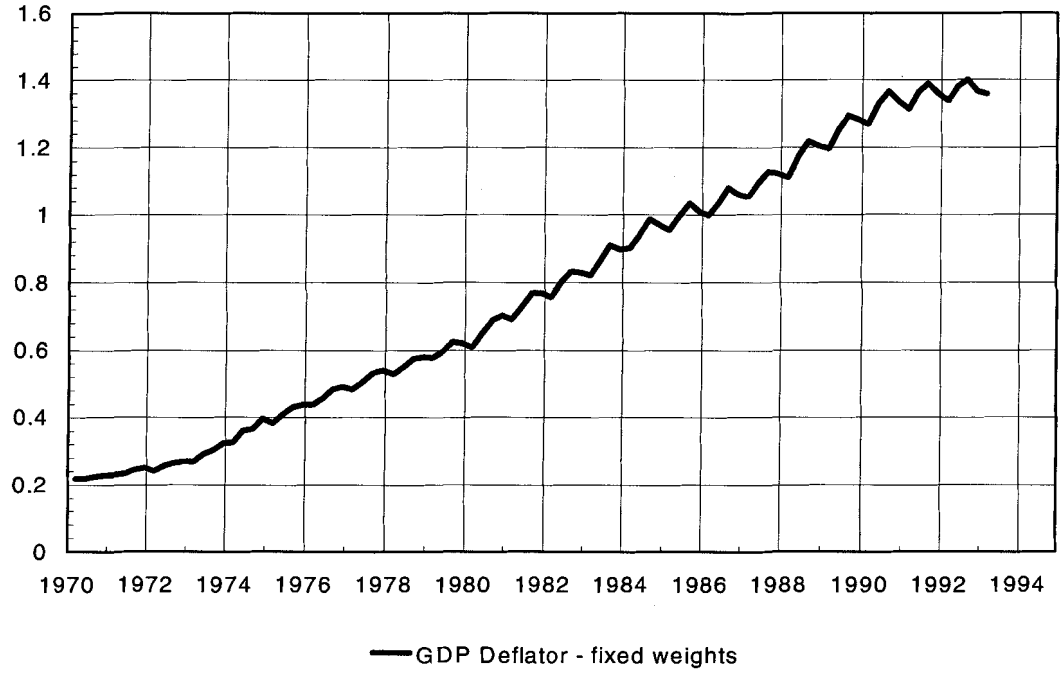
The index of wage and salary earnings has some limitations for use as a measure of aggregate labour costs. First, the data do not include self-employed persons, unpaid family workers in the agricultural sector and owners of unincorporated businesses. Secondly, the index of wages and salary earnings does not include piecework.

One advantage of the index is that it measures developments in wage and salaries frequently. However, the index is only recorded quarterly and is not therefore suitable as an indicator for inflation target.

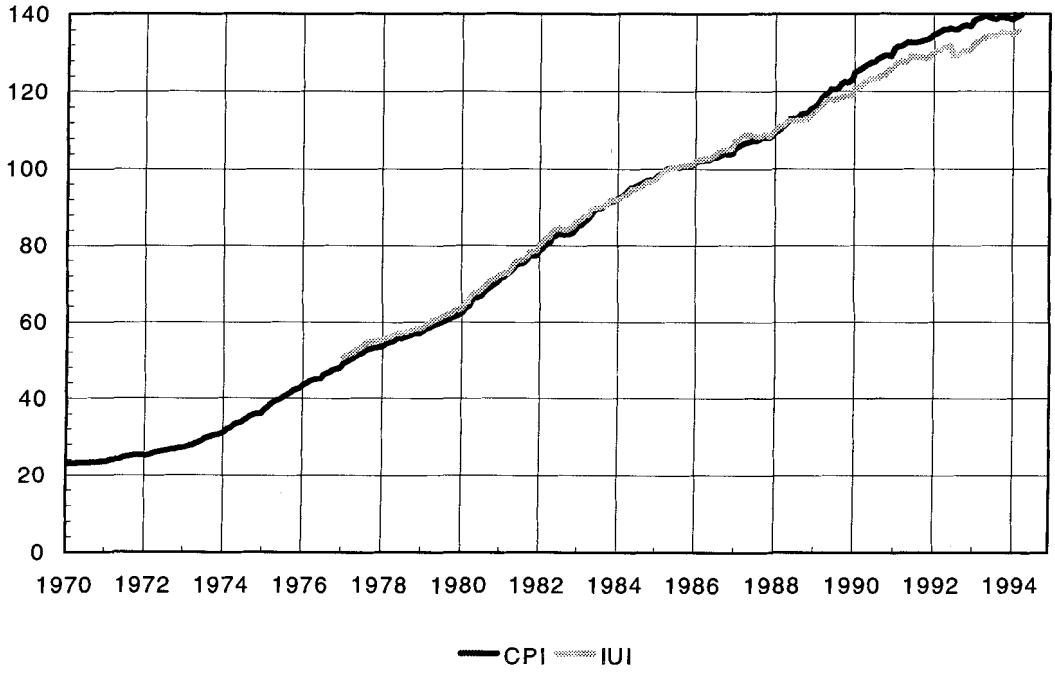
Labour cost index

Statistics Finland has recently published a new index on the cost of labour. The labour cost index measures changes in both wages and salaries paid for working hours and indirect compensation and other indirect labour costs (social security contributions ect.). The index was constructed in 1994 for industrial workers only; indices for labour cost in other parts of the economy are being constructed. The time series of the index is very short at the moment (only the 1990s). It is therefore too early to say anything about the value of the index. However, a complete labour cost index would provide a reliable description of changes in the cost of labour.

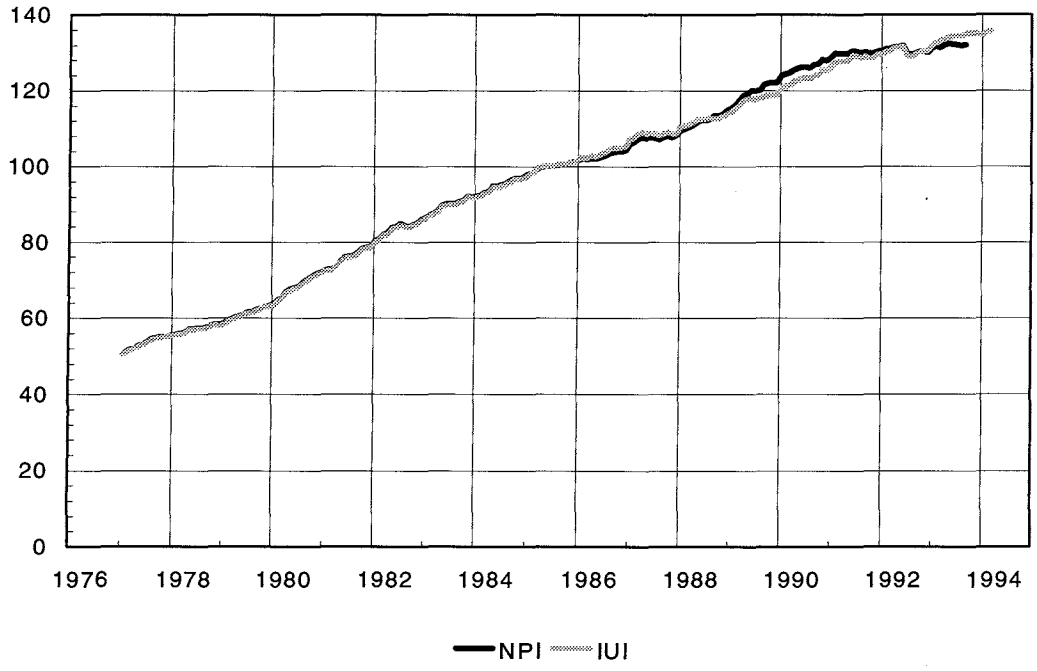
GDP Deflator - fixed weights, base year 1985



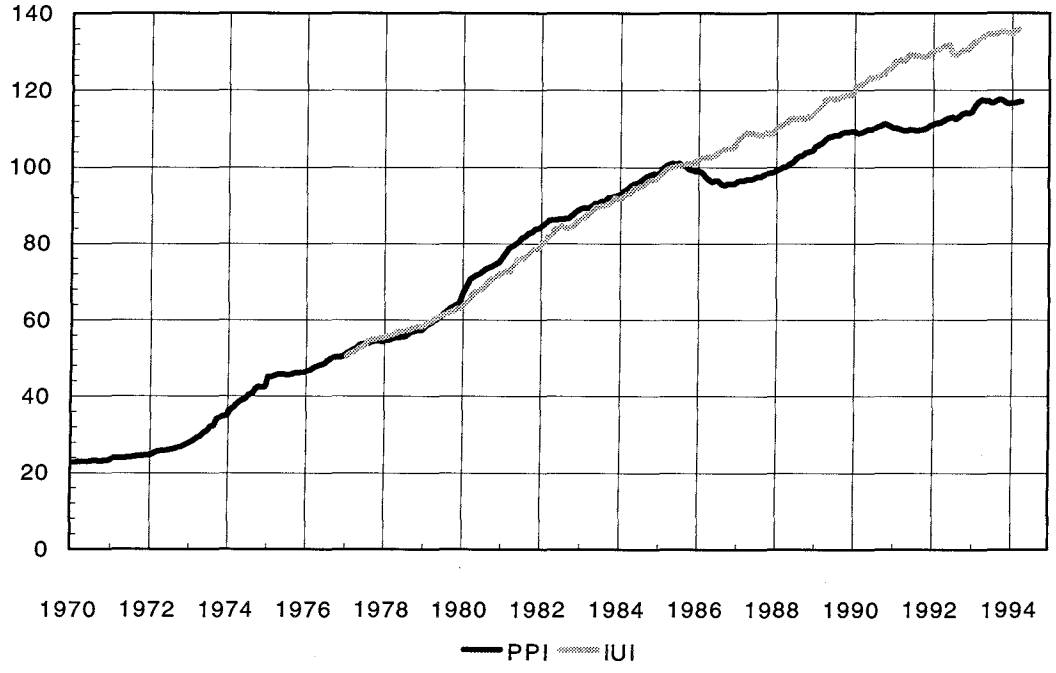
Finnish IUI and Consumer Price Index, base year 1985



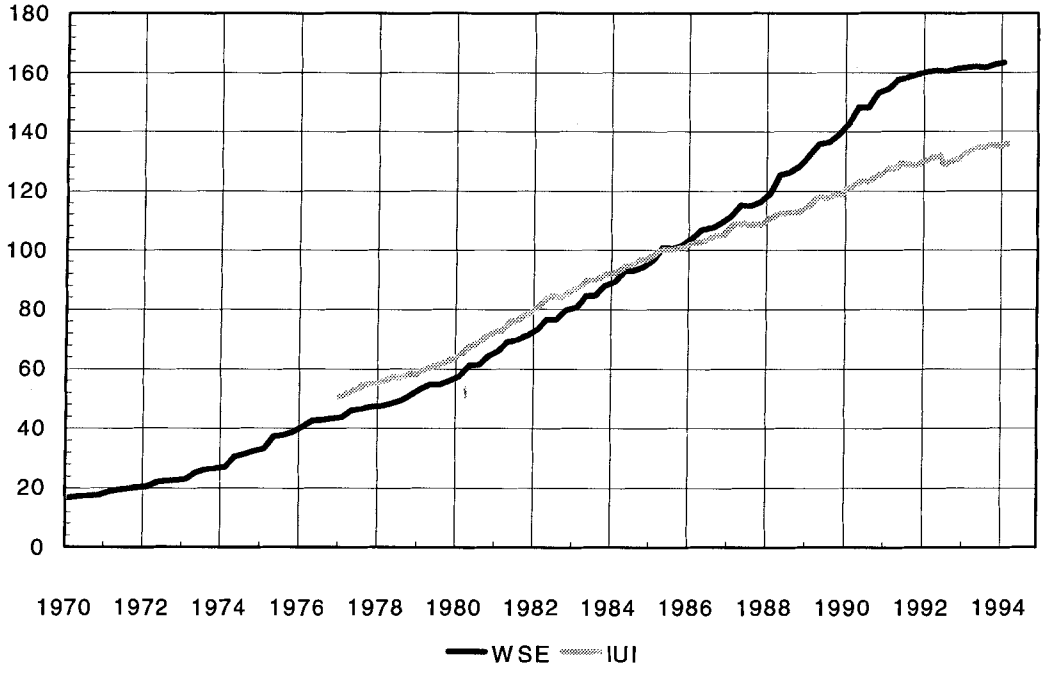
Finnish IUI and Net Price Index,
base year 1985



Finnish IUI and Producer Price Index,
base year 1985



Finnish IUI and Index of Wage and Salary Earnings, base year 1985



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