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WAGE INDEXATION AND PRICE AND WAGE CHANGES

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WAGE INDEXATION AND PRICE AND WAGE CHANGES

by Pentti Vartia

1. Introduction

Indexation has generally been proposed in order to eliminate the distributive and allocative effects of inflation. Recent discussion has also dealt with the effects of index clauses on the inflation rate, considering e.g. whether such clauses can be used as a policy instrument to reduce the inflation rate[1]. Some studies have also investigated the effects of wage indexation on the spreading of aggregate-level real and monetary disturbances in simple macro-models[2]. This paper compares indexed and non-indexed wage agreements only in the context of two alternative models for wage and price developments. We assume that wages are negotiated in more or less centralized manner, typical of e.g. Scandinavian countries, which makes it important to consider the effects of wage indexation on the price level. The bargaining situation is thus different from that of a single employee and a single firm, but we can still apply microeconomic results on Pareto-optimal payment plans in investigating it. We show how the question whether

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I have benifited from discussions with Leo Törnqvist, Tauno Ranta, Yrjö Vartia and participants in prof. Paunio's seminar. I would also like to thank Jaakko Railo for commenting on the text while checking the language.

1) See e.g. Friedman (1974), Goldstein (1975), Vartia (1975).
2) See Gray (1976) and Fischer (1976).

indexation leads to larger price or wage changes than non-indexation depends in a simple way on the relationship between price expectations and the predetermined variables of the wage-price block. In cases where the predetermined variables are stochastic the distribution functions of the price and wage increases connected with different agreements can be derived and only probability statements can be made ex ante as to which of these two kinds of agreement leads to higher wage and price increases. The paper also comments on the evaluation of risky wage agreements and investigates the process of making contracts in cases where views regarding future price movements differ. Situations where expectations differ raise interesting complications in wage bargaining, concerning e.g. the applicability of index clauses. It seems that these cases merit more attention than they have received hitherto in the study of labour (and other) contracts.

2. Basic wage-price models for the indexed and non-indexed agreements

A non-indexed wage agreement is a payment plan where the employer (or a group of employers collectively) agrees to pay certain nominal payments to the employee (or to employees) regardless of the price developments during the agreement period. Indexed wage agreements are payment plans where the payments depend on the uncertain future rate of inflation. On the national level the actual developments do not always follow the negotiated agreements, and we also allow for factors which cause wage drift, but these factors are assumed to be exogenous.

In order to study the interconnections between wage indexation and the inflation rate we use the following wage-price model[1].

$$\underline{W}_t = \underline{a}_t + a_1 P_t^e \tag{1}$$

$$\underline{P}_t = \underline{b}_t + b_1 \underline{W}_t$$

Here $\underline{W}$ is the percentage change in the money wage rate, $\underline{P}_t$ is the change in price level, and P_t^e is the expected change in price level during the contract period. We have underlined random variables to stress their random character. The first equation describes wage bargaining and the second price markup behaviour.

As $\underline{W}$ and $\underline{P}$ are the only endogenous variables in the model we have included all exogenous variables in the terms $\underline{a}_t$ and $\underline{b}_t$. Here $\underline{a}_t$ could include e.g. autonomous wage increases (not depending on the expected or realized course of prices), effects of unemployment and labour productivity and $\underline{b}_t$ could include the effects of import prices, taxes, cost of capital services, the rate of capacity utilization, etc. Also, $\underline{a}_t$ and $\underline{b}_t$ can be interpreted to include disturbance terms. In a more realistic model $\underline{a}_t$ and $\underline{b}_t$ would not be exogenous: one should take into account feed-backs from wages and prices to other variables, e.g. to export performance, profitability and investments, to the volume of foreign trade and that of production, to unemployment and back to wages, to exchange rates and import prices and back to prices. We thus disregard feed-back effects from important real determinants of long-run productivity and real wages and try to concentrate on the short-run dynamics of prices and nominal

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1) Similar but deterministic model was used by Goldstein (1975) and Vartia (1976). For an empirical application of this kind of model see e.g. Vartia (1974).

and real wages. In the longer run success of one of the negotiators with a single agreement may turn illusory when a sequence of agreements is investigated. Of course, even in the short run the feed-backs to wages and prices are important e.g. in the case where real wage increases are completely out of line with productivity changes.

For the most part it is not necessary in the following analysis to make any specific hypothesis of the way expectations P_t^e are formed. A value or a probability distribution for P_t^e may be determined for example by some kind of adaptive scheme with or without stochastic elements, say, with the adaptive expectations hypothesis

$$P_t^e = \sum_{i=1}^{\infty} \alpha_i P_{t-i} \tag{3}$$

Another possibility of arriving at P_t^e is to assume that economic agents derive their expectations employing economic models. If expectations about the exogenous variables are stochastic, expectations concerning the future course of prices will also be stochastic and the distribution of P_t^e will depend on the distribution of the exogenous variables[1]. In actual

1) With our non-indexed model, rational expectations, i.e. the mathematical expectation of future price increase that will satisfy $E(P_t) = P_t^e$ once P_t^e is used for determining the nominal wage increase, may be derived from equations (1) and (2) in combination with condition $E(\underline{P}_t) = P_t^e$, to get $P_t^e = E(\underline{P}_t) = [1/(1-b_1a_1)][E(\underline{b}_t)+b_1E(\underline{a}_t)]$. Deviations of P_t^e from the actual price movements are likely to occur but large deviations are surprises. With stochastic models the probability that P^e is exactly equal to P is zero. Thus if anticipations can only be represented by a scalar P^e, we almost always end up in a situation where inflation is more or less unanticipated.

negotiations independent information on expectations is also often available; expectations may be expressed e.g. by the negotiating partners during wage negotiations without any reference to the more or less complicated ways in which they may be generated or use may be made of non-partisan forecasts[1].

The determination of a common P_t^e to be used for setting the nominal wage increase in the non-indexed alternative (deciding, e.g., whose expectations are to be used if the expectations of the negotiating parties differ) may thus be a complicated process, but we assume that some kind of compromise is found. After all, it is not so important that P_t^e even reflects the true expectations of negotiating parties; what is more important are the distributions of $\underline{P}_t$ and $\underline{W}_t$ for given P_t^e:s, $\underline{a}_t$:s and $\underline{b}_t$:s, i.e. the price and wage increases corresponding to different agreements. Thus in eq. (1) term $a_1 P_t^e$ represents the (controllable) basic nominal wage increase and $\underline{a}_t$ other factors, and an increase in $E(\underline{a}_t)$ may compensate for a decrease in $a_1 P_t^e$ and vice versa. It might well be possible that in actual negotiations trade unions offer higher and employers smaller than their true price expectations for the determination of nominal wage increase on the basis of an "expected" inflation rate. Successful selling of over-pessimistic (over-optimistic) views on the inflation rate and the corresponding higher (lower) basic nominal wage increase will according to our model for the non-indexed agreements, ceteris paribus, lead to higher (lower) real earnings.

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1) Thus in Finland, for instance, the state has set up an incomes policy commission which prepares price forecasts for the negotiators.

For our analysis it is important to remember that with non-indexed agreements a priori ideas concerning future price movements can only be taken into account by a scalar, e.g. by the mathematical expectation, not by a whole distribution. However, once P_t^e has been used to determine the nominal wage increase in the non-indexed alternative, the outcome $\underline{P}_t$ is again a random variable.

Goldstein (1975) analysed the effects of indexation on wage and price developments by investigating the effects of indexation on the parameters of model (1)-(2). For our purposes it is natural also to formulate explicitly the alternative model describing the formation of wages and prices when wages are indexed. It seems quite safe to assume that the price equation (2) under indexation of wages is the same as in the absence of indexation. However, under indexation of wages the wage equation is different; new explanatory variables enter and some of the coefficients may be altered. Thus, for example, if the equation explains both the negotiated wages and wage drift, it may be that wage drift under indexation is not the same as without indexation. We denote by small letters the price and wage variables corresponding to our model for indexed agreements. In its structural form it is

$$\underline{w}_t = \underline{a}_t^i + a_1^i \underline{p}_t \qquad (4)$$

$$\underline{p}_t = \underline{b}_t + b_1 \underline{w}_t \qquad (5)$$

Here a_1^i gives the extent of indexation[1]; with full indexation it is given the value 1. As the wage rate directly enters the price equation we have to assume that all wages in the economy are indexed in the same way, which often happens in centralized collective wage negotiations. It should also be noted that we have here idealized away the lags between price changes and the resulting index corrections in wages. Notice that full indexation in our model (because of the term a_t^i) generally does not make it possible to determine the development of real wages, since there are determinants of wages other than prices even when wages are fully indexed. Only if we can control $\underline{a}_t^i$ and set it equal to a given value $\underline{a}_t^i = \bar{a}$ can we (with full indexation) determine the development of real wages.

3. Comparison of the wage and price movements related to the indexed and non indexed agreements

We calculate the reduced forms of models (1) - (2) and (4) - (5) and compare them with each other in order to see which regime for a single period (given the predetermined variables) can be expected to lead to higher inflation and which to higher nominal and real earnings.

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1) It is often assumed that $0 \leq a_1^i \leq 1$, but as e.g. the analysis on Pareto-optimal wage agreements shows, we need not necessarily confine ourselves to this interval. However, note that the stability of the system imposes some requirements on a_1^i, see the numerator of eqs. (7) and (8) which may approach zero with large values of a_1^i.

The reduced form (together with the corresponding real wage change) of the model for the non-indexed agreement is given by the equations[1]

$$\underline{W}_t = \underline{a}_t + a_1 P_t^e \tag{1}$$

$$\underline{P}_t = \underline{b}_t + b_1 \underline{a}_t + b_1 a_1 P_t^e \tag{6}$$

$$(\underline{W}_t - \underline{P}_t) = (1 - b_1)(\underline{a}_t + a_1 P_t^e) - \underline{b}_t \ . \tag{7}$$

Similarly we have for the indexed agreement

$$\underline{w}_t = \frac{1}{1 - b_1 a_1^i}[\ \underline{a}_t + a_1^i \underline{b}_t] \tag{8}$$

$$\underline{p}_t = \frac{1}{1 - b_1 a_1^i}[\ \underline{b}_t + b_1 \underline{a}_t^i] \tag{9}$$

$$(\underline{w}_t - \underline{p}_t) = \frac{1}{1 - b_1 a_1^i}[\ (1 - b_1)\underline{a}_t^i - (1 - a_1^i)\underline{b}_t] \ . \tag{10}$$

These equations give the random wage and price increases as functions of the random predetermined variables, and they can be used to derive distribution functions for $\underline{W}$, $\underline{P}$, $\underline{w}$ and $\underline{p}$. Of course, similar equations can be written for values of the random variables which give values for $\underline{W}$, $\underline{P}$, $\underline{w}$ and $\underline{p}$ as functions of the values of the predetermined variables.

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1) Eqs (7) and (10) are for percentual changes only approximations, for logarithmic changes they are exact.

In the non-indexed alternative the distribution of nominal wage increase depends only on $\underline{a}_t$ and not on $\underline{b}_t$ (i.e. not on uncertainties connected with the price equation), but the distribution of the real wage increase ($\underline{W} - \underline{P}$) depends both on the distribution of $\underline{a}_t$ and $\underline{b}_t$. Eq. (10) clearly shows what we can do with an indexed wage agreement: as $a_1^i \to 1$ (i.e. as we are approaching full indexation) we can (by making the nominal wage increase depend on the uncertain price increase) eliminate more and more of the uncertainty carried over to the wage increase by the random term $\underline{b}_t$ in the price equation. Thus with indexation we can eliminate uncertainties due to unexpected price movements but not such changes in wages as are due to unexpected exogenous shocks in the wage equation[1]. Of course, there may be other methods of eliminating unexpected changes in the wage equation: we can try to make $\underline{a}_t^i$ constant by various clauses and regulations (e.g. by wage controls) or at least make its distribution more concentrated. A simple possibility would be to use, instead of indexed equations of the type $\underline{w}_t = \underline{a}_t + 1p_t$, equations of the type $\underline{w}_t = \underline{a}_t + 1(p_t - (\underline{a}_t - a_0)) = a_0 + \underline{p}_t$, which would guarantee the real wage increase a_0. Here wage increases would be indexed to price increases exceeding the difference between the wage increase stemming from other sources except index compensation, i.e. $\underline{a}_t$, and some given (perhaps desired) real wage increase a_0. This kind of indexation would thus make price compensation unnecessary provided that the (desired) real wage increases were already established without them. The use of clauses of this kind, however, is rendered difficult by the fact that the average wage increase does not reflect developments in all wage groups.

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1) Gray (1976) and Fischer (1977) have shown that in a simple neo-classical model wage indexing insulates the real sector from monetary disturbances. However, if these monetary disturbances are also reflected in the disturbance term of the wage equation $\underline{a}_t$ then real wages (and thus possibly also labour input and production) will be affected by these monetary shocks.

In order to find out which wage-price block is likely to lead to a higher inflation rate, to higher nominal wages and to higher real wages, we calculate the following differences

$$(\underline{W} - \underline{w}) = \underline{a}_t + a_1 P_t^e - \frac{\underline{a}_t^i + a_1^i \underline{b}_t}{1 - a_1^i b_1} . \tag{11}$$

$$(P - p) = b_1 \left[\underline{a}_t + a_1 P_t^e - \frac{\underline{a}_t^i + a_1^i \underline{b}_t}{1 - a_1^i b_1} \right] = b_1 (W - w) \tag{12}$$

$$(W - P) - (w - p) = (W - w) - (P - p)$$

$$= (1 - b_1) \left[\underline{a}_t + a_1 P_t^e - \frac{\underline{a}_t^i + a_1^i \underline{b}_t}{1 - a_1^i b_1} \right] = (1 - b_1)(W - w) \tag{13}$$

From (11)-(13) it is easy to see that in our models an indexed agreement will lead to a smaller nominal wage increase than a non-indexed agreement just in those cases where the inflation rate and the real wage increase are also smaller[1]. This will be the case when P_t^e, $\underline{a}_t$, $\underline{b}_t$, $\underline{a}_t^i$, $\underline{b}_t^i$ and the indexation parameter a_1^i take such values that

$$P_t^e > \frac{a_1^i b_t - (1 - b_1 a_1^i) a_t + a_t^i}{a_1 (1 - b_1 a_1^i)} \tag{14}$$

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1) This characteristic of the model is partly due to the absence of feedbacks from employment and productivity developments to wage and price developments.

Thus, e.g., when the expectations P_t^e are very high with respect to the values of the exogenous variables a_t and b_t we have the case where indexation leads to less inflation[1]. On the other hand, ex ante, when values for the predetermined variables are not known, we have only probability statements concerning the wage changes and inflation rates connected with different agreements; we can say, e.g., that an indexed agreement is expected to result in lower real wages, i.e. $E(\underline{W} - \underline{P}) > E(\underline{w} - \underline{p})$ iff

$$P_t^e > \frac{a_1^i\, E(\underline{b}_t) - (1 - b_1 a_1^i)\, E(\underline{a}_t) + E(\underline{a}_t^i)}{a_1(1 - b_1 a_1^i)} \qquad (15)$$

As the relationship between inflation rates and nominal and real wage changes are in our short-run models closely connected we will in the following concentrate on the comparison of real wage changes only. A fully analogous comparison can be made for e.g. price changes of indexed and non indexed agreements in order to study which kind of agreement and in what kind of situations is likely to be the more inflationary.

From eqs. (7) and (10) we get the following mean expectations for real wage increases in the two alternatives:

$$E(\underline{W} - \underline{P}) = (1 - b_1)a_1 P^e + (1 - b_1)E(\underline{a}_t) - E(\underline{b}_t) \qquad (16)$$

$$E(\underline{w} - \underline{p}) = \frac{1}{1 - b_1 a_1^i}\left[(1 - b_1)E(\underline{a}_t^i) - (1 - a_1^i)E(b_t) \right] \qquad (17)$$

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1) We have here compared inflation rates resulting from the use of indexed and non-indexed agreements but not much has been said of the relationship between the two resulting inflation rates P and p on the one hand and P^e on the other. Whether expectations turn out to be under- or over-estimates may be studied by comparing P^e with eqs. (6) and (9).

For the variance of the real wage change in the non-indexed and indexed agreements respectively we have

$$\mathrm{Var}(\underline{W} - \underline{P}) = \mathrm{Var}\,[\,(1 - b_1)\underline{a}_t - \underline{b}_t] = (1 - b_1)^2\mathrm{Var}(\underline{a}_t) + \mathrm{Var}(\underline{b}_t)$$

$$- 2(1 - b_1)\mathrm{Cov}(\underline{a}_t, \underline{b}_t) \qquad (18)$$

$$\mathrm{Var}(\underline{w} - \underline{p}) = \left(\frac{1 - b_1}{1 - b_1 a_1^i}\right)^2 \mathrm{Var}(\underline{a}_t^i) + \left(\frac{1 - a_1^i}{1 - b_1 a_1^i}\right)^2 \mathrm{Var}(\underline{b}_t)$$

$$- \frac{2(1 - b_1)(1 - a_1^i)}{(1 - b_1 a_1^i)^2} \mathrm{Cov}(\underline{a}_t^i, \underline{b}_t)\ , \qquad (19)$$

the last two terms of (19) vanishing with full indexation.

If the frequency function of $\underline{a}_t^i$ is flat enough, i.e. if there is much uncertainty as to how much non-price (exogenous) terms will contribute to wage increases, Var(w - p) may be larger than Var(W - P). On the other hand, when the distribution of $\underline{a}_t^i$ concentrates on a single point, Var(w - p) approaches zero, i.e. the uncertainty connected with the real wage increase can effectively be eliminated by indexation.

EXAMPLE 1. To give some examples of the comparison of indexed and non-indexed agreements we simplify our models in the following way

1. $\underline{a}_t = \underline{a}_t^i \sim N(2,\sigma^2)$, i.e. the contribution of exogenous variables to the increase in wages is both in the indexed and non-indexed cases normally distributed with $E(\underline{a}_t) = 2$ and $\mathrm{Var}(\underline{a}_t) = 1$.

2. $\underline{b}_t = 0.4\underline{P}_{mt}$ where $\underline{P}_{mt} \sim N(E(\underline{P}_{mt}), k\sigma^2)$ refers to import prices

3. $b_1 = 0.6$

4. $a_1 = 1$, i.e. nominal wage claims are completely adjusted to price expectations (in the non-indexed alternative)

5. $a_1^i = 1$, i.e. we have full indexation (in the indexed alternative)

Referring with (i') to the corresponding more general formula (i) we then have

$$\underline{W}_t = \underline{a}_t + P_t^e \tag{1'}$$

$$\underline{P}_t = 0.6(\underline{a}_t + P_t^e) + 0.4\underline{P}_{mt} \tag{6'}$$

$$(\underline{W}_t - \underline{P}_t) = 0.4(\underline{a}_t + P_t^e - \underline{P}_{mt}) \tag{7'}$$

$$\underline{w}_t = 2.5(\underline{a}_t + \underline{b}_t) \tag{8'}$$

$$\underline{p}_t = 2.5(\underline{b}_t + 0.6\underline{a}_t) \tag{9'}$$

$$(\underline{w}_t - \underline{p}_t) = \underline{a}_t \tag{10'}$$

Indexation can be expected to result in a smaller real wage increase (and a smaller inflation rate) if

$$E(\underline{W} - \underline{P}) - E(\underline{w} - \underline{p}) = E(\underline{a}_t - [0.4(\underline{a}_t + P_1^e) - 0.4\underline{P}_{mt}])$$

$$= E(0.6\underline{a}_t - 0.4P_t^e + 0.4\underline{P}_{mt}) > 0$$

This is expected to happen if

$$P_t^e > 1.5E(\underline{a}_t) + E(P_{mt}) = 3 + E(P_{mt}) \qquad (15')$$

Of course, if we knew the values which P_t^e and $\underline{P}_{mt}$ will take we could directly say which kind of agreement will result in higher price and wage increases. If, for example, P_t^e were during the negotiations stated to be $P_t^e = 10$ and if it turned out (or were known) that $P_{mt} = 6$ and $a_t = 2$, our models suggest that the indexed agreement would lead to a lower inflation rate ($p_t = 9$) than the non-indexed one ($P_t = 9.6$).

In actual negotiations the negotiating parties need not operate with similar wage price models and/or the same expectations. However, if one side has expressed its expectations, the other side can use analysis of the present kind to investigate various indexed and non-indexed agreements from its own standpoint. Thus if in the above example it were the trade unions, e.g., that had expressed their price expectations to be $P_t^e = 10$ and proposed this as a basis for determining the nominal wage increase in the non-indexed alternative according to equation (1'), employers could use our analysis to support indexation regardless of their own price expectations as long as they expected that $a_t = 2$ and $P_{mt} = 6$ (and considered the simple model satisfactory).

If we know the mechanism by which expectations are generated, e.g. that they result from the adaptive expectations hypothesis (3), then equation (15) relates not only expectations P_t^e but also the past inflation rate to the exogenous variables of the price-wage-block. Let us, for the purpose of illustration, assume the simplest possible scheme for the generation of expectations

$$P_t^e = P_{t-1} \qquad (3')$$

i.e. the expected inflation rate for this period is the same as the preceding period's realized rate. Then, eq. (15') tells us that in a situation where the inflation rate has been more than 9 % we can, given the other assumptions of our numerical illustration, expect less inflation with a fully indexed agreement than with a non-indexed agreement.

EXAMPLE 1.A. To make more concrete comparisons between indexed and non-indexed agreements, assume that $P_t^e = 11$ and $E(\underline{P}_{mt}) = 7$, $Var(\underline{a}_t) = \sigma^2 = 1$, $Var(\underline{P}_{mt}) = k\ Var(\underline{a}_t) = k\sigma^2 = k$ and that $Cov(\underline{a}_t, \underline{P}_{mt}) = 0$. From (7') and (10') the expected real wage increase is in the non-indexed case $E(W - P) = 0.4\,[\,E(\underline{a}_t) + P_t^e - E(P_{mt})] = 2.4$ and in the indexed case $E(w - p) = E(\underline{a}_t) = 2$. From (18) and (19) the variance of the real wage increase is in the non-indexed alternative $Var(W - P) = 0.16 + 0.16Var(\underline{P}_{mt}) - 0.32Cov(\underline{a}_t, \underline{P}_{mt}) = 0.16(1 + k)$ and, in the indexed alternative, $Var(\underline{w} - \underline{p}) = Var(\underline{a}_t) = 1$. The distribution functions connected with these indexed and non-indexed agreements are presented in fig. 1 A[1].

EXAMPLE 1.B. If we take $P_t^e = 10 = 3 + E(\underline{P}_{mt})$ (cf. eq. (15')) then $E(\underline{W} - \underline{P}) = 2$ and we have the situation where the expected increase in real wages is the same in both agreements. If we further set $Var(\underline{P}_{mt}) = 5.25$ we have the situation where the variance of the real wage increase also is the same in the non-indexed and in the indexed case, see fig. 1 B. By changing the value of k, we can generate distribution functions where the variance is smaller either in the indexed or in the non-indexed alternative.

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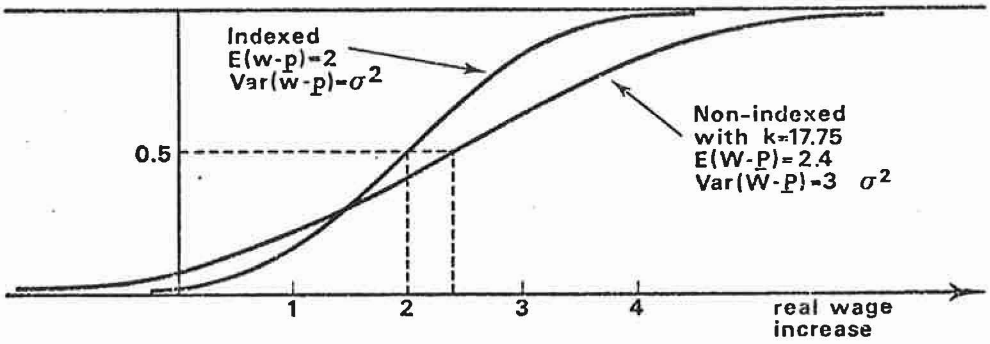
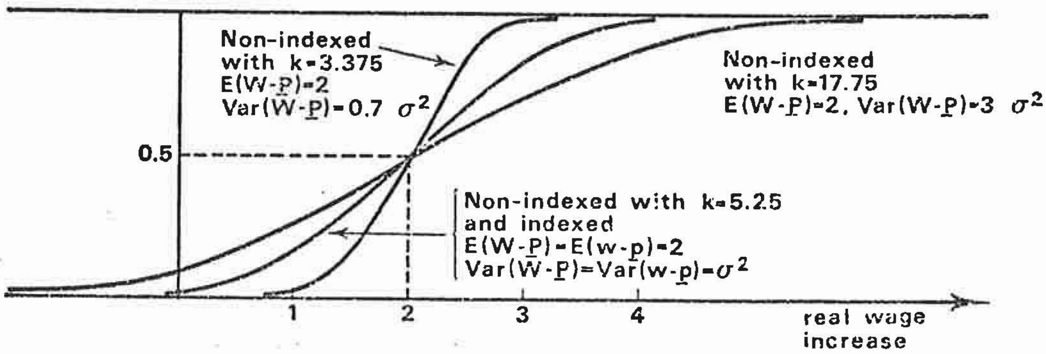
1) Wage and price increases obey normal distribution if the predetermined variables are random samples from a multinomial distribution, which we assume in the following.

Fig. 1. Distribution functions of the real wage increases (in percent) corresponding to indexed and non indexed wage agreements of examples 1A, 1B and 1C.

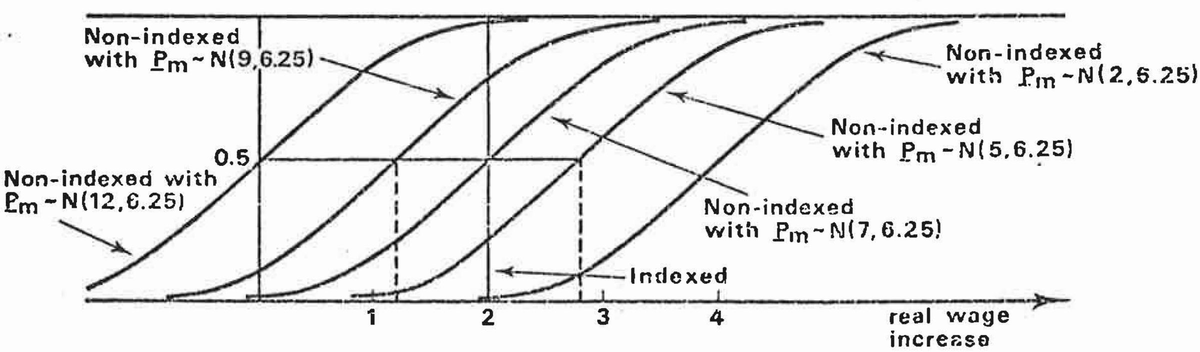
1A.



1B.



1C.



EXAMPLE 1.C. To simplify the situation further suppose that $Var(\underline{a}_t)$ = $Var(\underline{a}_t^i)$ = 0. Under the indexed agreement real wages will then, for a certainty, increase by 2 %. In the non-indexed agreement there is a basic nominal wage increase of 12 % ($a_t + P_t^e = 12$) and the real wage increase will depend on the random price increase. If the increase in import prices obeys the normal distribution $\underline{P}_{mt} \sim N(\mu, 6.25)$, i.e. k = 6.25, we can from figure 1C see how radically the ideas held concerning μ = $E(\underline{P}_{mt})$ affect the location of the distribution function of the real wage increase connected with the same non-indexed agreement.

These three examples clearly show that the choice between indexation and non-indexation in the stochastic case is not as clear as in the deterministic case. In order to make the choice between the two alternative agreements, some kind of weighting function for the various outcomes is necessary. Furthermore, the choice between indexation and non-indexation is seen to be quite sensitive to expectations concerning the future course of the exogenous variables. In comparing two indexed agreements (the general reduced form of which is given by eq. (8)) with each other we are usually led to very similar comparisons. It can also be seen that generally two indexed agreements different, e.g., in the extent of indexation, i.e. a_i^1, lead to distribution functions crossing each other, and thus the choice between them is not trivial.

4. Evaluation of risky wage agreements by a negotiator

The situation where one negotiating side compares different indexed and non indexed agreements with each other (given the nominal wage increase, indexing parameter a_1^i and its subjective ideas about the exogenous variables $\underline{a}_t$, $\underline{b}_t$, $\underline{a}_t^i$ and $\underline{b}_t^i$) and tries to set them in order of preference is an example of decision making under uncertainty and similar to e.g. the evaluation of risky portfolios. This problem logically precedes the bargaining problem, because before starting the bargaining each side should have an opinion on the relative goodness of different agreements.

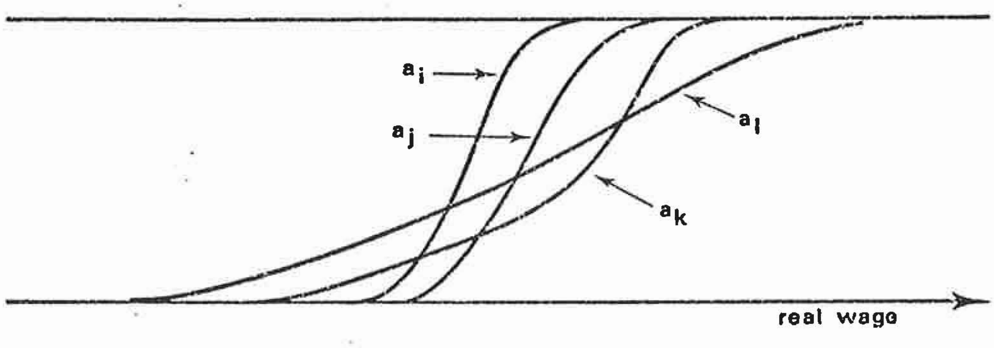
Speaking generally, a negotiator is faced with n alternative agreements (payment plans) a_i, $i = 1,\ldots,n$, which are characterized by given basic nominal wage increase and/or by given degrees of indexation. In accordance with the analysis of previous chapters a negotiator should try to connect with each agreement a_i a distribution function $F(x|a_i) = P(\underline{x} \leq x|a_i)$ of real wages, which we in the following denote by x[1]. These distributions are also conditional on the expectations concerning the course of the exogenous variables, i.e. the distributions of $\underline{a}_t$ and $\underline{b}_t$ (or $\underline{a}_t^i$ and $\underline{b}_t^i$). Thus $F(x|a_i) = F(x|a_i;\underline{a}_t,\underline{b}_t)$, which explains why the same agreement may be seen differently by the negotiators when they hold differing views concerning the future course of the exogenous variables. Above we have dealt with the evaluation of different wage agreements only, completely disregarding the evaluator's other activities. In reality the position of employees and that of employers are affected also by several other factors e.g. by political considerations and by how inflation affects income from other sources. If all these factors are taken into account the ordering of the hypothetical future worlds given a_i becomes a really difficult task. Even if we think that the distribution functions of all

1) In the previous chapters distribution functions were derived for the change in real wages. Given the level of previous real wages this determines the distribution of new real wages.

the relevant variables could be derived, the comparison of the agreements cannot in the general case be based on the expected utility hypothesis as will be done in the next chapter.

In some case, the ordering of the agreements is more simple. Let us suppose that the outcome of the agreements can be presented by a single variable, e.g. the real wage x, and that the distribution functions of x corresponding to different agreements can be derived. If the distribution functions of the outcomes of two alternative agreements a_i and a_j do not cross each other, i.e., when e.g. $F_i(x|a_i) \geq F_j(x|a_j)$ for all x, $F_i \neq F_j$, then a_j dominates stochastically the agreement a_i when seen from the trade union's side (see fig. 2) and vice versa when seen from the employers' side[1]. Rational behaviour leads trade unions with all non-decreasing utility functions of x to prefer a_j to a_i and employers with all non-increasing functions of x to prefer a_i to a_j[2]. Thus a_i need not be considered at

Figure 2. Distribution functions connected to different wage agreements a_i



1) The same agreements are, of course, usually arranged in different order by the different negotiators. Trade unions prefer higher real wages to lower real wages and employers lower wage costs to higher wage costs. For given expected real wage both parties are (because of risk aversion) usually assumed to prefer smaller variance to larger variance.

2) For stochastical dominance see Hanoch and Levy (1969, Y. Vartia (1973, p. 35-51) and Tesfatsion (1976).

all when choosing the best alternative for trade unions (the worst for employers). To choose the best agreement it is sufficient for a single negotiator to investigate only those agreements that are not dominated by others.

5. Comments on the bargaining situation

The bargaining situation where two (or more) negotiators decide which particular agreement both are ready to accept has been dealt with extensively in the literature using e.g. the game theoretic approach. We do not deal here with matters such as the bargaining power or the use of threat, which have been used to explain why and how negotiators enter into agreements that are not the best from their own point of view. Instead, we will give some examples of how different expectations concerning the predetermined variables bear on the applicability of index clauses in wage agreements.

Shavell (1976) has investigated risk sharing in the case of deferred payments and we use his results here. Let us denote by V the employer (or, in the centralized negotiations the group of employers collectively) that is to make the deferred wage payment to the employee (or to the members of trade unions) U. Using Shavell's notation we denote the utility functions of V and U by $V(\cdot)$ and $U(\cdot)$, their subjective probability distributions over the inflation rate by $d_V(\cdot)$ and $d_U(\cdot)$ and their wealths exclusive of the payment by $v(P)$ and $u(P)$. A wage agreement a_i can be characterised by function $x(\cdot)$ giving (in real terms) the amount $x(P)$ which the employers give to employees if the inflation rate turns out to be P.

We call $x(P)$ here the real wage and $x'(P)$ the (local) degree of indexation for short. Thus an agreement, e.g., where $x(P)$ is constant corresponds to full indexation. For example, in our previous example 1 C. the real wage payment (in prices of the previous period)[1] and the degree of indexation are in the case of a non-indexed agreement

$$x_n(P) = \tilde{W}_{-1}(1 + W - P) = \tilde{W}_{-1}(1 + a_t + P_t^e - P) = \tilde{W}_{-1}(1 + 0.12 - P)$$

$$x'_n(P) = -\tilde{W}_{-1}$$

where $\tilde{W}_{-1}$ denotes the wage level of the previous period. In the case of 100 % indexed agreement we have

$$x_i(P) = \tilde{W}_{-1}(1 + W - P) = \tilde{W}_{-1}(1 + a_t) = \tilde{W}_{-1}(1 + 0.02)$$

$$x'_i(P) = 0$$

The negotiators' expected utilities are then[2]

$$\int V[v(P) - x(P)]d_v(P)dP \tag{20}$$

$$\int U[u(P) + x(P)]d_u(P)dP \tag{21}$$

---

1) In the example 1 C (where the nominal wage increase is a non-random variable) the derivation of equation (28), i.e. real wage payment as function of inflation rate, is simple but in the general case it is more difficult because wage and price changes are random variables and simultaneously determined by exogenous factors.

2) Notice that real wages and not nominal are the argument of the utility functions.

Using the Pareto-optimality condition[1] for payment plans Shavell derives for the slope of the payments schedule the expression

$$x'(P) = \frac{-v'(P)\mathrm{Dlog}V'(P)+u'(P)\mathrm{Dlog}U'(P)+\mathrm{Dlog}d_u(P)-\mathrm{Dlog}d_v(P)}{-\mathrm{Dlog}V'(P)-\mathrm{Dlog}U'(P)} \qquad (22)$$

where $U'(P) = U'[u(P) + x(P)]$, and similarly for U", V' and V". The "local" degree of indexation is thus determined by the derivative of wealth exclusive of payment with respect to price level, the levels of absolute risk aversion and the difference in subjective beliefs. We decompose $x'(P)$ further to

$$x'(P) = M(v'(P), - u'(P)) + h(P)\mathrm{Dlog}\frac{d_u(P)}{d_v(P)} \qquad (23)$$

where M is a weighted arithmetic average of the derivatives of wealth exclusive of payment, the weights being the degrees of absolute risk aversion. Employers are often assumed to be risk neutral or less risk averse than employees and, thus have the possibility of selling insurance against unexpected price changes and of obtaining in return agreements with a lower expected real wage. When they are acting as a group in nationwide negotiations, however, employers are probably more concerned about the expected variance of wages than when they are taking decision on the wage of a single employer. In the following we assume that there is so much absolute risk aversion that the term $(-\mathrm{Dlog}V'(P) - \mathrm{Dlog}U'(P))$ and, thus, also $h(P)$ are positive. From (23) it is easy to see that if wealth exclusive of payment is not affected by inflation (or if it is affected

1) For derivation of this condition $d_v(P)V'(v(P) - x(P)) = kd_v(P)U'(u(P) + x(P))$ see Borsch (1960) and Arrow (1971).

in precisely the same way for both parties and the degree of risk aversion is the same) then the first term will vanish. We concentrate in the following on these cases. If, further, $h(P)$ is approximated by a constant then the optimal indexing depends in a simple way on the difference in subjective beliefs concerning the inflation rate[1]. If beliefs were the same, the last term would also vanish. Then $x'(s) = 0$ and full indexation seems to be Pareto-optimal. On the other hand, when expectations concerning the future rate of inflation differ, a simple cost of living index clause does not lead to Pareto-optimal wage agreements.

If the price expectations obey normal distribution as in the previous numerical examples, formula (23) can be developed further. For the density function $d(P)$ of a normally distributed variable $P \sim N(\mu, \sigma^2)$ we have

$$\text{Dlog } d(P) = - \left(\frac{P-\mu}{\sigma^2} \right) . \tag{24}$$

Thus (23) becomes

$$x'(P) = h(P) \left[\frac{1}{\sigma_v} \frac{(P-\mu_v)}{\sigma_v} - \frac{1}{\sigma_v} \frac{(P-\mu_u)}{\sigma_v} \right]$$

$$= \frac{h(P)}{\sigma_u^2 \sigma_v^2} \left[\frac{\sigma_v^2 + \sigma_u^2}{2} (\mu_u - \mu_v) + \left(P - \frac{\mu_u + \mu_v}{2}\right)(\sigma_u^2 - \sigma_v^2) \right] . \tag{25}$$

---

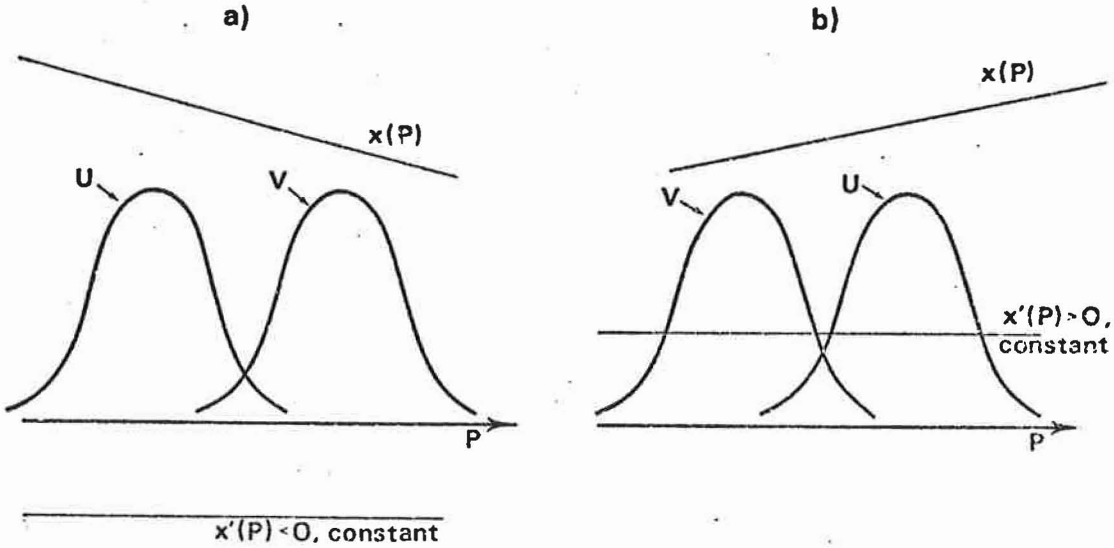
1) Real wage changes connected with wage agreements are usually of the order of a few percent and the local approximation of $h(P)$ by a constant does not change the qualitative nature of the results as long as $h(x) > 0$.

As h(P) is assumed to be positive we have in cases where the variance of the expected inflation rate is the same

$$\text{sign } x'(P) = \text{sign}(\mu_u - \mu_v) \tag{26}$$

If, further, $\mu_u = \mu_v$, we have the case of the same subjective beliefs and full indexation, i.e. $x'(P) = 0$. Situations where $\mu_u \neq \mu_v$ but $\sigma_u = \sigma_v = \sigma$ are described in figure 3.

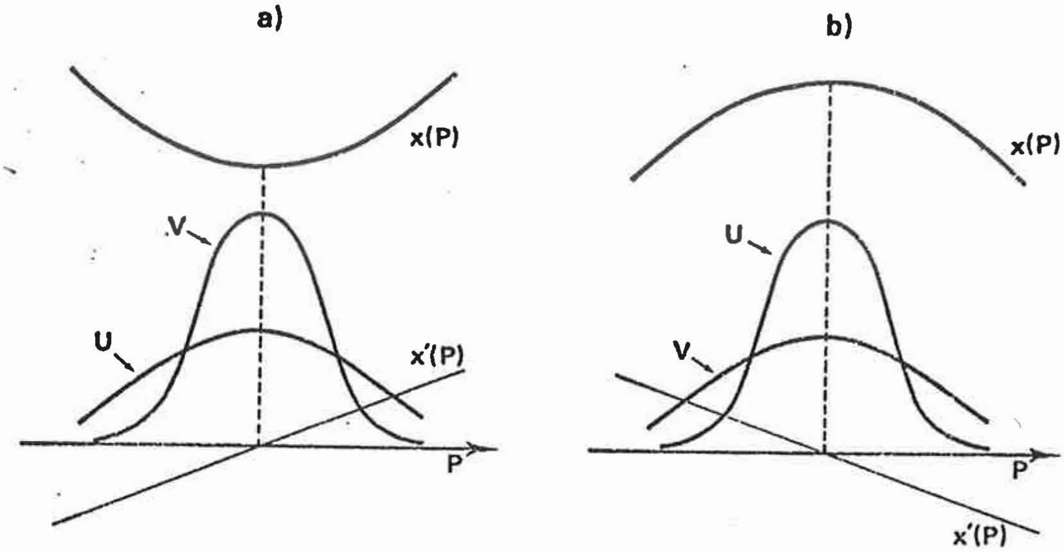
Figure 3. Qualitative behaviour of real wage x(P) and degree of indexation x'(P) in Pareto-optimal wage agreements when both employers V and employees U have the same variance for the expected inflation rate, i.e. $\sigma_v = \sigma_u = \sigma$, but a) employers expect faster inflation, i.e. $\mu_v > \mu_u$ b) trade unions expect faster inflation, i.e. $\mu_u > \mu_v$.



In cases where both parties have the same mean expected rate of inflation but uncertainty over the rate is not the same, i.e. $\sigma_v \neq \sigma_u$ but $\mu_v = \mu_u = \mu$, we have

$$\text{sign } x'(P) = \text{sign}\,[\,(P-\mu)(\sigma_u^2 - \sigma_v^2)]\ . \tag{27}$$

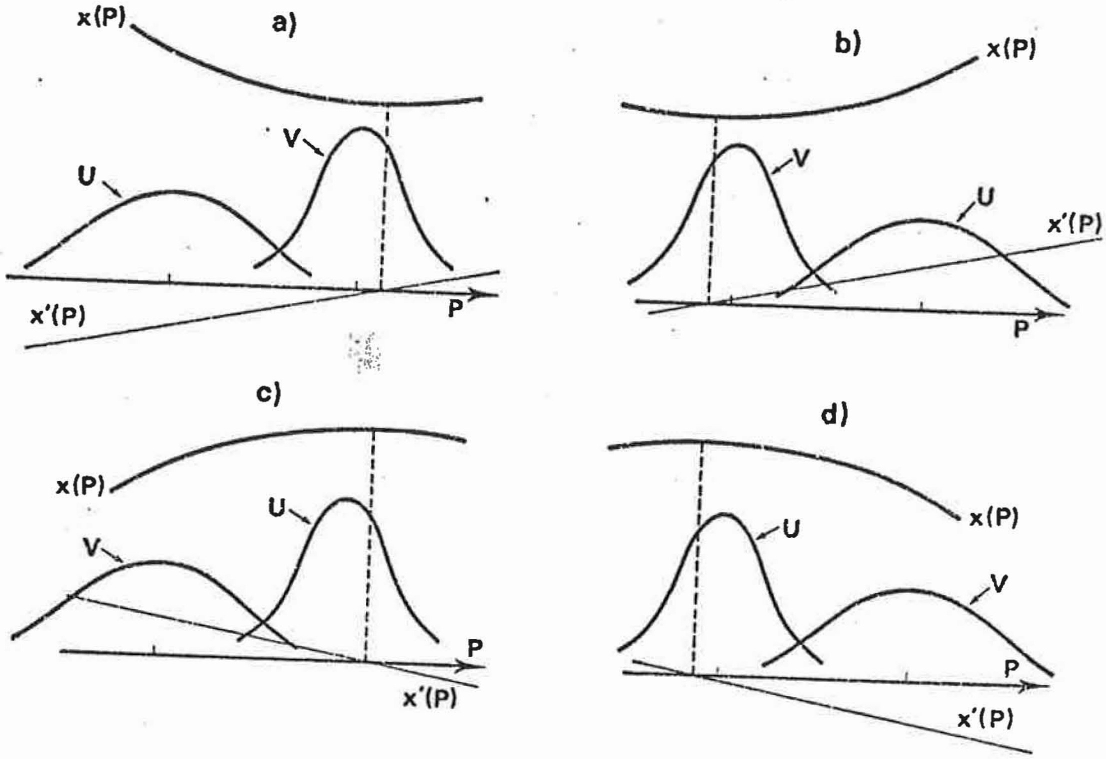
Figure 4. Qualitative behaviour of real wage x(P) and degree of indexation x'(P) when the mean expected inflation rate is the same for employers V and employees U, i.e. $\mu_V = \mu_u = \mu$, but a) employees' expectations have greater variance, i.e. $\sigma_u > \sigma_b$ and b) employers' expectations have greater variance, i.e. $\sigma_V > \sigma_u$.



The degree of indexation connected with optimal payment plans can thus increase or decrease with inflation, depending on which of the two sides is more certain about the future price movements (cf. fig. 4). Situations where both variances and mean expectations differ between the negotiating parties are illustrated in figure 5.

To connect the results concerning Pareto-optimal payment plans to our models for non-indexed and indexed agreements let us return to example 1 C, where we investigated the effects of negotiator's expectations on the expected outcome of the agreement. Let us first investigate the case of fig. 3 a., where trade unions expect a smaller price rise than employers do. In this kind of situation trade unions may be willing to have a high nominal increase and less guarantee against price increases, which are not

Figure 5. Qualitative behaviour of real wage x(P) and degree of indexation x'(P) and real wage payment plans x(P) in Pareto-optimal wage agreements when both the mean expected inflation rate and its variance differ between employers V and employees U.



expected to be large. This also suits the employers' side, because they believe prices to rise more and thus expect real wage costs (with a given nominal increase) to be small. Suppose, e.g., that in example 1 C (and fig. 1 C) trade unions expect that $\underline{P}_{mt} \sim N(2, 6.25)$ and employers that $\underline{P}_{mt} \sim N(12, 6.25)$. Then, with $W = a_t + P_t^e = 12$, the non-indexed agreement leads trade unions to expect that $P \sim N(8, 1)$ and $(W - P) \sim N(4, 1)$ but employers to expect that $P \sim N(12, 1)$ and $(W - 0) \sim N(0, 1)$. With the same non-indexed agreement trade unions thus expect real wages to rise by 4 %, whereas employers expect that they will not rise at all. Furthermore, trade unions think that the probability that real wages will increase by less than 2 % is only $\Phi(\frac{2 - E(\underline{W} - \underline{P})}{\sigma}) = \Phi(\frac{2 - 4}{1}) = \Phi(-2) = 1 - \Phi(2) = 0.0228$, whereas employers think that the probability is $\Phi(2) = .9772$. Owing to differing expectations concerning the future inflation rate it is possible to find non-indexed agreements that are closer to the Pareto-optimality than indexed agreements (e.g. the fully indexed agreement of fig. 1 C), in the sense that these non-indexed agreements are jointly preferred to the indexed agreements.

On the other hand, it is easy to see that the situation in fig. 3 b., where employers expect a slow rate of inflation and trade unions a rapid rate will be conducive to indexed agreements. In these cases employers (by consenting to have an index clause) insure employees against something that they do not believe will happen in any case. The situation of employers' situation is comparable to the one facing an insurance company selling insurance policies against attacks from Mars and the situation of trade unions to that of a person taking an insurance with minor cost against a bad accident he knows will happen certainly. This kind of situation may occur, e.g., if trade unions in an open economy are convinced that a devaluation will take place during the contract period and speed up the inflation rate but employers are convinced that this will not happen.

For illustration, let us again use example 1 C. Suppose now that employers expect that $P_{mt} \sim N(2, 6.25)$ but trade unions that $P_{mt} \sim N(12, 6.25)$, i.e., trade unions expect a considerably higher import price rise due, e.g., to fear of a future devaluation. Distribution functions connected with the non-indexed agreement, where $W_t = a_t + P_t^e = 12$ but expectations concerning exogenous variables differ in this way, are shown in fig. 1 C. For trade unions the probability that the real wage increase will exceed, e.g., 2 % is only $1 - \Phi(\frac{2 - E(\underline{w} - \underline{P})}{\sigma}) = 1 - \Phi(2) \approx 0.0228$ but for employers it is $\Phi(2) \approx 0.9772$. In this case an index clause may eliminate the critical uncertainty and the difference of views concerning the future exchange rate policy that make non-indexed agreements difficult. Resorting to an index clause contracting becomes easier because employers arrive at a smaller expected real wage increase (compared to non-indexed agreements, given employers' expectations) and simultaneously trade unions arrive at a higher expected real wage increase (compared to the same non-indexed agreements, given labour unions' expectations)[1]. Note, however, that if there is no uncertainty about $\underline{a}_t^i$, i.e. if we know that it will take on a given value, e.g. 2 % as in example 1 C, then the indexed agreement does not stochastically dominate the non-indexed agreement (even though it is very likely to be jointly preferred). This can be seen from figure 1 C, where the distribution functions of the indexed agreement and the non-indexed agreements with $E(\underline{P}_{mt}) = 2$ and $E(P_{mt}) = 12$ cross each other[2].

The results concerning Pareto-optimal payments plans suggest that even more than 100 % compensation for price increases could be used, but in practice these cases seem to be rare, though not totally non-existent[3]. This may be due to the fact that notable over-compensation is seen to affect the stability of the wage-price-mechanism (see footnote on page 4).

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1) Of course, the Pareto-optimality condition does not tell us how large the optimum payment is; it is only a condition that has to be met by the different optimal payment plans. Which wage agreement is chosen also depends on other considerations, e.g., on market forces (which are represented by $\underline{a}_t$ and $\underline{b}_t$ in our wage-price equations).

2) The indexed agreement with $\underline{a}_t \sim N(2, 1)$ in example 1 B would also be stochastically dominated.

3) Finland, for instance, had some experience of "over-compensation" in the late 1940's.

Those cases (variances of the expected inflation rate differ) where the degree of indexation should according to the Pareto-optimality condition depend non-linearly on the inflation rate would in practice require quite complex index clause arrangements, and we shall not discuss these questions here. However, it is easily seen that with, e.g., different kinds of threshold indexation and with varying degrees of indexation the parabolic form of the real wage payment plan can be approximated. Perhaps the not totally uncommon use of these kinds of techniques in practice has resulted from an unconsious aiming at Pareto-optimality.

6. Concluding remarks

We have investigated the effect of indexation on wage and price movements and found that it is impossible to give simple answers to questions such as "is wage indexation inflationary"? Depending on the circumstances it may or may bot be. We have also commented on the evaluation of risky wage agreements and found that in the general case some kind of weighting function for the possible outcomes of an agreement is necessary if a negotiator wants to order the agreements according to his preferences. If the expectations concerning the exogenous variables (or negotiators' models) differ, interesting considerations emerge, which complicate the bargaining situation and affect the applicability of index clauses. Situations where expectations differ seem to be an interesting area of future research in several fields of economic theory. It is also clear that in cases where expectations differ, good forecasts are valuable and offer one side the possibility of taking advantage of the other side's "wrong" expectations. These situations seem to form interesting games under uncertainty and the results of this paper suggest that the quality of the players and their command of available strategies is also important in determining the results of the game.

Wage and price movements in indexed and non-indexed economies have been investigated with very simple models constructed for the case of a single agreement, not for a sequence of agreements. In drawing conclusions from these excercises it is thus important to point out some limitations of the analysis. Use of index clauses as a part of counterinflationary programs, for instance, requires selective and well-timed action and it is thus evident that their introduction and abandoning is made difficult because of various institutional constraints. In addition to the basic considerations dealt with above, resorting to indexation thus requires extensive research on their applicability to the institutional setting in various countries. Indexation must also be seen as one tool in the struggle for income shares and it cannot be separated from general social and political developments in society. Questions that are important in the actual practice of wage indexation also include technical aspects of indexing, e.g., how often is compensation effected, what are the time lags, is there some treshhold increase in prices before compensation is made, what is the duration of contracts, etc?

It is thus clear that a great deal of further research is required to arrive at, e.g., a well-founded decision as to whether a given country in a given situation should or should not apply the indexation of wages.

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