Prices and Wages in the OECD Area 1913 – 1980

A Study of the Time Series Evidence*

By Svend Hylleberg and Martin Paldam with the assistance of Michael Poulsen

The dominating time series patterns of the yearly rates of price and wage inflation in 17 developed western economics from 1913 to 1980 are investigated. On the basis of an economic model the corresponding univariate time series (Final Equations) are analyzed together with the socalled Autoregressive Final Form. In addition the lead-lag relations between wage and price inflation are examined by use of tests for Granger non-causality.

I. Introduction

This paper reports on an attempt to find the dominating time series patterns of price and wage inflation in 17 developed western economies during the last 68 years, and to interpret these patterns in economic terms. The series used are:

- p, percent rises in consumer prices.1
- w, percent rises in nominal wage rates for workers in manufacturing.2

Wage inflation \dot{p}_w is related to price inflation \dot{p} and to wage rises \dot{w} through the following two identities — taken to be linear

(1a)
$$\dot{p}_w = \dot{w} - \dot{g}$$
, where \dot{g} is productivity growth

(1b)
$$\dot{p} = \dot{p}_w - \dot{l}_w$$
, where \dot{l}_w is wage share changes.

^{*} The authors gratefully acknowledge assistance from Torben M. Andersen, Hans Jørgen Biede, Claus Nielsen, Kirsten Stentoft, and Kirsten Østergaard. The paper has been presented at ESEM 84 in Madrid and at the Universities in Regensburg, Munich, and Urbana-Campaign and discussed with several colleagues. The paper belongs to a set analysing price-wage dynamics in a comparative setting, and we shall rely on the findings in other parts of the project.

¹ For the period 1948/50 - 80 we use the implicit consumer price index in the OECD Tables of National Accounts and before that such consumer price indices as are available.

² The wage series are taken from the ILO-yearbooks, linked up with national sources. Note that the series are for manufacturing only, so that, strictly speaking, the l_w in relation (2) should be for workers in manufacturing only.

Table 1

The p and w series covered 1913 - 1980

Country	Missing observations	Main deviations from average pattern as shown on Figure 1
1 Australiaa)	none ^{b)}	VR, low 50 - 70, peaks in 51 and 73
2 Belgium	b 20,30/47	High in late 20s, strange peak in mid 60s
3 Canada	none	VR, low 50 - 73
4 Denmark	none	High early 20s, peak 40, high mid 50s to 72
5 Eire	b 22	Low till 60, 2-year cycles in 60s, high since 70
6 Finland	b 15	Wild 15 - 21 and 40 - 52, R since 52
7 France	none	High 15 - 30 and 35 - 52, R since 52
8 Germanya)	b 15, 43/47c)	Wild 15 - 25, 31/32, low since 70
9 Hollanda)	none	VR, some large fluctuations in 50s
10 Italy	b 14	R, but with peaks 16/21, 29, 43/4, 74/77
11 Japan	nonec)	R, but peaks 18/19 and 44/50
12 New Zealand	none	VR, but low throughout
13 Norway	none	VR, but high 17/20, low 22, 25/26
14 Österreicha)	ь 19, 34/47	R since 50
15 Sweden	none	VR, high 17/20 and low 22
16 UK	none	R, high 15, 18, 40, 75 and low 21/22
17 USA	none	R, but jumpy till 50 and low since
Altogether $\Sigma = 110$	1	"VR" means that Fig. 1 is "very representative"
Missing is $4.80/_0$ b)		"R" means that Fig. 1 is "representative"

Sources ref. Paldam and Madsen (1978) and Pedersen (1981). "bn" means that data begins in n.

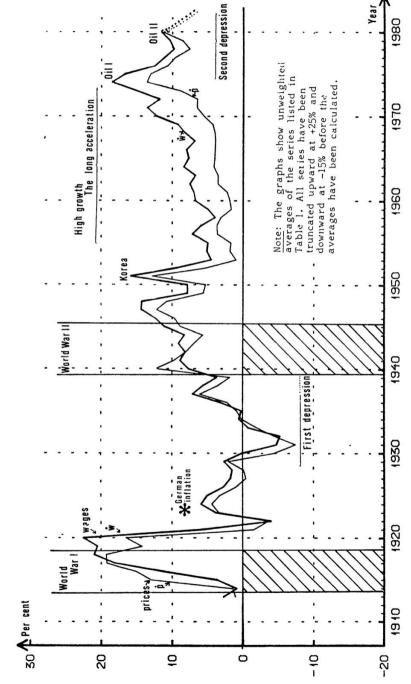
In Section II we shall take a look at the data, as presented in Table 1 and Figure 1. It is argued that g is fairly constant implying that we may study wage inflation in the directly available w series as well as in the p_w series. If, furthermore, l_w could be taken as constant, p and w are the same except for a constant. In this situation he have one rate of inflation on the two markets as is often presumed. However, since l_w is not constant the *one-rate-presumption* is a dubious one.

a) Germany is GFR only from 46, The Netherlands are termed Holland and Austria appears as country 14, not to be mixed up with 1.

b) From 1913 to 80 are 68 years, hence the maximum available would have been $17\cdot 68-1156 \; observations.$

c) In post-war runs we start in 1950 for Germany and Japan, further it is noted that the Japanese \dot{p} series starts in 23.

Figure 1: The Path of Price and Wage Rises in the OECD Area 1913 - 80



13 Zeitschrift für Wirtschafts- und Sozialwissenschaften 1985/2/3

Therefore there are good reasons to analyse the dynamics of the p series and the w series in isolation. This is done in Section IV. The next step is then to analyse the pattern of interdependence between the two series, see Section V.

Finally Section VI gives a brief summary of the main economic implications of our findings.

A vast literature discusses the economics of price and wage inflation and this literature contains many controversies. Some of these concern the relationship between our two variables and other variables, such as the money stock, *not* covered by the present paper. But we hope to throw light over some of the remaining debates. Section III gives a brief survey of the more relevant theoretical discussion pointing out what to look for in the following sections.

II. A Look at the Time Series

The paths of our p and w series in the average OECD country are displayed in Figure 1. The two curves are unweighted averages. In Table 1 the coverage of the series analysed is listed and the main deviations from the pattern of Figure 1 are mentioned. It appears that Figure 1 is very representative for the price-wage inflation in each of the countries. In other words: both price and wage rises contain large international elements; but they will not be our concern at the moment.

For our purpose the following four observations are the essential ones:

- (ts 1) Price rises p and wage rises w have a fairly parallel development over time.
- (ts 2) The two inflation rates display large fluctuations in the period considered.
- (ts 3) A lot of the action in the series appears in connection with specific political events.
- (ts 4) There are no clear long run trends over the full 68-year span covered but it is easy to find sub-periods (covering one or more decades) with strong trends.

In view of the importance of these points they are worth elaborating a little. To discuss (ts 1) we have to return to the two identities from the introduction:

³ See here Paldam (1983 c) and Paldam (1980) for a discussion.

(1a)
$$\dot{p}_w = \dot{w} - \dot{g}$$
 and (1b) $\dot{p}_w = \dot{p} + \dot{l}_w$

Two of the other papers in our project analyse g_w and l_w on the data for the same countries and years:

In Paldam (1984 a) we analyse the time series of the rate of unemployment u and the real growth rate \dot{y} . The relevant finding here is that, except for a couple of shifts, \dot{y} comes remarkably close to being white noise around country specific long-run growth rates.

However, these long-run growth rates are rather constant and they deviate from g for two reasons: (d_1) different growth rates of the labour force, (d_2) the amount by which technical progress differs from Harrod neutrality. The sum d_1+d_2 is likely to vary little relative to the size of the long-run growth rate and hence we conclude that g may be taken to be rather constant. From this follows that we may take it for granted that p_w and w are essentially the same series — so that we can analyse the dynamics of inflation on the labour market by analysing the w series.

While, therefore, (1a) is unproblematic, (1b) is not. In Paldam (1979) it is demonstrated that wage shares are far from constant. The average value of $|l_w|$ on annual data comes to no less than $1.25\,^{\rm 0/0}$ (percentage points of net national income). About half of that is of a long run character — between 1949 and 1975 wages shares rose by about 20 $^{\rm 0/0}$ (of net national income), but the rest is of a short run character. As the longrun averages of w_w and p are around 4-5 $^{\rm 0/0}$, we know that it is problematic to build on the one-rate presumption of inflation:

(ts 5) Price and wage inflation deviate by an average amount of 25 to 30%, where half is a long-run deviation. When, nevertheless, (ts 1) holds this means that the feed back mechanisms between p and w extend over more than one year. Also it strongly suggests that there are feed back effects between the inflation rates at the two markets.

One main purpose of writing this paper is to analyse these mechanisms — they will be the theme of Section IV below.

From Figure 1 it is possible to argue that there is a weak upward trend in the long run inflation rates, but this tendency is dubious and certainly it is dwarfed by large fluctuations, so we shall stick to the formulation (ts 4).

In the time series tradition the combination of trendlessness and large fluctuations call for an analysis of the cyclical structure of the series. This, however, appears less interesting for the economist when reference is made to the *exogenous* character of the "political" events generating a great deal of the fluctuations.⁴

Lots of entertaining stories have been told about the wild price-wage fluctuations following World War I, and the altogether different adjustments after World War II, where wild price-wage movements only occurred in a few countries — especially Japan, Germany, Italy and France. Then there is the seemingly totally unpredicted Korean War price explosion 1950/51 and the causally rather different price explosion after the Yom Kippur War of 1973 involving the OPEC cartel and later the second oil price hike after the Iranian revolution.

In addition to these "world events" there are a number of country specific historical events where some crises occurred that had to be accomodated by a round (or some rounds) of inflation. The most extreme case being the German inflation of 1923/24, but most countries have experienced mild cases — the typical ones being like the French ones of 1936 after the victory of the Front Populaire. 1957/58 during the Algerian crisis where De Gaulle took over, and the "events" of May 1968. Many of those events have included large scale labour unrest, as is evident from *Paldam* and *Pedersen* (1984), and political changes, so there are many stories that beg to be told, but we shall, for the present, resist the temptation.

The large fluctuations generated by political and other exogenous events — each having its own complex explanation — suggest a highly irregular cyclical structure of the series. This, indeed, is what we find, as we shall return to in Section IV. When the cyclical structure becomes less interesting to study, the crucial points instead become: Firstly, the dynamic structure of the processes taking the series into such big swings once they are hit by an exogenous event. Secondly, the centrifugal forces letting price wage movements return to the moderate long run path. Here it is worth remembering that it is no law of nature that inflation has to come down once it goes up — in several Latin American countries inflation rates have continued for several decades around 50 % per year. Also it is worth noting how large the latest big inflation wave has been.

Our main object of study will be the first of these points — the structure of autocorrelation in the series and cross correlation between the series. We have argued that there are no long run trends in the series,

⁴ Digging one step deeper one may argue that there are economic factors involved causally in many of the political events mentioned below. However, they are different economic events — often of a long run nature — and they are probably in most cases only minor factors, so for any realistic analytical purpose it is better to cut the causal structure here.

but obviously lots of dynamics. To keep things simple we will work with subperiods without trends too. We have chosen to consider the following three periods:

- (P 1) The full period 1913/18 80. Here consistent series exist for 14 countries. The main problem is that the 1918 21 fluctuations are so wild and unique. Whether or not they are included makes an impact on some of the results.
- (P 2) An early period 1923/24 54. Here the series exist for (the same) 14 countries. The main problem is the post World War II inflations in a few countries.
- (P3) A later period 1948/50 80, excluding the post war inflations. Here consistent series are available for all 17 countries.

The reader should note that (P 1) and (P 2) have some variation in the starting year — the one used for each country is found in Table 1.

Finally, the second point — e.g. the forces returning the inflation rates to their long run averages: Here there is little doubt that the main forces are associated to economic policy making. Governments and (their) central banks clearly want inflation to be strictly limited and so do the populations. The returning pattern, hence contains endogenous policy reactions likely to appear as autocorrelations in the residuals. Therefore, we have two kinds of "policy" elements — the exogenous ones previously discussed and the endogenous ones that come to influence the time series processes estimated.

III. The Theories — what Patterns to Expect

There is a huge literature dealing with the macro dynamics of price and wage rises, see e.g. Santomero and Seater (1978) and Chan-Lee (1980) for surveys. However, the very fact that new work keeps pouring out points to the lack of basic agreement in the field. We shall not attempt to provide another survey of the literature, but only draw a few main lines. A main notion is the one distinguishing between the following three types of terms in price-wage models:

Pull-terms, Π . They are normally taken to be functions of unemployment (u) and related terms (...). At the goods market the basic formulation is the "naive" Keynesian two gap model, and the analogous formulation at the labour market is the "simple" Phillips curve.

⁵ The is a large literature on the relation between the changes in economic conditions and changes in the popularity of government. The most relevant article perhaps is *Hibbs* (1979) and the summary in *Paldam* (1983 b).

Push-terms, ψ . Here two schools exist. In one school the main reason, why people push, is that they expect inflation — i.e. we here use expected inflation p^e as the argument. The other school tries to identify actual push variables. It has come up with a large bag of mixed ad hoc variables of which some are truly exogenous, while most may be causally related to the p^e variable. On the goods market we may use import prices (p_M) , the degree of monopoly, etc. On the labour market we may use some expression for the power of trade unions, for the labour market climate (such as the number of industrial conflict, c_n) or for policy influences on the push. The latter being e.g. tax rates, τ , the degree of compensation in unemployment relief payments, various incomes policy proxies etc.

Cross-terms, R. When keeping track of both the goods and the labour market, we need to model how the rate of inflation at the two markets influence each other.⁶

Hence, by presuming the terms to be additive, we have as our basic 'frame' the following model:

(2a)
$$\dot{p} = \Pi_{p}(u, \ldots) + \psi_{p}(\dot{p}^{e}, \dot{p}_{M}, \ldots) + R_{p}(\dot{w}, \dot{w}_{-1}, \ldots) + \varepsilon_{1}$$

(2b)
$$\dot{w} = \Pi_w(u, ...) + \psi_w(\dot{p}^e c_n, \tau, ...) + R_w(\dot{p}, \dot{p}_{-1}, ...) + \varepsilon_2$$

$$\dot{w} = \dot{p} + \dot{g} + \dot{l}_w$$

The model in (2) is obviously a nasty one to work with: It is *simultaneous*, almost *symmetrical*, so that certain effects are likely to be very hard to ascribe to the right equation, and finally it contains variables (such as p, w and p^e) that are likely to be very *collinear*. In short, (2) is an inoperative model for applied work.

However, (2) does contain a number of often discussed issues. As (2) is simultaneous one immediately asks for the reduced form. By linearization of the cross terms:

(3)
$$\partial R_w/\partial \dot{p} = \alpha$$
 and $\partial Rp/\partial \dot{w} = \beta$

one obtains the following reduced form:

(4a)
$$\dot{p} = \gamma_0 \left[(\Pi_p + \beta \Pi_w) + (\psi_p + \beta \psi_w) \right] + \varepsilon_1'$$

(4b)
$$\dot{w} = \gamma_0 \left[(\Pi_w + \alpha \Pi_p) + (\psi_w + \alpha \psi_p) \right] + \varepsilon_2' ,$$

where
$$\gamma_0 = 1/(1 - \alpha \beta)$$
.

 $^{^6}$ Many terminologies are in use in these matters, and the reader should note ours, especially since we distinguish between push-terms and cross-terms that are merged by most writers. Note that wage indexation is contained in the R_n -term.

Here γ_0 is the short-run inflation multiplier.⁷ By taking the lags in the cross terms, and in a few other terms to be discussed, into consideration, we may obtain the delayed multipliers, and the (steady-state) total multiplier:

$$\gamma = \sum_{i=0}^{\infty} \gamma_i$$
 where γ_i is the delayed multiplier with the lag *i*.

If the γ 's are even moderately stable, they are a very important set of parameters to estimate. Our findings below and previous work imply that $\gamma_0 = 1.25$ and $\gamma = 2$ -3. We shall return to model (2) in a moment, but first it is worth considering the standard trick in about 90 % of the literature operationalizing (2). The trick is to apply the one-rate-presumption of inflation, saying that $g + l_w$ is constant. That presumption makes (2a) and (2b) collapse into one equation, so that we need one Π and one γ only. Also the cross terms have to be deleted. This reduces (2) to the much discussed expectation augmented Phillips curve (as originally proposed by *Friedman* (1968) and *Phelps* (1967)):

(5a)
$$\dot{p} = \dot{w} - \dot{k}$$
 (k is a constant)

(5b)
$$\dot{w} = \Pi(u, \ldots) + \psi(\dot{p}^e, \ldots)$$

Model (5) becomes highly *dynamic* once we make p^e a function of previous values of p (and w) and other relevant information I:

(6)
$$\dot{p}^e = e (\dot{p}_{-1}, I_{-1})$$

The many versions of (6) have been in the center of macroeconomic research for about 15 years. The minimal information available to those setting p^e is the inflationary experience p_{-1} , p_{-2} ,..., and therefore the first version of (6) was the *adaptive* one:

(7)
$$\dot{p}_{t}^{e} - \dot{p}_{t-1}^{e} = (1 - \lambda) (\dot{p}_{t-1} - \dot{p}_{t-1}^{e}) + \varepsilon_{et} \quad 0 < \lambda < 1$$

where $\varepsilon_{et} \sim \text{i.i.d.}(0, \sigma_{\varepsilon}^2)$ is the error term.

In order to simplify the derivations let us now consider a linearized version of (5) with error terms added, i.e.,

(8a)
$$\dot{p}_t = \dot{w}_t - k + \varepsilon_{pt}$$

(8b)
$$\dot{w}_t = \alpha u_t + \beta \dot{p}_t^e + \varepsilon_{wt}$$

where $\varepsilon_{pt} \sim \text{i.i.d.}(0, \sigma_p^2)$ and $\varepsilon_{wt} \sim \text{i.i.d.}(0, \sigma^2)$. Note that we have allowed some "price illusion" as β may be different from 1.

⁷ Sometimes termed the price-price or the price-wage multiplier, it summarizes the price-wage spiral. The effects of indexations on inflation can be made explicit from (3) and the expressions for the γ 's.

From (8a) and (8b) we may reformulate (8a) as

(9)
$$\dot{p}_t = \alpha u_t + \beta \dot{p}_t^e - k + \varepsilon_{wt} + \varepsilon_{pt} ,$$

while the expectation generating mechanism in (7) may be written as

(10)
$$p_{t}^{e} = \frac{1 - \lambda}{1 - \lambda L} \dot{p}_{t-1} + \frac{\varepsilon_{et}}{1 - \lambda L}$$
$$= (1 - \lambda) \sum_{i=0}^{\infty} \lambda^{i} p_{t-i} + \sum_{i=0}^{\infty} \lambda^{i} \varepsilon_{et-i} ,$$

where L is the lag operator.

By inserting (10) into (9) we get

(11a)
$$\{1 - [\lambda + \beta (1 - \lambda)] L\} \dot{p}_t = -k (1 - \lambda) + \alpha (1 - \lambda L) u_t$$
$$+ \beta \varepsilon_{et} + (1 - \lambda L) (\varepsilon_{int} + \varepsilon_{nt}) ,$$

while (8b) becomes

(11b)
$$\{1 - [\lambda + \beta (1 - \lambda)] L\} \dot{w}_t = -\beta k (1 - \lambda) + \alpha (1 - \lambda L) u_t$$

$$+ \beta \varepsilon_{et} + (1 - \lambda L) \varepsilon_{vot} + \beta (1 - \lambda) L \varepsilon_{vot} .$$

Notice that if u_t is considered exogenous (11a) and (11b) are autoregressive distributed lag models of order (1,1), i.e. they have 1 lag on the dependent variables and 1 on the exogenous variable. In addition the disturbance term will be a moving average process at most of order 1, i.e. MA (1) as the sum of independent moving average processes is of an order at most equal to the maximum order of the individual processes. Last but not least, the autoregressive lag polynomials and the lag polynomials on the exogenous variable are identical between (11a) and (11b). This implies that (11a) and (11b) constitute the Autoregressive Final Form, see Hylleberg (1984).

The univariate time series representation of p_t and w_t now depends upon the univariate time series representation of u_t . Let this representation be a stationary and invertible autoregressive moving average process of order (r, s),

(12)
$$\Phi (L) u_t = \Theta (L) \varepsilon_{ut} ,$$

where $\varepsilon_{ut} \sim \text{i.i.d.}$ $(0, \sigma_u^2)$ while $\Phi(L) = 1 - \sum_{j=1}^r \Phi_j L^j$ and

$$\Theta(L) = 1 + \sum_{j=0}^{\infty} \Theta_j L^j.$$

Inserting (12) into (11) gives us

(13a)
$$\Phi(L) \{1 - [\lambda + \beta (1 - \lambda)] L\} \dot{p_t} = -k (1 - \lambda) \Phi(1) + \alpha (1 - \lambda L) \Theta(L) \varepsilon_{ut} + \beta \Phi(L) \varepsilon_{et} + (1 - \lambda L) \Phi(L) (\varepsilon_{ut} + \varepsilon_{vt}) \}$$

and

(13b)
$$\begin{split} \Phi\left(L\right)\left[1-\left(\lambda+\beta\left(1-\lambda\right)\right)L\right]\,\dot{w}_{t} &=-\beta\,k\left(1-\lambda\right)\,\Phi\left(1\right)\\ &+\alpha\left(1-\lambda\,L\right)\,\Theta\left(L\right)\,\varepsilon_{ut}\\ &+\beta\Phi\left(L\right)\,\varepsilon_{ot}+\left(1-\lambda\,L\right)\,\Phi\left(L\right)\,\varepsilon_{int}+\beta\left(1-\lambda\right)\,\Phi\left(L\right)\,L\,\varepsilon_{nt}\;. \end{split}$$

The time series processes in (13) are then seen to be ARMA processes of order (R,S) where $R \leq r+1$ and $S \leq [r+1,s+1]$, and where the autoregressive parts are identical, i.e. (13) constitutes the Final Equations of the model, see Hylleberg (1984). From this result several models emerge as special cases. The most interesting case is where u_t is an AR (1) process as seems to be the case — see Paldam (1984 a). (13a) and (13b) may then be shown to be ARMA (2,2) processes, unless $\Phi_1 = \lambda$, in which case they reduce to ARMA (1,1) processes. The same is true if u_t is white noise and $\Phi_1 \neq \lambda$.

Note that (13) builds on the one-rate presumption that has been rejected in Section I. When we nevertheless use (13) as the basis for our estimates in Section IV it is because we do not know how the two relationships differ in their dynamics. Our main strategy is that we try to let the data point out the differences in the two processes of the \dot{p} and the \dot{w} series.

Model (13) corresponds to the adaptive model of expectations — being the one extreme end of the spectrum: the LIRE-case, i.e. the Low Information Rational Expectations case, either because people don't care to collect the information or because of the unavailability of the relevant information.8 In the HIRE-case, the High Information Rational Expectations case, the information I contains the models (5) and (6) also as well as other relevant information. Here the adjustments become fast and irregular and the main time series language message is that we expect no stable time series process in the two series.

Therefore we expect, in the RE-theoretical framework to find model (13) as the one extreme and the unstable process as the other extreme. What is really hard to describe are the cases in between. With a little luck (6) might, in these cases, be approximated by another fixed formula, more complex presumably than (7). Then it is in principle straightforward to derive the corresponding time series formulation. The presumptions being that we reach something that contains (13) plus some extra terms of a higher order, which we shall look for in Section IV.

⁸ Much depends on the processes revealing the information, and one of the many paradoxes in a RE-world is that a sufficient pedestrian information revealing process may give in adaptive adjustment process even when the agents take all revealed information into consideration, see the analysis by Andersen (1983).

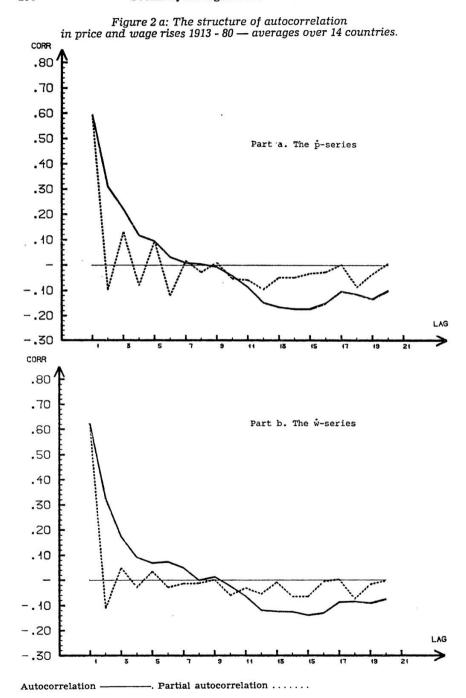


Figure 2 b: The structure of autocorrelation in price and wage rises 1922 - 54 — averages over 14 countries.

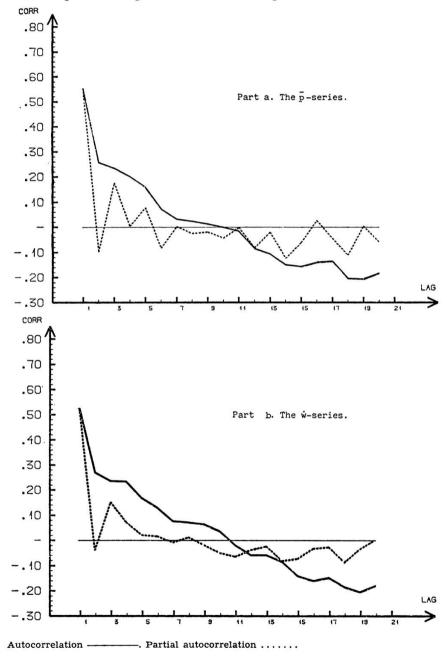
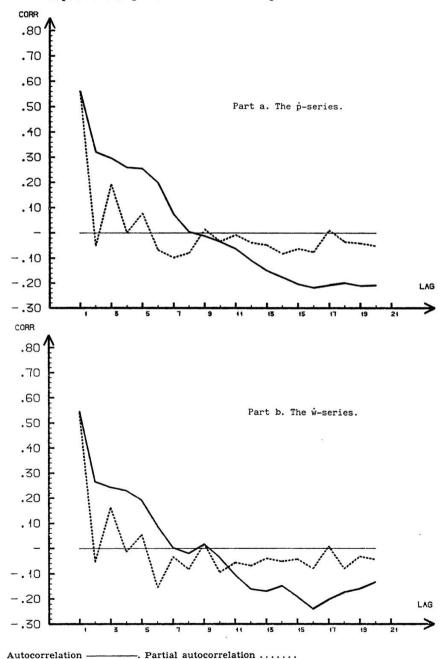


Figure 2 c: The structure of autocorrelation in price and wage rises 1948 - 80 — averages over 17 countries.



There is, however, another mixed possibility that on the face of it appears rather reasonable. We shall term it the mild RE case. In this case the information I entering into eq. (6) depends on the efforts made in data collection and analysis — or in other words on the attention given to expectation formation. That attention is likely to change over time. Perhaps, under "normal" conditions people do not care much, and we observe that the smiple LIRE-pattern modelled in (13) comes to dominate, but then from time to time events (of transitory character perhaps) occur making people care about inflation so that the HIRE-pattern emerges. This we should observe in the form of a disintegration of the nice and simple pattern (8). In such a mild RE world it is important to note how often breakdowns of such patterns occur, and also it is crucial to learn to identify the types of events making the HIRE instability turn up.

Above it was suggested that the dynamics may involve more variables than \dot{p}^e — in Paldam (1983 a) it is demonstrated that the number of industrial conflicts has links to wage inflation both ways and with lags, and more variables may very well enter into the complex dynamics of inflation. Therefore there are no need to identify the dynamics of the two inflation variables with inflationary expectations as we have done in the derivation above. In fact Paldam (1984 b) is an attempt to present a dynamic theory of price-wage inflation without expectations, but where the dynamics is carried by wage structure shifts involving industrial conflicts.

IV. The Univariate Time Series Structure of Price and Wage Rates Changes: The Final Equations and the Autoregressive Final Form

In Section III it was argued that the Final Equations for p_t and w_t are ARMA (R, S) processes with identical autoregressive parts. Furthermore, if the unemployment series are AR (1) processes, which seems to be the dominating feature of the applied data set, the order becomes R=2=S. To investigate these findings, univariate time series models are formu-

⁹ Of course, the RE-school is mostly known for exploring the extrem HIRE-case, where the new and striking results have emerged, often of a counter-intuitive or paradoxial character, such as the inefficiency results for economic policies. But, on the other hand, what most proponents of RE really seem to have in mind, as their realistic version of the RE-idea would seem to be our mild RE-case.

 $^{^{10}}$ The \dot{p}^e -variable is a measurable variable with a standard polling technique. From the attempts made it appear dubious that this variable is actually able to carry the whole of the dynamics of inflation as it does in our formulation following standard theory, see, e. g., Sheffrin (1982) for a survey of the evidence.

Table 2 a: Autoregressive Moving Average Processes of Order 2,2 for the series p; in the period 1948/50 - 1980* Model ARMA (2,2): $(1 - \Phi_1 L - \Phi_2 L^2) \dot{p}_t = \mu + (1 + \Theta_1 L + \Theta_2 L^2) \varepsilon_b \varepsilon_t \sim \text{n. i. d. } (0, \sigma^2)$

Country	(3,	(6)	Φ_1	σΦ1	\$ 2	ά <u>Φ</u> 2	$\hat{\theta}_1$	â 0 1	92	∂ 0-2	ď۶	013[Fract.]
1. Australia	1.383	1.507	1.105	.557	346	.394	212	.592	990. –	.286	3.357	5.57 [.04]
	.778	.277	.492	.257	.463	.354	450	.234	- 1.007	.233	2.162	8.24 [.17]
3. Canada	085	.659	1.192	.260	106	620.	636	.356	723	.281	1.929	3.53 [.00]
4. Danmark	.058	.364	.544	.255	.529	.322	304	.182	- 1.102	.221	1.919	5.58 [.04]
	727.	.400	.551	.222	.491	.258	247	.143	- 1.107	.170	3.074	12.06 [.48]
6. Finland	7.412	2.130	.819	.235	868. —	.116	886	.429	1.176	.231	6.535	3.39 [.00]
7. France	.239	1.527	.534	.422	.442	.260	507	.381	912	.200	3.068	9.13 [.24]
8. Germany	3.247	1.126	.058	.224	146	.103	706.	.299	.645	.292	1.280	12.42 [.51]
9. Holland	.122	.824	.509	.199	.491	.230	246	.193	-1.224	.190	2.199	3.48 [.00]
10. Italy	171. —	.270	.643	.240	.553	.252	350	.208	- 1.087	.205	3.219	17.51 [.82]
11. Japan	3.861	2.978	.140	.325	.185	.173	.572	.386	.058	.354	3.515	3.28 [.00]
12. New Zealand	093	1.055	.602	.238	.555	.229	340	.223	- 1.106	.199	2.530	6.76 [.09]
13. Norway	.683	.495	1.218	.289	295	.303	511	.263	6132	.249	2.921	13.46 [.59]
14. Österreich	3.445	.654	.472	.026	355	.018	403	.315	1.509	.144	1.452	5.21 [.03]
15. Sweden	.194	.963	.544	.219	.510	.400	500	.213	864	.357	2.860	6.30 [.07]
16. UK	553	1.148	.665	.243	.485	.382	490	.226	- 1.074	.315	2.984	5.59 [.04]
17. USA	060	.288	.595	.131	.491	.235	534	.195	849	.248	1.557	4.59 [.02]
2-03												
	1.255	980	.628	.255	.179	.242	302	.285	. 491	.246		
(Standard error)	(2.084)	(.734)	(314)	(.112)	(.446)	(.114)	(.429)	(114)	(.855)	(.061)		

* L is the lag operator and Qp the Box-Pierce test statistic for autocorrelation of order 15. Under the null of no autocorrelation Q_{ν} is asymptotically distributed as χ_{ν}^2 . The bracketed number indicates the Prob $(\chi_{\nu}^2 \le Q_{\nu})$. Notice that the numbers in the parentheses are the standard errors on the observations and not on the average, and furthermore, $\hat{\mu}$ is not an estimate of the man but an estimate of the mean times $(1-\Phi_1-\Phi_2)$.

Table 2b: Autoregressive Moving Average Processes of Order 2,2 for the series w_t in the period 1948/50 - 1980* $- \phi_0 L^2$ $\dot{w}_i = u + (1 + \Theta, L + \Theta, L^2) \varepsilon_i, \varepsilon_i \sim \eta$. i. d. $(0, \sigma^2)$ $-\phi$, L. Model ARMA (2.2): (1

	013 [Fract.]	2.82 [.00]	12.56 [.52]	7.24 [.11]	8.91 [.22]	15.91 [.75]	9.13 [.24]	3.45 [.00]	12.44 [.51]	7.84 [.15]	12.71 [.53]	2.89 .[00]	7.15 [.11]	6.53 [.08]	7.36 [.12]	6.92 [.09]	8.26 [.17]	8.42 [.18]		
	ď	5.323	3.923	2.507	2.532	3.944	5.859	4.027	2.121	3.970	4.075	4.248	4.172	3.394	2.385	3.493	3.057	1.320		
1. α. (υ, σ²)	∂ 02	.149	.157	.312	.373	.702	.290	.068	.408	.326	.165	.276	.677	.208	.222	.169	.152	.249	.288	(.175)
$\mu + (1 + \Theta_1 L + \Theta_2 L^2) \varepsilon_t, \varepsilon_t \sim \text{n. 1. d. } (0, \sigma^2)$	θ_2	- 1.096	- 1.190	321	-1.018	692	.651	-1.179	.654	868.	-1.256	065	.843	-1.053	.373		-1.122	015	592	(.667)
$1 + \Theta_2 L^2$	$\hat{\sigma}_{\Theta_1}$.255	176	.537	.324	.341	.363	171.	.377	.314	197	.283	.509	.175	.225	.121	.195	.321	.287	(117)
$(1 + \omega_1 T)$	$\hat{\theta}_1$	445		136	564	824	378	309	.644	531	286	999.	.584	355	.456	280	481	191	230	(.425)
$w_t = \mu +$	$\hat{\sigma}_{\Phi 2}$.251	.209	.334	.358	.518	.216	.193	.226	.356	.209	.195	<u>1</u> 69.	.444	101.	.258	.283	.245	.299	(.143)
$\omega_{c} - \Phi_{2} L^{2} w_{t} =$	\$ 2	.396	.528	221	.490	.529	773	.493	.019	409	.525	181.	.501	.436	246	.018	.512	.271	.239	(.370)
$(1 - \Psi_1 L)$	$\hat{\sigma}_{\Phi_1}$	292	761.	.531	.299	.426	.301	.250	.307	.308	181.	.195	.586	.310	.100	.239	.228	.265	.295	(.122)
Model AKMA (2,2): (1	$\tilde{\phi}_1$.552	.528	1.103	.493	.547	.702	.505	.265	.421	.561	.208	.527	.499	.245	.670	.520	.664	.530	(.204)
Model Ar	n o	1.307	.398	1.640	797.	1.172	4.105	1.908	4.283	.643	.445	3.327	1.111	1.390	1.550	1.572	.957	.792	1.610	(1.187)
	ή	229	.466	168.	.442	177	11.422	.531	5.752	2.432	.500	6.486	800.	1.402	8.435	3.399	.480	.482	2.450	(3.435)
	Country	1. Australia	2. Belgium	3. Canada	4. Danmark	5. Eire	6. Finland	7. France	8. Germany	9. Holland	10. Italy	11. Japan	12. New Zealand	13. Norway	14. Österreich	15. Sweden	16. UK	17. USA	Average	(Standard error)

See Table 2a for notes.

Table 2 c: Autoregressive Moving Average Processes of Order 2,2 for the series pt and we averages*

	502	1.139	(3.821)	.146	(.095)		.303	(.294)	.280	(060')	.246	(.061)	.288	(.175)
	$\hat{\Phi}_2$	009. —	(.297)	648	(.334)		973	(.123)	826	(.188)	491	(.855)	592	(.667)
i. d. $(0, \sigma^2)$	9 €1	 1.288	(3.646)	.161	(.062)		.322	(.286)	.257	(.063)	.285	(.114)	.287	(.117)
) $arepsilon_t,arepsilon_t \sim ext{n}.$	$\hat{\theta}_1$	250	(.378)	438	(.214)		493	(106)	580	(.112)	302	(.429)	230	(.425)
$L+\Theta_2 L^2$	σ Φ2	1.213	(3.645)	.196	(.058)		.300	(.290)	.252	(.123)	.242	(.114)	.299	(.143)
$\mu + (1 + \Theta_1 L + \Theta_2 L^2) \varepsilon_t$, $\varepsilon_t \sim$ n. i. d. $(0, o^2)$	Φ2	.124	(.383)	.083	(.326)		.211	(.299)	.171	(.298)	.179	(.446)	.239	(.370)
$\Phi_{\rm g} L^2$) $(p_t, w_t) = \mu$	$\hat{\sigma} \phi_1$	1.307	(3.663)	.196	(.039)		.338	(.274)	.289	(.087)	.255	(.112)	.295	(.122)
$-\Phi_{ m g}{ m L}^2$ (1	$\hat{\phi}_1$.802	(.421)	.884	(.298)		.725	(.286)	.743	(.242)	.628	(.314)	.530	(.204)
: $(1-\phi_1L-$	σ̂μ	2.050	(3.996)	.500	(.267)		.652	(.480)	.608	(.458)	.980	(.734)	1.610	(1.187)
odel ARMA (2,2): (1 —	ĵ. Jû	.883	(1.335)	.826	(.818)		.312	(.627)	.563	(.843)	1.255	(2.084)	2.450	(3.435)
Model A	Series	. ç	14		3	į	2	3,4		<i>1</i> 33	• 8	² 2		3
	Period	1913/19 - 1980					1922/23 - 1954				1948/50 - 1980			

See Table 2a for notes.

lated and estimated based on the well-known procedure of Box and Jenkins (1970). The time series models are constructed for all countries available in the sample for each of the overlapping time periods P1: 1913/19 - 1980, P2: 1922/23 - 1954, and P3: 1948/50 - 1980.

In formulating the time series models, i.e., socalled autoregressive moving average or ARMA models, the usual tools are applied, i.e. the autocorrelation function and the partial autocorrelation function. In addition the estimated spectra are used in order to investigate the possibility for applying an unobserved components model of the time series models. The unobserved components model where the series is assumed to contain two or more additive unobserved components, often denoted the trend, the cycle, and the irregular component, each having an ARMA representation may be seen as a parsimonious formulation of an ordinary ARMA model, see *Hylleberg* (1984) for a detailed discussion.

The main results obtained in the formulation stage are

- (C1) the autocorrelation functions and the partial autocorrelation functions are very similar for the two series \dot{w} and \dot{p} for each country.
- (C2) the general picture of the autocorrelation functions for the different countries is one where the autocorrelations die out smoothly. The partial autocorrelation functions have large significant peaks at lag 1 and in some cases lag 2 only, see Figures 2a to 2c, where the average results are shown.

This implies that the first model to estimate is an AR (1) process, but a thorough diagnostic analysis of the residuals indicates that this model doesn't produce a satisfactory description of neither the wage nor the price series. Higher order ARMA processes are then estimated and the general results show that the ARMA (2,2) process is second to none although it by no means produces an excellent description for all countries. In addition the parameters vary across countries especially for the price series while the AR parts are not as similar for both series \dot{w}_t and \dot{p}_t for the individual country as could be expected from the theoretical results. However, the average AR coefficient are quite similar. The results for the period 1948 - 1980 are shown in Tables 2a and 2b, while the average results are presented in Table 2c.

In Section III it was also argued that if the unemployment rate is considered exogenous — a reckless assumption of course — the Autoregressive Final Form of the model described earlier consists of two equations where p_t and w_t are explained by the unemployment rate unlagged and lagged one period and p_{t-1} and w_{t-1} respectively, while

 $Table \ 3 \ ac$: Conditional Maximum Likelihood Estimates of the Autoregressive Final Form for Price Series (period 1926 - 1980)*

	LM_1 [Fract.]	.15 [.30]	3.85 [.95]	5.08 [.98]	4.58 [.97]	2.46 [.88]	3.53 [.94]	.72 [.60]		
	3 0	2.77	2.58	4.17	4.56	10.09	3.32	2.37		
0	99	.157	.173	.204	.181	.279	.177	.132	.186	(.047)
$\text{Model: } \dot{p_t} = \gamma + \beta_0 u_t + \beta_1 u_{t-1} + \alpha_1 \dot{p}_{t-1} + \varepsilon_t + \Theta \varepsilon_{t-1} \cdot \varepsilon_t \sim \text{n. i. d. } (0, \sigma_\epsilon^2)$	ø	.401	.401	.050	485	.111	200	.611	.127	(.381)
$-1 \cdot \varepsilon_t \sim n$.	ĝal	.132	.164	.156	660.	.255	760.	.146	.150	(.053)
$\epsilon_t + \Theta \epsilon_t$	â	.625	.515	.653	.920	.418	.882	.444	.637	(.200)
$\alpha_1 \dot{p}_{t-1} +$	ô _{β1}	.357	.186	.549	.488	1.967	.346	.161	.579	(.628)
$\beta_1 u_{t-1} +$	$\hat{\theta}_1$.881	198	913	310	.530	.741	.517	.235	(.640)
$+\beta_0 u_t +$	7,80	.350	.182	.539	.481	1.810	.348	.160	.553	(.572)
lel: $\dot{p}_t = \gamma$	βo	- 1.073	393	.946	.465	-2.004	754	627	. 491	(.975)
Moc	ô,	1.218	1.244	1.603	1.045	4.659	.860	1.145	1.683	(1.332)
	۶	2.633	2.263	1.502	393	8.510	.873	2.392	2.325	(2.979)
	Country	1. Australia	3. Canada	4. Denmark	5. Eire	6. Finland	16. UK	17. USA	Average	(Standard error)

* LM is the Lagrange Multiplier test for an MA (2) error process. Under the null of an MA (1), the LM statistics is asymptotically x_1 , see Hylleberg (1984).

 $Toble\ 3\ b$: Conditional Maximum Likelihood Estimates of the Autoregressive Final Form for Wage Series (period 1926 - 1980)*

	LM ₁ [Fract.]	1.24 [.73]	1.23 [.73]	24.50 [1.00]	.00 [.04]	1.27 [.74]	.78 [.62]	8.35 [.99]		¥.
	ĝ	5.23	2.22	3.51	4.15	11.26	4.71	3.34		4
σ_{ε}^{2})	ê ê	.248	.125	.180	.132	.259	.170	.138	179	(.055)
· п. і. d. (0,	θ	171.	.616	400	0.9-	189. —	644	.589	153	(.586)
Model: $\dot{\omega}_t = \gamma + \beta_0 u_t + \beta_1 u_{t-1} + \alpha_1 \dot{\omega}_{t-1} + \varepsilon_t + \Theta \varepsilon_{t-1} \cdot \varepsilon_t \sim \text{n. i. d. } (0, \sigma_t^2)$	ĝal	.210	.120	760.	.041	.179	.093	.137	.125	(.057)
$1 + \varepsilon_t + \epsilon$	â	.506	.578	.846	896.	906	.957	.123	869*	(.313)
$_1+\alpha_1\dot{w_t}$	ĝβ1	.590	.155	.454	.342	1.715	.336	.280	.553	(.534)
$+\beta_1 u_t$	$\hat{\beta}_1$.961	.595	.063	.248	2.751	.652	1.175	.921	(.893)
$= \gamma + \beta_0 u_1$	° 80	.582	.146	.420	.355	1.481	.339	.225	.507	(.451)
odel: $\dot{w_t}$ =	βo	- 1.332	737	356	315	-2.871	634	-1.255	- 1.071	(.888)
M	, e	2.352	1.342	1.451	1.809	4.005	.985	1.482	1.918	(1.014)
	Ŷ	4.940	3.499	2.463	0.991	1.711	.482	4.809	2.699	(1.778)
	Country	1. Australia	3. Canada	4. Denmark	5. Eire	6. Finland	16. UK	17. USA	Average	(Standard error)

* See Table 3 a for notes.

Table~3~c Estimates of α , λ and β obtained from Tables 3 a and 3 b

Country	Equation	$\hat{lpha} =$	β_0	ã −	\hat{eta}_1/eta_0	$\hat{\beta} = (\hat{\beta_0} \circ \hat{\beta_0} \circ \hat{\beta_0} - \hat{\beta_0} \circ \hat{\beta_0} - \hat{\beta_0} \circ \hat{\beta_0} - \hat{\beta_0} \circ \hat{\beta_0} \circ \hat{\beta_0} - \hat{\beta_0} \circ $	
1. Australia	$\dot{p}_t \ \dot{w}_t$	— 1.073	- 1.332	.821	.721	— 1.095	771
3. Canada	$\dot{p}_t \ \dot{w}_t$	393	737	.504	.807	.022	- 1.187
4. Denmark	$\dot{p}_t \ \dot{w}_t$.946	356	.965	.177	- 8.914	.813
5. Eire	$\dot{p}_t \ \dot{w}_t$.465	.315	.667	.787	.760	.849
6. Finland	$\dot{p}_t \ \dot{w}_t$	- 2.004	- 2.871	.264	.958	.209	— 1.238
16. UK	$\dot{p}_t \ \dot{w}_t$	754	634	.983	1.028	- 5.941	2.536
17. USA	$\dot{p}_t \ \dot{w}_t$	— .627	— 1.225	.825	.936	- 2.177	- 12.703
Average	\dot{p}_t	491 (.975)		.718 (.260)		- 2.248 (3.637)	
	\dot{w}_t		- 1.071 (.888)		.773 (.284)		- 1.672 (5.052)

the error processes are first order moving average processes. The autoregressive parts of the two equations are identical here as well, as are the coefficients to the unemployment series. The results of a conditional maximum likelihood estimation of the parameters applying the Gauss-Newton algorithm, see *Hylleberg* (1984), are shown in Tables 3a and 3b, for only 7 countries. For the eighth country, Sweden, the maximum likelihood algorithm doesn't converge while the unemployment series

are presently unavailable for the remaining countries, at least for the whole period.

Again the results are somewhat mixed, as the coefficients to the lagged dependent variables, i.e. \dot{p}_{t-1} and \dot{w}_{t-1} are very similar on average at least while the coefficients to the unemployment series are not. For the price equation some of the estimates also exhibit 'wrong' signs although not significantly so.

From (11a) and (11b) it is seen that the estimates of α and λ may be found as $\hat{\beta}_0$ and $-\hat{\beta}_1/\hat{\beta}_0$ respectively and an estimate of β is found as $(\hat{\beta}_0 \hat{\alpha}_1 + \hat{\beta}_1)/(\hat{\beta}_0 + \hat{\beta}_1) = (\hat{\alpha}_1 - \hat{\lambda})/(1 - \hat{\lambda})$. While the estimates of the adjustment parameter λ look reasonable the estimates of β are implausible. However, it is worth remembering that the variance on these estimates are very high due to the form of the formula $(\hat{\beta}_0 \hat{\alpha}_1 + \beta_1)/(\hat{\beta}_0 + \hat{\beta}_1) = \hat{\beta}$.

In concluding this section it must be admitted that the 'theories' put forward in section II are only partly supported by the results, and that more analysis is required before any conclusion is drawn.

V. The Interdependence of Price and Wage Rises

In order to throw some further light on the questions already addressed in Section IV a correlation analysis of the lead-lag structure of the series p and w is undertaken.

The correlation analysis consists of the calculation of the following 7 correlations for our (14 + 14 + 17 =) 45 countries and 3 periods:

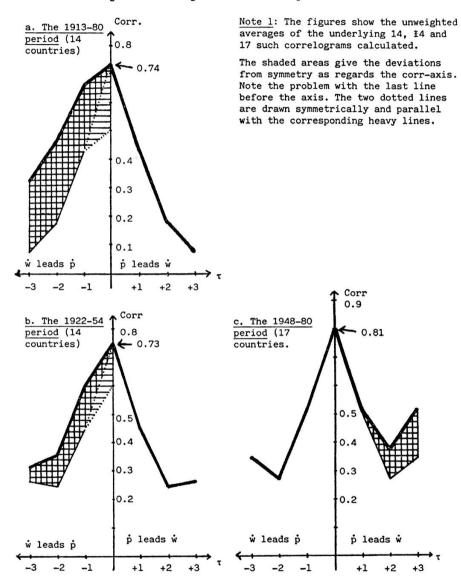
(14)
$$r_{\tau} = r(\dot{w}, \dot{p}_{\tau}), \tau \in [-3, -2, -1, 0, +1, +2, +3]$$
.

I.e. r_{-2} is the correlation between the \dot{w} -series and the \dot{p} -series lagged 2 years etc.

If identical univariate time series generate w and p the correlogram r_{τ} should be symmetrical around $\tau=0$ and fall from the axis as the corresponding autocorrelation functions on figures 2a-f. From Figure 3a-c it is obvious that the correlograms are not symmetrical and they indicate that w_t leads p_t in the periods 1913-1980 and 1922-1954 but not in 1948-1980.

To further investigate this point formal tests for Granger non-causality have been carried out. Three test statistics have been computed, see Harvey (1981) in order to test the hypothesis that \dot{w}_t non Granger causes p_{tj} ; i.e. »n.G.c.«. The so-called direct test, Test No. 1, is executed by a regression of p_t on lagged values of itself, i.e. p_{t-i} , $i=1,2,\ldots,m_1$ and on lagged values of \dot{w}_t i.e. \dot{w}_{t-j} , $j=1,2,\ldots,m_2$, testing the joint significance of \dot{w}_{t-j} , $j=1,2,\ldots,m_2$ by the usual F-test.

Figure 3: Correlograms between the p & w series



Note 2: τ = -3, -2, -1, 0, +1, +2, +3 defines the lead/lag axis where \dot{p} lags \dot{w} by 3, 2, 1 and 0 years and then leads by 1, 2 and 3 years.

 $Table\ 4\ a$ Tests for Granger non-causality. Fractile probabilities*

Country	Hypothesis	1913 - 1980 1 2 3	1922 - 1954 1 2 3	1948 - 1980 1 2 3
1. Australia	\dot{w}_t »n.G.c.« \dot{p}_t \dot{p}_t »n.G.c.« \dot{w}_t	.61 .92 .86 .99 1.00 .99	.76 .61 .29 .88 .51 .30	.05 .77 .46 .96 .81 .62
2. Belgium	w_t »n.G.c.« p_t p_t »n.G.c.« w_t			.99 .99 .97 .89 .68 .68
3. Canada	w_t »n.G.c.« w_t p_t »n.G.c.« w_t	.96 .92 .94 .99 .98 .99	.80 .50 .57 .88 .70 .82	.35 .94 .83
4. Denmark	\dot{w}_t »n.G.c.« \dot{p}_t	.95 .96 .61	.56 .14 .28	.25 .06 .11
5. Eire	p_t »n.G.c.« w_t w_t »n.G.c.« p_t	.85 .05 .50 .85 1.00 .98	.61 .77 .64	.85 .64 .85 1.00 .89 .73
6. Finland	p_t »n.G.c.« w_t w_t »n.G.c.« p_t	.89 .48 .73 1.00 1.00 1.00	.87 .42 .33 1.00 .75 .84	.91 .58 .57 .70 .98 .82
7. France	p_t »n.G.c.« w_t w_t »n.G.c.« p_t	.35 .99 .97 .98 1.00 1.00	.45 .95 .91 .97 .99 .98	.80 .83 .70 .80 .99 .91
8. Germany	p_t »n.G.c.« w_t w_t »n.G.c.« p_t	.82 .82 .66	.68 .89 .69	.15 .40 .55 .68 .64 .99
•	\dot{p}_t »n.G.c.« \dot{w}_t			.59 .07 .42
9. Holland	w_t »n.G.c.« p_t p_t »n.G.c.« w_t	.16 .01 .23 .72 .82 .82	.39 .12 .24 .99 .94 .86	.31 .22 .25 .53 .04 .05
10. Italy	$\overset{\cdot}{w}_t$ »n.G.c.« $\overset{\cdot}{p}_t$ $\overset{\cdot}{p}_t$ »n.G.c.« $\overset{\cdot}{w}_t$.12 .03 .20 1.00 1.00 1.00	.00 .49 .65 1.00 1.00 1.00	.65 .98 .97 .19 .68 .57
11. Japan	w_t »n.G.c.« p_t p_t »n.G.c.« w_t	.83 .34 .74 1.00 1.00 1.00	.43 .87 .57 1.00 1.00 1.00	.94 .96 .74 .76 .96 .97
12. New Zealand	w_t »n.G.c.« p_t	.26 .86 .86 .72 .84 .58	.07 .17 .03 .81 .74 .51	.36 .62 .87 .68 .98 .94
13. Norway	p_t »n.G.c.« w_t \dot{w}_t »n.G.c.« \dot{p}_t	1.00 1.00 .88	.33 .87 .52	.68 .53 .50
	p_t »n.G.c.« w_t	1.00 .91 .99	.78 .86 .65	.14 .50 .13

Country	Hypothesis	191	3 - 1	980	192	22 - 1	954	194	18 - 1	980
Country	Hypothesis	1	2	3	1	2	3	1	2	3
14. Austria	\dot{w}_t »n.G.c.« \dot{p}_t	_		_	_	_		.72	.68	.73
	p_t »n.G.c.« \dot{w}_t	_	_	-	-	_	-	.66	.54	.51
15. Sweden	\dot{w}_t »n.G.c.« \dot{p}_t	.84	.30	.24	.64	.17	.50	.19	.53	.36
	\dot{p}_t »n.G.c.« \dot{w}_t	1.00	.68	.71	.87	.17	.44	.43	.17	.35
16. UK	$\overset{\cdot}{w}_t$ »n.G.c.« $\overset{\cdot}{p}_t$	1.00	.43	.35	.09	.12	.11	1.00	.79	.72
	\dot{p}_t »n.G.c.« \dot{w}_t	.97	.98	.88	.76	.64	.67	.73	.58	.34
17. USA	$\overset{\cdot}{w_t}$ »n.G.c.« $\overset{\cdot}{p_t}$.87	.24	.84	.76	.42	.72	.69	.82	.78
	\dot{p}_t »n.G.c.« \dot{w}_t	.62	.60	.99	.67	.66	.94	.67	.24	.05

^{*} The fractile probabilities indicate the probability of obtaining a value less than or equal to the F statistical computed under the null. The degrees of freedom in the numerator are 8 for the period 1913 - 80 and 5 for the remaining periods. The notation » n.G.c. « indicates "non-Granger causing".

Sims' test, Test No. 2, is based on a regression of w_t on p_{t-i} , $i=0,1,2,\ldots,m_1$ and p_{t+j} , $j=1,2,\ldots,m_2$ and the test statistic is the well-known F statistic for the joint significance of the coefficients to the future values p_{t+j} , $j=1,2,\ldots,m_2$.

In the last test, Test no. 3 or Geweke's test, the set of regressors in Test no. 2 is extended by m_3 lagged values of \dot{w}_t , i.e., \dot{w}_{t-i} , $i=1,2,\ldots,m_3$ and by p_{t-m_1-i} , $i=1,2,\ldots,m_3$. This extension is made in order to decrease the sensibility of Test no. 2 to serially correlated errors.

The tests of p_t non-Granger causing w_t are carried out analogously and the results are shown in Table 4a while Table 4b contains a summary of these results. To explain the results in Table 4a consider the test of the hypothesis HO w_t »n.G.c.« p_t , i.e., w is non-Granger causing p_t for Australia in the period 1913 – 1980. Here Test no. 1 gave an F-value equal to .61 whereby the null hypothesis may be rejected at a level of significance of .39 or higher.

The results in Table 4b show a surprisingly weak indication of causality i.e. prediction ability except for the period 1913 - 80 where the dramatic years following World War I gave some significant results. In that period especially Geweke's test, which may be preferable, indicates a direction of causality from prices to wages, if any. The overal weak indication of the direction of causality may be due to the data being yearly. This conjecture is supported by later works applying quarterly data.

 $Table\ 4\ b$ Summary of the Granger non-causality tests

Hypotheses	Period	Test	Number lev	of rejection	ons at sign in or equa	nificance l to	Total
Trypomeses	reriou	ber	0.05	0.10	0.15	0.20	num- ber
		1	6	6	8	10	1
	1913 - 80	2	5	7	8	8	14
		3	2	3	6	7	
Wages non- Granger		1	2	2	2	3	
Causing Prices	1922 - 54	2	1	1	4	4	14
\dot{w}_t »n.G.c.« \dot{p}_t		3	1	1	1	2	
		1	3	4	4	5	
	1948 - 80	2	5	6	7	8	17
		3	3	4	5	7	
		1	7	7	9	10	
	1913 - 80	2	6	7	7	10	14
		3	7	7	8	9	
Prices non- Granger		1	3	3	7	8	
Causing	1922 - 54	2	3	4	6	6	14
Wages \dot{p}_t »n.G.c.« $\dot{w_t}$		3	2	4	5	6	
		1	2	3	5	6	
	1948 - 80	2	3	3	3	5	17
		3	2	3	4	3	

Summary

The results presented above explain why so many controversies have managed to stay alive within the field of price-wage inflation. At the same time it is demonstrated that it is essential to base empirical conclusions on large data sets, since it is quite easy to choose subsets 'confirming' very different views.

Although the dominating feature of the Final Equations for the wage and price inflation seems to be ARMA (2,2) processes corresponding to the

simple adaptive expectation augmented Phillips-curve the exceptions are many. The Autoregressive Final Forms with the unemployment rate as the exogenous variable likewise exhibit considerable variation.

However, in some cases like Germany the deviations from the dominating pattern may be explained by their specific inflationary experience.

At last, the analysis of the lead-lag relation between price and wage inflation also shows a very mixed picture with a surprisingly weak indication of 'causality' in the Granger sense of the word.

Zusammenfassung

Die vorliegenden Ergebnisse erläutern die Ursache der lang bestehenden Kontroverse der Preis-Lohn-Inflation. Die Wichtigkeit von großen Daten-Sätzen in empirischen Resultaten wird durch die Tatsache dargelegt, daß durch entsprechende Wahl von Daten-Untergruppen sehr verschiedene Ansichten bestätigt werden können.

Der ARMA (2,2)-Prozeß erscheint als das Hauptmerkmal der "Final Equation", die der Phillips-Kurve mit adaptiven Erwartungen entspricht. Die Dominanz der ARMA (2,2)-Prozesse ist jedoch nicht sehr ausgeprägt. Auch die "Autoregressive Final Forms' mit der Rate der Arbeitslosigkeit als exogener Variablen zeigt große Variationen.

In einigen Fällen jedoch, wie zum Beispiel für Deutschland, können die Abweichungen von dem allgemeinen Muster durch spezifische Inflationserfahrungen erklärt werden.

Schließlich zeigt auch die Analyse der "lead-lag"-Verbindungen zwischen Preis- und Lohn-Inflation ein sehr gemischtes Bild mit einer überraschend schwachen Indikation von "ursächlichem Zusammenhang" im Sinne Grangers.

References

- Andersen, Torben M. (1984), Price Dynamics under Imperfect Information. Memo 198-5 Institute of Economics, University of Aarhus.
- Box, G. E. P. and G. M. Jenkins (1970), Time Series Analysis: Forecasting and Control. San Francisco.
- Chan-Lee, J. H. (1980), A Review of Recent Work in the Area of Inflationary Expectation, Weltwirtschaftliches Archiv 116, 45 56.
- Friedman, M. (1968), The Role of Monetary Policy, American Economic Review 58, 1-17.
- Grubb, D., S. Hylleberg and M. Paldam (1983), On the Use of Country Sets of Estimates of the Same Equation. Memo 1983-2, Institute of Economics, University of Aarhus.
- Harvey, A. C. (1981), The Econometric Analysis of Time Series. London.
- Hibbs, D. A. (1979), The Mass Public and Macroeconomic Performance: The Dynamics of Public Opinion Towards Unemployment and Inflation, American Journal of Political Science 23, 705 - 31.
- Hylleberg, Svend (1984), Seasonalty in Regression. New York (forthcoming).

- Paldam, M. (1979), Towards the Wage-Earner State. A Comparative Study of Wage Shares 1948 - 75, International Journal of Social Economics 6, No. 1.
- (1980), The International Element in the Phillips-Curve, Scandinavian Journal of Economics 82, No. 2.
- (1983 a), Industrial Conflicts and Economic Conditions. A Comparative Empirical Investigation, European Economic Review 20, No. 1.
- (1983 b), The Political Dimensions of Wage Dynamics. Chapter 32 in: Kristen R. Monroe (ed.), The Political Process and Economic Change. New York.
- (1983 c), The International Element of Economic Fluctuations at 20 OECD-Countries 1948 - 75, Regional Science & Urban Economics 13, No. 3.
- (1984 a), How Much Does One Per Cent Growth Change the Unemployment Rate? A Study of 17 OECD Countries 1948 80. Forthcoming.
- (1984 b), A Wage Structure Theory of Inflation, Industrial Conflict and Trade Unions. Memo 1984-2. Institute of Economics, University of Aarhus.
- and E. Strøjer Madsen (1978), Economic and Political Data for the Main OECD-Countries 1948 - 75. Memo 1978-9, Institute of Economics, Aarhus.
- and P. J. Pedersen (1984), The Large Pattern of Industrial Conflict
 A Comparative Study of 18 Countries, International Journal of Social Economics 10, No. 1.
- Pedersen, P. J. (1981), Inter-War Data on Industrial Conflicts, Wages, Cost of Living, Unemployment, Degree of Organization, and a Selection of Political Variables for 23 Countries. Institute of Economics, University of Aarhus.
- Phelps, E. S. (1967), Phillips curves. Expectations of Inflation and Optimal Unemployment over Time, Economica 24, 254 281.
- Phillips, A. W. (1958), The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957, Economica 25, 283-299.
- Santomero, A. M. and J. J. Seater (1978), The inflation unemployment tradeoff: a critique of the literature, Journal of Economic Literature 16, 499-544.
- Sheffrin, S. M. (1982), Rational Expectations, Cambridge Surveys Series, Cambridge UK.