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Sectoral Wage and Price Formation and Working Time in Germany: An Econometric Analysis

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In this paper a variety of theories concerning the wage and price formation in Germany are tested. More specifically, wage and price equations are specified in a fairly general manner which nests several theoretical arguments (such as the target real wage bargaining model, hysteresis effects, outsider ineffectiveness, interindustry wage competition) and a perceived tradeoff between reductions in working time and wage increases. Related arguments hold for the price setting process. Recently developed econometric techniques such as error correction models are applied.

1. Introduction

Sectoral wage equations have experienced new attention in the past few years. This is partly due to new theoretical insights highlighted by hypotheses such as efficiency wages and insider effects in wage determination. *Holmlund/Zetterberg* 1991 and *Nickell/Wadhwani* 1990 are prototypes of these studies.

This paper attempts to contribute to this field of research by focussing on two major extensions. First, sectoral wage equations are specified in a fairly general manner which nests several theoretical models and institutional regulations. While this is in the spirit of the work by *Coe* 1990, the novelty of our study is that the perceived trade-off between wage increases and working time reductions in Germany especially in the eighties is taken into account. More specifically, it is investigated to what extent workers were compensated for the fall of income due to a reduced working time.

The second emphasis of our paper concerns the theoretical underpinning and estimations of sectoral price equations for Germany. We employ the same approach as in the wage equations, i.e. we specify a general theoretical framework which nests several theoretical aspects of price formation. The econometrics then allow a distinction between these hypotheses by evaluating the significance of parameter restrictions.

The paper is organized as follows. The next section is devoted to a brief overview of the debate about the effects of reduced working time in Germany. Section 3 contains a theoretical framework for the analysis of wage and price formation. The results of the estimations are displayed in section 4. The final section summarizes our findings and caveats.

2. Reductions in working time: a brief survey of the debate in Germany

Reductions in working time are an issue with a long history in many countries (see *table 1*).[1] While at the end of the last century the normal working week was as much as 60 hours in many countries, it has now been reduced to 40 or less hours in many industrialized economies. Gradual reductions of annual working time have taken place through e.g. shorter working hours per week, longer annual holidays, changes to part-time work, and, moreover, the working lifetime has been shortened by measures such as flexible retirement.

With a few exceptions, the principal aim of these actions has been to improve living and working conditions. Solving the unemployment problem, however, was an aspect central to the debate during and after the Great Depression. For instance, in France the left wing coalition of the Front Populaire headed by León Blum enacted a reduction of weekly hours from 48 to 40. This measure went into effect in September 1936 (see *Majolin* 1938, for example). In Germany, unions argued that mass unemployment was "structural" rather than due to business fluctuations and would not disappear in a recovery. Although shortening working time was not viewed as a cure all, it was supposed to serve as an instrument for achieving a more distribution of jobs. While government did not legislate a general reduction in the number of hours worked per week, governmental employment programs made firms' entitlement to grants or loans conditional upon a 40 hours week for all employees in that firm. An example for such measures is the employment program of December 15, 1932 issued by Chancellor von Schleicher.

Hardly any substantial new arguments have been advanced in a revival of the debate in Germany since the beginnings of the eighties. The extremely lively dispute on working time in Germany can be explained by the very adverse situation which the German labour market was expected to experience in the late eighties. Given the path of increased labour supply in the eighties, the forecast at the beginning of the eighties was that, if real GNP would grow at a constant 2.5 (zero) percent annual rate, the German economy would wind up with three (six) million unemployed persons in 1990 (including non-registered unemployment), i.e. with an unemployment rate of some 11 (22) percent.[2] Given these figures, it is not difficult to understand

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[1] Parts of this section draw upon *Franz* 1984.

[2] See *Franz* 1984, pp. 631 for more details and sources.

Table 1

Annual hours worked per person 1890 - 1979

country	1890	1929	1950	1979
Austria	2,760	2,281	1,976	1,660
Bęlgium	2,789	2,272	2,283	1,747
France	2,770	2,297	1,989	1,727
Germany	2,765	2,284	2,316	1,719
Japan	2,770	2,364	2,272	2,129
UK	2,807	2,286	1,958	1,617
USA	2,789	2,342	1,867	1,607

Source: *Maddison*, A., 1982, Phases of Capitalist Development, Oxford.

Table 2

Components of working time in Germany[a)]

year	negotiated time		overtime hours[c)]	reduction of hours[d)]	actual weekly hours
	weekly hours	vacation[b)]			
1960	44.6	15.5	95.0	138.0	40.0
1970	41.5	21.2	157.3	170.4	36.3
1975	40.3	24.3	99.7	174.1	33.4
1980	40.1	27.3	80.2	181.3	32.5
1985	39.8	30.1	66.5	162.2	31.5
1990	38.5	30.7	71.0	173.1	30.2

a) aggregate economy
b) days per year
c) per worker and per year
d) due to part-time work, short-time work, strikes, sickness; per year and per quarter
Source: Institut für Arbeitsmarkt und Berufsforschung, Arbeitsvolumenrechnung 1991.

the public concern about future employment possibilities. “No future-generation” was a frequently used term in public discussions about youth unemployment at that time.

Another reason for the very lively discussion of reduced working time was the apparent inability of economic policy to restore full employment within a reasonable time period. By and large, the conservative-liberal government of chancellor Kohl was more in favour of a supply side oriented economic policy. While this policy undoubtedly has its merits, it needs considerable time to effect a cure. Since the unions viewed such a governmental policy as insufficient and, realistically, regarded an expansionary demand policy as politically unfeasible, "conventional methods" of solving the unemployment problem appeared to them as unavailable. Hence, in their opinion, a "second best" strategy was to redistribute the burden of unemployment rather than to eliminate it. Although this solution was not commonly agreed upon by all the individual unions (which in Germany are organized by industry), its apparent simplicity and effectiveness was appealing at first glance by the following back of the envelope calculation: a 12.5 percent reduction in weekly worked hours (from 40 to 35 hours) creates arithmetically some 2.8 million jobs thus solving the problem of unemployment. While there were various fields of action for a reduction in working time, the most widely discussed measure and, hence, the focus of this paper is the reduction in weekly worked hours. The "40-hours week" represented the main point of attack by the unions in the strikes organized in the metal and printing industry in 1984. The agreements in these industries compromised then on a 37 to 40-hours week and left it up to the individual firm what degree of flexibility was chosen. More precisely, the 1984-settlement in the metal industry stated that "the negotiated working time per week is 38.5 hours. (...) Different working times between 37 and 40 hours may apply to specific parts of the firm, to individual employees, or to specific groups of workers. (...) The weekly working time must be achieved in averaging over two months." (*Franz* 1984, 637).

Table 3 presents an overview on which sectors at what time agreed upon reductions in weekly worked hours. As can be seen this issue was the subject of negotiations in many sectors during the eighties, but with different outcomes and a different timing. In a second attack on working time after 1984, the unions in the iron and steel industry 1988 reached the lowest working time in the history of the FRG with 36.5 hours per week. In 1990, a third round of working time reductions took place, and the 35 hours workweek was agreed upon in some sectors from 1995 onwards.

There are many channels through which reductions in working time affect output and employment in the short and in the long run.[3] The key variables are real unit labour costs. Developments in them depend on how much nominal pay per week is reduced, on productivity and substitution effects, and on how successful employers are in charging higher prices. Indeed, as *Drèze/Modigliani* 1981 put it: "Shorter hours make sense, if and only if they permit some form of cost absorbtion, like productivity gains, wage

[3] Theoretical models are developed by e.g. *Hart* 1984, 1987; *Tödter* 1988.

Table 3

Selected wages settlements with reductions in weekly worked hours

Year	Sector	Reduction
1984	metal industry	from 40 to 38.5 hours from April 1985 contract term 2 years
	printing	from 40 to 38.5 hours form October 1984 contract term 2 years
	automobile[1)]	from 40 to 38.5 from Januar 1985 contract term 2.5 years
	iron and steel	from 40 to 38 hours from October 1984 9 month wage freeze, then 2 years term
1985	wood, plastic	from 40 to 38.5 hours from October 1985
	trade	from 40 to 38.5 hours from January 1986
1986	paper	from 40 to 38.5 from November 1986
	insurances	from 40 to 38.75 from January 1987
1987	metal industry	from 38.5 to 37.5 from April 1988 and from 37.5 to 37 from April 1989
	printing	from 38.5 to 37.5 from April 1988 and from 37.5 to 37 from April 1989
	chemistry	from 40 to 39 from July 1989
	automobile[1)]	from 38.5 to 37 from August 1988
1988	public sector	from 40 to 39 from April 1989 and from 39 to 38.5 from April 1990
	iron and steel	from 38 to 36.5 from November 1988
	textil	from 40 to 39 from May 1989 and from 39 to 38.5 from May 1990
1989	wood, plastic	from 38.5 to 37 from October 1989
	paper	from 38.5 to 37.5 from November 1989 and from 37.5 to 37 from November 1990
	insurances	from 38.75 to 38 from July 1990
	trade	from 38.5 to 37.5 from January 1991
1990	metal industry	from 37 to 36 from April 1993 and from 36 to 35 from October 1995
	printing	from 37 to 35 from April 1995
1991	textil	from 38.5 to 37.75 from May 1992 and from 37.75 to 37 from October 1993
	iron and steel	from 36.5 to 35 from April 1995

1) Volkswagen only
Sources: Jahresgutachten des Sachverständigenrats, Konjunkturberichte des RWI, various issues.

restraint or selective subsidies" (p. 35). Therefore, the next step in our paper is to formulate a theoretical framework of wage and price determination which is capable of taking into account the effects of reductions in weekly worked hours.

3. Theoretical framework of wage and price determination

3.1 Wages

The basic idea which governs the following theoretical considerations is to present a fairly general wage equation which nests several theoretical models, such as the Phillips-curve model, hysteresis and persistence, and aspects of sectoral wage adjustments, respectively.[4] Since much of the derivations of those hypotheses can be found in the literature, we will be very brief here and concentrate on our modifications of that work.

1. *Phillips-curve:* As a starting point, the hypothesis of the Phillips-curve approach is that wages move in the direction that the excess demand for labour XD,

$$XD = \frac{L^d}{L^s}, \tag{1}$$

is eliminated by a rate which is proportional to the level of the gap between labour demand L^d, and labour supply L^s, i.e.:

$$\Delta xd = -c \cdot xd. \tag{2}$$

A lowercase letter indicates the log of the variable and Δ is the difference operator. Note that in equilibrium XD equals unity (and its log equals zero) as long as L^s does not include voluntary unemployment. Using standard formulations for labour demand and supply functions,[5] inserting them in equation (1), and taking time derivatives of xd yields the following equation:

$$\Delta xd = -a \cdot (\Delta w - \Delta p^e - \Delta \theta) - b \cdot (\Delta w - \Delta pc^e - \Delta r). \tag{3}$$

The first r.h.s. term stems from the labour demand function where the expected real wage equals the marginal productivity of labour. W is the nominal wage rate,[6] P^e stands for the expected output price, and θ is approximated by log labour productivity. The second r.h.s. term of eq. (3) is derived from the labour supply function where workers compare their reservation wage R with the approximated by consumption wage $\frac{W}{PC^e}$ where PC^e

[4] A similar approach is applied by e.g. *Coe* 1989, 1990; *Nickell/Wadhwani* 1990; *Holmlund/Zetterberg* 1989; and *Holmlund* 1991.

[5] The production function is: $Y = \Theta \cdot L^{\gamma}$ with $0 < \gamma < 1$, where Y represents output and Θ is an exogenous productivity shift parameter. Then $a = 1/(\gamma - 1) < 0$ is the real wage elasticity of labour demand. See *Gordon* 1987 for a full derivation of the model.

[6] Tax rates are neglected in the theoretical section already, because a tax wedge turned out to be insignificant in the estimates.

is the expected consumer price index. The parameter b is the real wage elasticity of labour supply. Substituting eq. (3) into eq. (2) and rearranging terms yields:

$$(4) \qquad \Delta w = \Delta p^e + \Delta \theta + \frac{1}{a+b} \cdot \left[b \cdot [\Delta (r-\theta) + \Delta (pc^e - p^e)] + c \cdot xd \right].$$

In equilibrium, labour demand equals labour supply, i.e. $xd = 0$. If the reservation wage increases according to the productivity shift term and $\Delta pc^e = \Delta p^e$, then $\Delta w - \Delta \theta = \Delta p^e$, i.e. the growth of unit labour costs equals the inflation rate of output prices. Since $\Delta w - \Delta \theta - \Delta p^e$ is approximately the growth rate of labour's share, in equilibrium the level of labour's share is constant. This equilibrium level of labour's share, S^* can easily be obtained by solving the equilibrium condition $L^s = L^d$:

$$(5) \qquad \begin{aligned} s^* &= w - \theta - p \\ &= \frac{a}{a+b} \cdot \ln \gamma + \frac{b}{a+b} [(r-\theta) + (pc - p)]. \end{aligned}$$

From eq. (5) it is clear that log labour's share boils down to a constant $\left(\frac{a}{a+b}\right) \ln \gamma$, if r equals θ and if the wedge between product and consumption wage is absent, i.e. $pc = p$. The above considerations can be summarized and simplified by the following error-correction form of the wage equation:

$$(6) \qquad \begin{aligned} \Delta w_t = {} & \alpha_1 \cdot \Delta p_t + \alpha_2 \cdot \Delta \theta_t + \alpha_3 \cdot \Delta z_t + \alpha_4 \cdot xd_t + \alpha_5 (L) \cdot \Delta w_{t-1} \\ & + \lambda \cdot [s - \alpha_0 - \alpha_{31} \cdot z]_{t-1} + u_t, \end{aligned}$$

where u_t is a residual and $\alpha_5 (L)$ denote polynomials in the lag operator (L). These lag distributions reflect inertia in the adjustment of wages such as staggered contracts as well as expectations adjustments. The vector Z (and its growth rate Δz) incorporates the wedge between consumption and product wages, namely the price ratio $pc^e - p^e$. The exact definition of Z is relegated to the empirical section. In equilibrium, all growth rates and xd are zero. Then, equilibrium log labour's share s^* is the constant α_0 corrected for the wedge variables. Since S is actual labour's share, the error correction term is the log ratio of actual to equilibrium labour's share which drives wage growth. Finally, a candidate to replace xd, which is not observed, is the actual unemployment rate UR minus its equilibrium component, i.e. $UR - \overline{UR}$.

Eq. (6) displays already two different but not mutually exclusive hypotheses of wage formation, namely the pure Phillips curve model for $\lambda = 0$ and an extended version for $\lambda < 0$ which, in addition, determines the equilibrium value of W and of labour's share. Thus, it captures also the real wage bargaining model which is characterized by a wage adjustment in the direction of a target income share. However, an empirical discrimination between these approaches is difficult. The income share is an important variable also in Phillips-curve models, and, on the other hand, unemployment is a main determinant of union power and probably also influences the target income share. Eq. (6) can further be extended in order to test additional aspects of wage formation.

2. *Hysteresis, persistence, and outsider ineffectiveness:* Long-term unemployed persons may not exert a strong influence on wage determination, if any at all. This view rests on the hypothesis that long-term unemployed persons are imperfect candidates for filling vacancies. Their human capital and work attitudes may have deteriorated during their extended spell of unemployment.[7] To allow for this approach, the term $\alpha_4 \cdot xd_t$ in eq. (6) is substituted by:

$$-\alpha_{41} \cdot (UR_t - \overline{UR}_t) + \alpha_{42} \cdot (UR_t - URS_t). \tag{7}$$

If complete outsider ineffectiveness is present, this requires the restriction $\alpha_{41} = \alpha_{42}$, so that only the short-term unemployment rate URS matters. In equilibrium, URS equals $\overline{UR}$. If both groups of unemployed persons influence wage settlements equally, then $\alpha_{41} > 0$ and $\alpha_{42} = 0$. This represents the basic Phillips curve model as a special case. Intermediate cases are characterized by $\alpha_{41} > 0$, $\alpha_{42} > 0$ and $\alpha_{41} > \alpha_{42}$, so that the influence of short-term and long-term unemployment is $-\alpha_{41}$ and $-(\alpha_{41} - \alpha_{42})$, respectively.

Besides the ineffectiveness of long-term unemployment, a central variable in bargaining models, which captures elements of the insider/outsider-hypothesis, is lagged employment. This is an additional variable to $\alpha_4 \cdot xd$ in eq. (6) such as

$$-\alpha_{43} \cdot l_{t-1}, \tag{8}$$

where L is employment. The theoretical justification for the inclusion of this variable deserves some comments, however, since it usually differs from the institutional framework in Gemany. One possible justification for this variable is that it represents union membership in the firm (see, for example, *Nickell/Wadhwani* 1990). This is, in insider/outsider-models, the incumbent workforce who wants to remain employed in the future, too (see *Lindbeck/Snower* 1989). Hence, the greater the number of these people, the smaller the wage increase. However, in Germany union membership does

[7] See, for example, *Layard/Nickell/Jackman* 1991 for a more recent example of that view.

not play such an important role because wage settlements cover all workers of the sector regardless of their union membership status.

There is another theoretical justification for introducing lagged employment which does not rely on union membership and which captures, in principle, the flavour of the insider/outsider approach more directly. Assume that the determination of the bargaining outcome is based on a Nash "right to manage model", i.e. the union and the employers' confederation bargain over the wage rate, and afterwards firms decide unilaterally over employment. The union faces a certain probability of workers being laid off which lowers the utility of wage increases. Let π denote this probability and L^d optimal labour demand as discussed previously. Then

$$\pi_t = \text{prob}\,(L_t^d < L_{t-1}) \cdot \left[1 - \frac{E\,(L_t^d \mid L_t^d < L_{t-1})}{L_{t-1}} \right]. \tag{9}$$

The first r.h.s. term is the probability that optimal labour demand falls short of lagged employment. The ratio in brackets is the share of workers kept in the firm, hence, the second r.h.s. term denotes the share of workers being laid off. Extending the work by *Nickell/Wadhwani* 1990, after some calculations, π can be shown to be approximatively[8]

$$\pi_t = 1 - \frac{[E\,(L_t^d)^{\varrho} + (L_{t-1})^{\varrho}]^{1/\varrho}}{L_{t-1}} \qquad \text{with } \varrho < 0 \text{ and } \frac{\partial \pi_t}{\partial L_{t-1}} > 0. \tag{10}$$

Besides L_{t-1} an interesting parameter is ϱ which is related to the uncertainty of future output price shocks. This uncertainty is one of the driving forces for a model which contains insider forces. If there were no uncertainty, unions would set wages as to maintain employment. As L_{t-1} becomes greater so does π and the union's utility of wage increases is reduced. This explains why L_{t-1} enters eq. (6) with a negative influence.

Several hypotheses (including the insider/outsider-model) wind up with the conclusion that the equilibrium unemployment rate $\overline{UR}$ is path-dependent.[9] This can be tested within the framework of eq. (6). In its simplest form, $\overline{UR}$ responds with a lag to actual unemployment:

$$\overline{UR} = \alpha_{44} + \alpha_{45} \cdot UR_{t-1}, \tag{11}$$

where α_{44} is a constant which contains elements of $\overline{UR}$ other than lagged unemployment. Then, the term $UR - \overline{UR}$ in the Phillips curve can be replaced by

$$(UR - \overline{UR})_t = \Delta\, UR_t + (1 - \alpha_{45}) \cdot UR_{t-1} - \alpha_{44}. \tag{12}$$

[8] A derivation of this result is available on request.

[9] See *Blanchard/Summers* 1987 and *Franz* 1990 for a survey.

Full hysteresis requires α_{45} to be unity, whereas partial hysteresis ("persistence") is given by $0 < \alpha_{45} < 1$. Put differently, the test in eq. (6) is then whether

- only ΔUR has a significant influence (hysteresis),
- both, the level and the change of UR exhibit a significant impact (persistence),
- only $(UR - \overline{UR})$ is significant (neither hysteresis nor persistence, i.e., for $\alpha_{45} = 0$ and $\alpha_{44} = \overline{UR}$). This is the basic Phillips curve model again.

3. *Interindustry wage competition and wage flexibility:* Since the estimation of the wage equations is based on a sectoral level it allows us also to test to what extent an interindustry wage competition is present. Both, theoretical considerations and institutional regulations suggests that there may exist a tendency to equalize wage differentials between sectors. Starting with theory, in order to reduce the fluctuations expecially of qualified workers, in whose human capital the firms have invested, sectors will attempt to keep up with the other sectors' wage increases. This argument has been discussed in the literature for many years and has been put forward more recently by the efficiency wage theory (see e.g. *Schlicht* 1978). According to this theory, wages may be non market-clearing with excess supply of labour and related job rationing.[10] In addition, to decrease fluctuations, wages are used as a screening and incentive device for labour productivity. An obvious weekness of these type of models is that they do not give unions a profound role in the bargaining process (see *Lindbeck* 1991, 6). Hence, there is a question mark as to whether efficiency wages may account for the observed sectoral wage differentials. *Thaler* 1989 calls interindustry wage differentials a legitimate anomaly in the sense that they are difficult to rationalize or that implausible assumptions are necessary to explain them within a paradigm. Whatever the merits of theoretical explanations for interindustry wage differentials are, most if not all studies conclude that some industries do pay more per unit of labour quality than others. The purpose of our test is, then, to evaluate to what extent such interindustry wage differentials are equalized by interindustry wage competition.[11]

Another but related argument stems from institutional regulations in Germany with respect to the lapse of time in the negotiating processes. Wage bargaining in Germany during the past three decades took place in wage rounds, with the metal industry or the public sector opening the rounds at the beginning of the year.[12] To some extent, the followers take into account

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[10] See *Franz* 1991, pp. 300 - 309 for an overview of efficiency wage models.

[11] See also *Holmlund/Zetterberg* 1989.

[12] See the discussion by *Meyer* 1990a, b.

the bargaining outcome previously achieved. These considerations can be summarized by the term:

$$\lambda_1 \cdot (w_i - w)_{t-1}. \tag{13}$$

The index i refers to the sector, and interindustry wage competition is implied if $\lambda_1 < 0$.

A second aspect is the question of sectoral wage flexibility. A compressed wage structure sometimes was blamed for the structural imbalances in the German labour market as is claimed by the proponents of the view that wage rigidities are partly responsible for the persistence of unemployment. The argument rests on the hypothesis that, for example, the sectoral wage structure has become more inflexible thus creating a higher sectoral dispersion of unemployment. Therefore, an investigation into what extent wages are influenced by aggregate rather than by sectoral variables may be helpful for an assessment of this hypothesis. More specifically, the analysis concentrates on the question, whether θ or θ_i, p or p_i, and the aggregate unemployment rate or sectoral demand pressure variables have more power in explaining sectoral wage movements. In concreteness, this is firstly taken into account by the following two variants of sectoral real unit labour costs:

$$\lambda_2 \cdot (w_i - p_i - \theta_i)_{t-1}, \tag{14}$$

$$\lambda_3 \cdot (w_i - p - \theta)_{t-1}. \tag{15}$$

The first expression is obviously sectoral real unit labour costs, where all variables refer to the sector under consideration. The second variant relates sectoral wages to aggregate values of the output price and productivity and captures the effect of aggregate conditions on sectoral wages. There is a third interpretation of these terms together with the relative wage term mentioned above: if $\lambda_2 = -\lambda_3$ and $\lambda_1, \lambda_2 < 0$, the relative wage of the sector is determined by relative prices and relative productivities:

$$w_i - w = \frac{\lambda_2}{\lambda_1} \cdot [(p_i + \theta_i) - (p + \theta)]. \tag{16}$$

Moreover, sectoral labour demand is captured by (lagged) sectoral employment, overtime working, and short-time working. A higher labour demand requires that the sector pay higher wages, hence we expect a positively signed coefficient associated with employment. If significant, such a coefficient stands in contrast to the insider/outsider hypothesis discussed before. One should be careful, however, in drawing too far reaching conclusions. A positive coefficient would dismiss one aspect of the insider/outsider hypothesis, namely that wage moderation is more likely the greater the size of lagged employment. It would not dismiss the whole body of the insider/outsider theory. It can be argued that the other variables partly capture insider power, such as a significant positive influence of overtime working reflecting high labour utilization within the firm.[13] The theoretical framework of sectoral wage determination is therefore limited in its ability to test the validity of the insider/outsider approach.

4. *Wage compensation for working time reductions:* Finally, one major topic of this paper is an inquiry as to what extent the bargaining wage outcome is affected by the negotiated reduction in working time. As has been outlined in section 2, the two polar cases are that

a) hourly nominal wages remain constant ("without compensation"), or that

b) weekly or monthly incomes do not change ceteris paribus despite a reduced weekly working time ("full compensation").

One possible procedure to shed light on this question empirically is to enrich the wage questions developed so far by the following terms:

$$\alpha_6 \cdot \Delta h^T_{i,t} + \alpha_7 \cdot h^T_{i,t-1}, \tag{17}$$

where h^T_i stands for the negotiated weekly hours in sector i. "Without compensation" is implied by $\alpha_6 = \alpha_7 = 0$ as long as the dependent variable is expressed in terms of the *hourly* wage rate. On the other hand, significant parameters α_6, $\alpha_7 < 0$ would indicate that the unions did succeed in achieving some compensation for the income loss resulting from the negotiated reduction in working time, i.e., for $\Delta h^T_i < 0$.

3.2 Theoretical aspects of price formation

For price determination the same approach is applied as for the wage model above. A general price equation is developed which nests several theoretical aspects of price formation and allows to distinguish between them by parameter restrictions. It will be shown that there is a close correspondence between the structure of these models of price formation and those of wages. For example, the Phillips-curve model of wage formation has its counterpart in the mark-up theories of price determination. Moreover, it is an open question whether prices react to the level or only to the rate of change of excess demand, i.e. whether there is hysteresis in the price-setting process, and finally, for the sectoral price-setting, the argument for interindustry competition must only slightly be modified to capture interrelated price patterns in sectoral price behaviour, too.

[13] In addition, significant effects of sectoral prices and productivity can be attributed to insider power. See e.g. *Nickell/Wadhwani* 1990.

1a. Dynamic market model: The "pure' Phillips-curve approach of wage formation can be carried over to a dynamic market model of price behaviour. As a starting point, the "law of supply and demand" is applied, which "... asserts that price rises when demand exceeds supply and falls in the contrary case." (*Arrow* 1959, 43). This leads to the following equation for price formation:

$$\Delta p = c' \cdot xd' , \tag{18}$$

c' is a parameter determining the adjustment speed of prices, and xd' is the excess demand on the goods market. The apostrophe distinguishes the goods market from the labour market.

1b. Cost-oriented pricing: By inserting standard formulations for demand and supply functions into eq. (18), a second cornerstone of most empirical models of price behaviour can be developed. The mark-up pricing hypothesis extends the pure market model by cost considerations.[14] Rewriting the model in an error correction formulation, and adding additional lags of the endogenous variable to capture inertia in the price-setting process yields the following price equation:

$$\begin{aligned} \Delta p_t = {} & \beta_1 \cdot \Delta w_t + \beta_2 \cdot \Delta \theta_t + \beta_3 \cdot \Delta z_t' + \beta_4 \cdot xd_t' + \beta_5 (L) \cdot \Delta p_{t-1} \\ & + \lambda' \cdot [p - w + \theta - \beta_0 - \beta_{31} \cdot z']_{t-1} + u_t' . \end{aligned} \tag{19}$$

The vector z' includes cost components others than wage costs, and W / Θ are unit labour costs. The excess demand for goods can be approximated, for example, by the rate of capacity utilization Q. Equation (19) includes already two models of price-setting, i.e. the market model and cost-oriented pricing, and the relative importance of these theories can be seen from the relative importance of the estimated coefficients of the respective variables.

2. Hysteresis: Corresponding to the wage model, hysteresis may be present in the price setting process, too. Eq. (19) can be used to calculate an equilibrium rate of utilization of capital, (or the equilibrium relation between the mark-up and the rate of utilization), and it can be tested whether this rate is stable or path dependent. Replacing $\beta_4 \cdot xd_t'$ by

$$\beta_{41} \cdot \Delta q + \beta_{42} \cdot q_{t-1} , \tag{20}$$

allows a straightforward investigation of this issue. If only the change of the utilization rate has a significant effect on prices, there is hysteresis in the price-setting process, while the basic model is obtained for $\beta_{41} = \beta_{42} = \beta_4$.

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[14] For a complete theoretical model of dynamic mark-up pricing, where the mark-up depends on the excess demand, see e.g. *Maccini* 1981.

3. Aspects of sectoral price-setting: Interrelated price patterns can be justified by economic theory, and their analysis has received renewed attention for the microfoundations of sticky price behaviour.[15] The arguments can be put forward from the supply side as well as from the demand side. Prices depend on marginal costs, and the adjustment of prices to nominal disturbances depends on a complex structure of interdependent intermediate goods and input price decisions. Similar arguments stem from the demand side, where the demand for the firms' (or sectors') product depends on other prices as well. This may give rise to inertia in the price setting process. The adjustment of sectoral prices to the aggregate price level is the extension which will be tested here. The following term will be included in eq. (19)

$$\lambda_1' \cdot (p_i - p)_{t-1}, \tag{21}$$

and the significance of λ_1' would be consistent with these arguments.

Finally, it is investigated, to what extent sectoral prices are determined by sectoral wages, productivity and demand, and/or by aggregate values of these variables. This aspect addresses the question whether sectors can pass specific shocks on to prices (e.g. a disadvantagous wage bargaining result or a productivity shock), or must stick to aggregate conditions. For instance, it can be argued that firms justify price increases more easily in face of common (cost) shocks. These considerations can be tested by introducing the terms

$$\lambda_2' \cdot (p_i - w_i + \theta_i)_{t-1}, \tag{22}$$

$$\lambda_3' \cdot (p_i - w + \theta)_{t-1}, \tag{23}$$

into the price equation where the same interpretation of the coefficients as for the wage equation holds. The first term stands for the sectoral price-cost relation. The second term relates sectoral prices to aggregate unit labour costs. Together with the relative price term mentioned above, the model also includes the case that relative prices are determined by relative unit labour costs. Sectoral demand pressure indicators will be used in addition to the aggregate capital utilization in eq. (19).

4. Estimation results

This section is devoted to a discussion of the empirical results. The estimates are carried out for the aggregate economy, for industry, and for seven industry sectors for which consistent data are available. We have deliber-

[15] See *Okun* 1981 and *Blanchard* 1983, 1987.

ately excluded the public sector and the agricultural sector due to specific (institutional) regulations concerning wage and price determination. For example, the price equations discussed in the previous section do not make much sense to the extent that prices for agricultural products are set by regulations within the EC.

The estimations are based on quarterly data covering the time period 1970.1 to 1989.4, i.e. we have 80 observations. Sector and data definitions are contained in subsequent tables (table 4 and 5).

In order to distinguish between short-run and long-run influences, all equations are specified in an error correction version with up to three error correction terms and additional lags of the endogenous variable.

Table 4

Sector definitions

TOT:	whole economy
IND:	industry
CAR:	car industry
HM:	industry of hardware and metal goods
CH:	chemical products
MA:	machinery and equipment
EL:	electrical equipment
IS:	iron and steel
FOO:	food

Table 5

Data definitions

W:	gross hourly wages
P:	output price
Θ:	labour productivity per hour
UR:	unemployment rate
L:	employment
PC:	consumer price index
H^T:	negotiated weekly working time
H^o:	rate of overtime working
H^s:	rate of short-time working
Q:	utilization of capital, ifo institute
Y:	output
O:	level of order books
OR:	output ratio, deviations of output from trend output
PMR:	price of imported raw materials and intermediate goods

4.1 Wages

To begin with, *table 6* displays the empirical results for the wage equations. The basic reference is eq. (6) in section 3.1. This equation is extended in order to test alternative or modified aspects of wage formation according to the hypotheses 1. to 4. in section 3.1.

As a starting point, the results for the aggregate economy (TOT) are considered. The dependent variable is the growth rate of nominal hourly wages Δw. The inflation rate Δp and the rate of productivity growth $\Delta \theta$ enter the equation with a (weak) significant influence,[16] the coefficients of the negotiated working time h^T and the price wedge $pc - p$ are only poorly determined, but the unemployment rate displays a significant effect. As can be seen from the estimates, aggregate wage formation can be characterized by an augmented Phillips-curve model.[17]

Rather than elaborating extensively on each sectoral wage equation, we comment on similarities and differences.[18] In all but one sector we found interindustry wage competition, where the interindustry wage differentials seem to fade away ceteris paribus; the coefficient associated with $w_i - w$ is negative. In three sectors (industry, chemical products, iron and steel), all three error correction terms are (weakly) significant. As has been shown in the previous section, this is consistent with the view that in the long run $w_i - w$ is determined by deviations of sectoral output prices and productivity from its aggregate values. In the short run, own price and productivity developments contribute to the explanation of sectoral wage growth, too, in some but not all sectors. While this may point to some insider power – weakly supported by the coefficients of the overtime working and short time working variables, respectively – one aspect of the insider / outsider theory is not supported by the estimates: lagged employment is significant in one sector only, but with a positive rather than a negative coefficient, and lacks significance in the other sectors.

This finding is in line with those obtained by *Holmlund / Zetterberg* 1991. They conclude that they could not find evidence that wages are inversely

[16] The contemporaneous values of these variables are omitted to avoid a simultaneous equation bias. Lags of the endogenous variable are introduced if they are significant and until significant autocorrelation of the residuals was removed.

[17] Assuming values of the equilibrium labour share and the price ratio, a NAIRU can be calculated which depends both on the rate of productivity growth and on the "tolerable" rate of inflation. Possible shifts in the NAIRU have been taken into acount by dummy variables, however, the respective coefficients were not significant. A shift in the NAIRU is probable at the beginning of the seventies, but our estimation period starts in 1971. See e.g. *Franz / Gordon* 1993.

[18] For the sectors CAR, HM, MA, and ET a dummy variable is included to capture postponed wage negotiations (not reported). The dummy is 1 for 1974.1, – 1 for 1974.2, and 0 else.

Table 6

Wage equations

Dependent variable: Δw_i

	TOT	IND	CAR	HM	CH	MA	EL	IS	FOO
$(w_i - w)_{t-1}$		−0.097	−0.423	−0.475	−0.524	−0.639	−0.876	−0.431	−0.066
		(−2.1)	(−2.9)	(−1.7)	(−4.6)	(−2.8)	(−4.0)	(−2.5)	(−1.3)
$(w_i - p_i - \theta_i)_{t-1}$	−0.114	−0.066			−0.057			−0.068	
	(−1.9)	(−2.4)			(−2.3)			(−3.7)	
$(w_i - p - \theta)_{t-1}$		0.063			0.070			0.079	
		(1.3)			(1.9)			(1.8)	
UR_{t-1}	−0.342		−0.411	−0.489		−0.487	−0.379	−0.274	−0.147
	(−3.1)		(−5.0)	(−4.3)		(−6.1)	(−5.0)	(−1.9)	(−3.2)
$l_{i,t-1}$		0.250			0.119				
		(7.4)			(1.5)				
$(pc - p)_{t-1}$	0.101								
	(1.2)								
$\Delta p_{i,t-1}$	0.177 [1)]		0.249 [1)]	0.217		0.895	0.176 [1)]		0.169
	(1.3)		(3.1)	(1.1)		(3.6)	(1.7)		(2.7)
$\Delta \theta_{i,t-1}$	0.145 [1)]			0.077		0.03			
	(2.0)			(2.0)		(1.2)			
ΔUR_t				−0.944		−1.401	−0.589	−1.422	
				(−1.9)		(−2.9)	(−1.1)	(−2.2)	
$\Delta h^s_{i,t}$					−0.511				
					(−1.3)				
$\Delta h^o_{i,t}$			0.159						0.124
			(1.1)						(1.9)
$h^T_{i,t-1}$		−0.093	−0.214	−0.117		−0.281	−0.442		0.130
		(−0.7)	(−2.8)	(−1.6)		(−2.6)	(−4.5)		(1.1)
$\Delta h^T_{i,t}$	−0.777	−0.643	−0.396	−0.735		−0.811	−0.715		−0.507
	(−1.3)	(−1.7)	(−1.2)	(−3.5)		(−3.3)	(−3.2)		(−1.9)
$\Delta w_{i,t-1}$	−0.363	−0.588	−0.342	−0.185	0.003	−0.370	−0.188	0.006	−0.123
	(−3.0)	(−5.2)	(−3.5)	(−1.1)	(0.0)	(−2.7)	(−1.7)	(0.0)	(−1.1)
$\Delta w_{i,t-2}$	−0.251	−0.494	−0.367	−0.163	−0.326	−0.207	−0.238	−0.237	−0.089
	(−2.1)	(−4.7)	(−4.2)	(−1.3)	(−2.7)	(−2.1)	(−2.7)	(−2.2)	(−0.9)
$\Delta w_{i,t-3}$	−0.236	−0.413	−0.435	−0.170	0.001	−0.273	−0.381	−0.178	−0.004
	(−2.1)	(−4.1)	(−5.2)	(−1.7)	(0.0)	(−3.3)	(5.1)	(−1.6)	(−0.1)
$\Delta w_{i,t-4}$	0.545	−0.113		0.147	0.237				0.310
	(5.1)	(−1.2)		(1.6)	(2.8)				(3.2)
$\Delta w_{i,t-5}$	0.206								
	(1.9)								
SEE	0.0094	0.0060	0.0108	0.0084	0.0097	0.010	0.0094	0.0130	0.0042
BG(8)	11.4	14.8	9.3	7.2	13.5	10.4	10.0	4.7	9.1

Quarterly data from 1970.1 - 1989.4. t-values in parentheses. All equations include a constant and seasonal dummies. BG is the Breusch/Godfrey test of autocorrelation of the residuals. The reported value is χ^2-distributed with 8 degrees of freedom. (The 5 percent significance level is 15.5.)

1) annual differences.

related to the size of the incumbent work force because lagged employment does not significantly enter any wage equation with a negative sign (p. 1028). The importance of this insider-based hysteresis effect is mixed in the study by *Nickell/Wadhwani* 1990. While these effects do appear as correctly signed in some equations, the results are not robust (p. 507).

In most sectors, the unemployment rate enters with a highly significant effect. In four (three) sectors, both the level and the first difference of the unemployment rate exhibits a (significant) influence. As has been discussed in the previous section, this is in accordance with the view that the equilibrium rate of unemployment is path dependent in the sense that persistence exists. If $\Delta\ UR$ is (weakly) significant, so is UR. Hence, the hypothesis of full hysteresis can be rejected. Moreover, the hypothesis of outsider ineffectiveness was tested by introducing, in addition, the short-term unemployment rate. In no version, however, was a significant coefficient obtained. It can therefore be concluded that the Phillips-curve/real wage bargaining model gives an appropriate characterization also for the sectoral wage formation. The estimates suggest that this model should be augmented by a variable which captures the tendency to equalize wages among sectors.

A central aspect of the estimates is the question as to what extent workers are compensated for reductions in weekly worked hours. The negotiated hours variables h^T are significant in the long run in three sectors. This means that in these sectors (car industry, machinery and equipment, electrical equipment) workers did in fact succeed in achieving some compensation for the income loss resulting from the negotiated reduction in working time. In the chemical industry, a reduction in the working time came in effect only in 1989, and the working time variables were insignificant. In the food industry, working time reductions took place only in the seventies (from 44 to 40 hours per week), and in the iron and steel industry there seems to be no wage compensation at all.[19] In the other sectors, the coefficients are weakly significant, and it can be concluded that the workers have achieved at least "some compensation" for the reduction in the working time.

4.2 Prices

The dependent variable of the price equation is the quarterly inflation rate $\Delta\ p$ and the basic reference is eq. (19) which is enlarged to test the additional aspects outlined above. The estimation results in *table* 7 show some marked similarities compared with the wage equations.

[19] When interpreting this result, one should have in mind the wage freeze associated with the first reduction in the working time in this sector. See table 3 above.

Table 7

Price equations

Dependent variable: Δp_i

	TOT	IND	CAR	HM	CH	MA	EL	IS	FOO
$(p_i - p)_{t-1}$		-0.118 (-1.8)	-0.097 (-3.2)	-0.108 (-3.1)	-0.094 (-1.4)	-0.038 (-3.2)	-0.044 (-1.5)	-0.149 (-1.9)	-0.046 (-2.1)
$(p_i - w_i + \theta_i)_{t-1}$	-0.108 (-4.5)	-0.059 (-3.4)	-0.033 (-1.0)	-0.063 (-1.8)			-0.020 (-1.5)		-0.155 (-5.1)
$(p_i - w + \theta)_{t-1}$			0.035 (1.5)	0.102 (2.0)					
q_{t-1}	0.093 (4.1)	0.033 (1.3)	0.041 (1.7)	0.045 (2.3)	0.086 (2.2)	0.039 (3.0)	0.031 (1.8)		
$(y_i - y)_{t-1}$								0.064 (1.8)	
$(pmr - p)_{t-1}$	0.009 (2.7)	0.021 (2.4)			0.021 (3.1)				0.016 (3.4)
$\Delta w_{i,t-1}$			0.086 (1.2)		0.182[1)] (3.2)				
$\Delta(pmr - p)_t$				0.033 (3.9)	0.112 (5.3)		0.016 (1.9)	0.086 (2.5)	0.017 (1.3)
$\Delta(pmr - p)_{t-1}$		0.062 (3.6)	0.018 (1.4)		0.053 (1.9)	0.029 (4.1)	0.031 (3.6)		
$\Delta(y_i - y)_t$					0.108 (3.2)			0.184 (4.8)	
$\Delta(y_i - y)_{t-1}$								0.089 (2.0)	
$\Delta(o_i - o)_t$				0.015 (1.3)					
$\Delta p_{i,t-1}$	-0.334 (-3.3)	0.287 (1.9)	-0.088 (-0.7)	0.274 (2.7)	0.545 (4.9)	0.192 (1.7)	0.109 (1.0)	0.432 (3.8)	0.023 (0.2)
$\Delta p_{i,t-2}$	-0.104 (-1.0)	-0.066 (-0.5)	-0.050 (-0.5)	-0.024 (-0.2)	-0.206 (1.8)	-0.124 (-1.1)	-0.070 (-0.7)	0.006 (0.1)	0.116 (1.1)
$\Delta p_{i,t-3}$	-0.112 (-1.1)	0.142 (1.4)	0.121 (1.2)	-0.040 (-0.4)	0.089 (0.8)	0.413 (3.8)	0.140 (1.3)	0.030 (0.3)	0.034 (0.3)
$\Delta p_{i,t-4}$	0.373 (3.8)		0.131 (1.2)	0.367 (3.8)	-0.100 (-1.2)	0.182 (1.8)	0.304 (2.7)	-0.258 (-2.4)	-0.202 (-1.9)
$\Delta p_{i,t-5}$						0.111 (1.1)		0.158 (1.6)	
$\Delta p_{i,t-6}$						-0.215 (-2.3)			
$\Delta p_{i,t-7}$						-0.122 (-1.4)			
SEE	0.0060	0.0064	0.0071	0.0049	0.0010	0.0040	0.0042	0.0202	0.0074
BG(8)	8.3	11.2	14.4	11.1	10.9	10.9	8.8	10.7	5.0

Quarterly data from 1970.1 - 1989.4. t-values in parentheses. All equations include a constant and seasonal dummies. BG is the Breusch/Godfrey test of autocorrelation of the residuals.

1) annual differences.

Aggregate price setting can be appropriately described by the mark-up pricing hypothesis, where the mark-up depends on demand pressure. In the long run, prices are determined by unit labour costs $w - \theta$ and by the costs of imported raw materials and intermediate goods pmr. The mark-up depends on the capital utilization rate which is our preferred indicator for demand pressure, and the long-run solution is significantly determined. Together with the aggregate wage equation, this price equation can be used to determine the equilibrium relation between the unemployment rate and the rate of capital utilization according to the procedure outlined by *Sneessens / Drèze* 1986. This equilibrium requires equal wage income shares in the wage and price equation and depends on relative import prices (i.e. the relative consumption goods deflator in the wage equation and the relative price of imported inputs in the price equation), the tolerable inflation rate, and on the rate of productivity growth. In contrast to Okun's law, this relation exhibits a positive slope between the unemployment rate and the rate of capital utilization. Our estimates imply that the inflationary pressure stemming from, for instance, a one percent lower unemployment rate has to be offset by an about three percent lower utilization rate of capital.

In the sectoral price equations, the capital utilization rate is also an important variable. It enters the price equation in most sectors. However, the effect is less determined than the effect of the aggregate unemployment rate on wages. This accentuates the importance of price rigidities compared with wage rigidities which is evident in the (weakly) procyclical real wage development. However, it is always the level rather than the change of the utilization rate which influences prices, therefore the hypothesis of hysteresis can be rejected. Sectoral demand pressure variables are modelled by the relative sector output and the relative level of the order books. These variables play a significant role in only two sectors (chemistry and iron and steel) which points out that the price setting is more oriented towards aggregate demand conditions. In the food industry no effects from demand on prices were found.

Finally, the effects of the error correction terms are discussed. The relative price variable enters all sectoral price equations and is significant in most sectors. This underlines the importance of interrelated price patterns. In two sectors (car industry and the industry of hardware and metal goods), all three error correction terms play a (weakly) significant role; the respective coefficients imply a long run relation between relative prices and relative unit labour costs. In two sectors (electrical equipment and food industry) and for the whole industry, only the sectoral real unit labour costs and the relative prices determine the long-run equilibrium.

These results, together with the significant effects of the relative import price, highlight that mark-up pricing is an appropriate hypothesis also for the sectoral price setting. Prices are determined by wage costs and the costs of other inputs. The mark-up factor depends significantly on demand pressure in most cases. While price setting is clearly related to other prices, the relative price term may also capture parts of input costs.

5. Conclusion

The primary theme of this paper is a unified framework of sectoral wage and price determination. More specifically, two aspects are dealt with. Firstly, the theoretical framework is formulated in an extended way which nests several but not mutually exclusive hypotheses of wage and price formation, respectively. It includes hypotheses such as dynamic market approaches, elements of insider/outsider considerations, hysteresis phenomena, and sectoral wage and price competition. Since the empirical results have been discussed in more detail in the previous section, the following common findings emerge from our study:

(i) An augmented Phillips-curve wage model and the mark-up pricing hypothesis are useful concepts for the aggregate and the sectoral wage and price setting, respectively.

(ii) Sectoral wages and prices do not simply have a life of their own, but are influenced by their aggregate counterparts and by other aggregate variables such as the unemployment rate and the rate of capital utilization.

(iii) The case of strong hysteresis can be rejected in favour of persistence.

(iv) One aspect of the insider/outsider model is not consistent with the estimates, namely that a high previous employment level leads to wage moderation. Moreover, other variables which are designed to proxy insider power wind up as less significant variables.

(v) Workers were, by and large, only partly compensated for the shortened work week.

There are, of course, several caveats concerning our results. Most importantly, sectoral wage and price changes may also be the result of intra-sectoral quality changes of labour and goods, respectively. Indeed, as *Bound/Johnson* 1992 have shown for the U.S., a principal reason for the development of wage differentials is a skilled-labour-biased technical change and changes in unmeasured labour quality. It remains an open question to what extent this holds for our sectoral wage equations and can be carried over to sectoral price equations.

Zusammenfassung

Der vorliegende Beitrag beschäftigt sich mit der theoretischen und ökonometrischen Analyse von sektoralen Lohn- und Preisfunktionen. Dazu wird ein einheitlicher Analyserahmen entwickelt, welcher es erlaubt, unterschiedliche Hypothesen der Lohn- und Preisbestimmung durch Parameter-Restriktionen zu testen. Als Ergebnis ergibt sich zunächst, daß das erweiterte Phillipskurven-Modell und die Hypothese einer Zuschlagskalkulation brauchbare Konzepte sowohl für die aggregierten wie auch die sektoralen Lohn- und Preisfunktionen darstellen. Sektorale Löhne und Preise werden neben sektorspezifischen Variablen auch von aggregierten Größen beeinflußt, wie zum Beispiel von der Arbeitslosenquote und dem Kapazitätsauslastungsgrad. Hysterese im strengen Sinn kann verworfen werden, stattdessen scheint Persistenz von Arbeitslosigkeit eher mit den Daten konsistent zu sein. Schließlich lassen die empirischen Resultate darauf schließen, daß die insbesondere in den achtziger Jahren vorgenommene Arbeitszeitverkürzung nur mit einem teilweisen Lohnausgleich einherging.

Summary

The topic of this paper is a unified framework of sectoral wage and price determination. The theoretical framework is formulated in an extended way which nests several but not mutually exclusive hypotheses of wage and price formation respectively. As a result, an augmented Phillips curve wage model and the mark up price hypothesis are useful concepts for the aggregate and the sectoral wage and price setting. Sectoral wages are influenced by aggregate variables such as the unemployment rate and the rate of capital utilization. The case of strong hysteresis can be rejected in favor of persistence. Finally, workers were, by and large, only partly compensated for the shortened work week.

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