Wages in the German Manufacturing Industry

An empirical investigation

Jørn Handal

January 2007

Department of Economics
University of Oslo
Preface

The main objective with this thesis has been to deepen my understanding of how the German labour market is working. As wage is one of the factors that is pointed at for being a reason for the high unemployment rates, I wanted to examine more closely how wages are determined in the country. Trying to fully explain wage outcomes and especially unemployment levels is to say the least a huge task, something that surely would require more than five months of work. The purpose is therefore to shed light on some of the most relevant aspects.

I also wanted to come up with some hard facts regarding how wages in the German industry sector have developed in the period from 1970 to 2004. In doing so I have made use of time series econometrics. And even though I have reached some viable conclusions, I recognize that I have a lot more to learn within this field.

When now having finished my master thesis, a number of people deserve my gratitude. First and foremost my supervisor Roger Bjørnstad, at Statistics Norway, for skilled guidance and helpful comments. My father, Olav Handal, for corrections and suggestions with respect to the language. Andreas Fagereng, fellow student in economics, for valuable comments on the empirical analysis. And finally, of course, friends and family for showing interest and listening to all my ups and downs during the work.

Oslo 29/1-07

Jørn Handal
CONTENTS

1 INTRODUCTION........................................................................................................................................ 1

2 THE GERMAN LABOUR MARKET........................................................................................................... 4
   2.1 The wage bargaining structure ............................................................................................................. 4
   2.2 The major labour institutions ............................................................................................................... 4
   2.3 Tendencies and future of the German wage bargaining system ...................................................... 6

3 THEORIES EXPLAINING WAGE LEVELS ............................................................................................ 8
   3.1 The hump-shaped relation between real wages and unemployment ................................................. 8
      3.1.2 Corporatism .................................................................................................................................. 9
      3.1.3 The theory behind ....................................................................................................................... 9
      3.1.4 Fiscal externalities ....................................................................................................................... 10
      3.1.5 Increased globalisation ............................................................................................................... 10
      3.1.5 The hump-shape and the time after 1988 .................................................................................. 11
   3.2 Alternative views ............................................................................................................................... 11
   3.3 The Insider-Outsider theory .............................................................................................................. 12
   3.4 Bargaining between the representative firm and union .................................................................... 13
      3.4.2 Degree of centralization ............................................................................................................ 14
      3.4.3 The concept of staggering wages ............................................................................................. 15
   3.5 A macroeconomic perspective on wage levels .................................................................................. 15
   3.6 The wage wedge ............................................................................................................................... 18

4 EMPIRICAL ANALYSIS .......................................................................................................................... 20
   4.1 VAR systems ...................................................................................................................................... 20
      4.1.2 Integrated variables I(1) ............................................................................................................. 21
      4.1.3 Systems with cointegrated variables ......................................................................................... 22
      4.1.4 Including exogenous variables ................................................................................................. 22
   4.2 Data .................................................................................................................................................. 23
   4.3 The model ......................................................................................................................................... 26
      4.3.2 Integration properties of the series ............................................................................................ 27
      4.3.3 Determining the lag order ......................................................................................................... 28
      4.3.4 Choice of cointegrating rank ................................................................................................... 29
      4.3.5 Estimation of the vector error correction model (VECM) ......................................................... 30
      4.3.6 Single equation estimation ....................................................................................................... 32
      4.3.7 Estimation results ....................................................................................................................... 33

CONCLUDING REMARKS ......................................................................................................................... 35

REFERENCES: ........................................................................................................................................... 36

APPENDIX.................................................................................................................................................. 38
   A.1: Data sources ................................................................................................................................... 38
A.2: Variables used in the analysis ........................................................................................................ 39
A.3: Integration properties ...................................................................................................................... 40
A.4: Information criteria ........................................................................................................................... 41
A.5: Diagnostic tests on equation (9) on level form ................................................................................. 41
1 Introduction
Since the mid seventies, with raising unemployment rates, labour market policies have been on top of the agenda in almost every political election in Germany. As excessive wage growth is assumed to be one of the factors explaining unemployment, a major issue of dispute has been whether something should be done in the way wages are determined. The most recent active step towards creating more jobs is the so called 'Kombilohn' reform. Heavily criticized by many of the leading economists in the country for being too costly, this reform tries to provide incentives for companies to hire formerly unemployed persons by a subsidy that in principle should equal the difference between the new employees` productivity and his reservation wage.

As in the rest of the world nowadays is also the German economy performing very well. Big companies can report large surpluses and for the first time in over three years did the unemployment rate drop below 10 per cent in October 2006. This has made the trade unions to demand their share of the cake, and as a consequence, moderate wage growth does now not longer seem like the most likely outcome in the upcoming wage negotiations. That the employees deserve a wage increase in line with the growth in productivity is also something supported by the trade unions’ main ally on the political arena, the Social Democratic party (SPD), which together with the two conservative parties, CDU and CSU, forms the government. Another debated issue, which has caused some controversies within the government, has been whether a minimum wage should be regulated by law. Not surprisingly, SPD is in favour of such an arrangement.

This thesis does not try to investigate the success of specific political measures with respect to the operating of the labour market in Germany, nor does it try to give a final answer as to why the country has been struggling with high unemployment rates. Its main objective is to look at what can be the main forces in determining wage levels. Is a flexible labour market, giving individual firms large scope for single-handedly setting wages in response to various economic conditions, always favourable compared with more centralized bargaining systems? Would for instance more employment protection lead to higher wages with the most likely consequence being higher unemployment? A commonly held view among many in Germany is that the trade unions only care about the welfare of their relatively few members, a kind of insider behaviour, a central question in the empirical section is whether this is true. Moreover,
the German economy is said to be very open with a large exporting sector. Usually this leads to the assumption that companies within the country have little market power and behave in more or less a ‘price taking’ manner. This is a question that the empirical section seeks an answer on.

The thesis is organized as follows. Section 1 gives a brief introduction to the German labour market. Attention is primarily paid to the major institutions and the way wage negotiations are conducted, in addition to tendencies observed during the last decade. Section 2 presents some selected theories for explaining wage levels. A highly debated theory in the economic literature has been Calmfors and Driffills (1988) hump-shaped relation between degree of centralization in wage negotiations and wage levels. Their main line of argument is on the internalization of externalities and market power. The most important reason why economies perform better than others is the way wage negotiations take place according to them. While wage negotiators at the intermediate industry level neglect the consequences of their action on the aggregate level, this no longer holds when say one bargaining cover all workers in the country. Here the employees’ union will recognize that a wage increase would only lead to higher prices and higher unemployment as firms become less profitable. In the completely decentralised level the firm has less market power, something that most likely cause workers to demand more moderate wage increases in fear of losing their jobs. A popular theory for explaining wage levels and thereby the occurrence and persistence of unemployment has been the insider-outsider model. A brief presentation of this theory is provided in section 2.¹

The last section consists of the empirical analysis.² A three dimensional cointegrated VAR-system (VECM) is estimated with nominal wages, producer prices and gross value added output per hour as the endogenous variables. The focus in this section is if the data support the notion of a constant wage share (nominal wages divided by gross value added product in current prices), and whether producer prices and productivity can be treated as weakly exogenous, implying that they are decided outside the system of interest. Since the German economy is characterized to be very open with a large exporting sector, one would, a priori, assume that the analysis should confirm that these two variables can be treated as weakly exogenous. Also searched for is the effect of unemployment. Has more unemployment been

¹ For a more thorough exposition see for instance Franz (2005).
² The software program used in the analysis is PcGive 10.0. Data can be sent on request. E-mail: jornhan@student.sv.uio.no
followed by more moderate wage growth, or is it true, as some claim, that the unions have demanded wages that more reflect the profitability in the industry than the interest of the outsiders?
2 The German labour market

This section seeks to give a brief overview of the way wage negotiations are being conducted in Germany. The main focus is on unions of employees and federation of employers.

2.1 The wage bargaining structure

The wage bargaining system in Germany is a complex structure that involves many parties each representing often conflicting interests. As in the Scandinavian countries there are large and powerful confederations of employers and unions of employees. A core element of the wage negotiations is the principle of wage bargaining autonomy (Franz 2005). A principle that is also manifested in the constitution (which makes it harder to change than ordinary laws). This means that the bargaining parties are free to negotiate a minimum wage without any government intervention. Not everyone can be a party to a wage bargaining, and also this is regulated by law, although not in the constitution (‘Tarifvertragsgesetz’). These laws do among other things, only allow for strikes and lockouts when the wage agreement has expired (‘Friedenspflicht’).

Only unions that are independent of any party and freely formed have a right to participate in a minimum wage agreement. One employee alone, for instance, can not be a party to such a settlement. Regarding the binding nature of the wage agreements, a firm that leaves a confederation is still obliged to pay the minimum wage as long as the contract says so and an employee that becomes a member of a union has equal rights with regard to wage as those who are already members. When it comes to the content of the settlements it should be noted that they do not only regulate minimum wage, but also issues concerning the work environment, days of holiday and education. In 2004 only 33% and 28 % of the settlements in the West- and East- German states dealt with wage (Franz 2005).

2.2 The major labour institutions

DGB (“Deutscher Gewerkschaftsbund”) is the organization that organizes the different unions. This organization can perhaps be compared with the Norwegian LO, but differs in a very important aspect, namely that it does not participate in any negotiations. Its most
important tasks are to make coordination between the 13 main unions (Industriegewerkschaft IG) easier and to represent their interests in the media. Every attempt to strengthen its position during the last years has failed, primarily because of resistance from its members, who also constitute its financial basis.

Analog to DGB is BDA ("Bundesvereinigung der Deutschen Arbeitgeber") the umbrella organization that consists of various employers `confederations each coming from a specific region or sector/branch (a firm itself cannot be member but only together with other firms). Represented here is the private sector such as banks, industry and insurance companies among others. Employers in the public sector in addition to iron and steel workers, are not members.

The many tariff-agreements (4688 new ones for West-Germany and 1412 new ones for East Germany in 2004) in Germany are often explained by the fact that unions of employees and confederations of employers are organized in regions and at sector/branch levels. A union that organizes the workers in a specific part of Germany will not participate in any nation wide bargaining, but together with the employers in either an enterprise (‘Firmentarifvertrag’) or a confederation of firms negotiate (‘Flächentarifvertrag’) on the minimum wage for the region or enterprise it concerns.

When it comes to coordination the German wage system has a kind of wage leading sector in the way that the workers in the metal industry, primarily in Nordwürttemberg/Nordbaden, where successful companies such as Porsche and Daimler-Chrysler are situated, first negotiate a wage that forms the basis for later wage negotiations in the rest of the country (Ochel 2005).

To which degree there can be said to be a wage leading sector in Germany in the sense that minimum wages agreed on here decide the wage outcome in other sectors/regions in Germany has been examined by Wolfgang Meyer for the period 1962-1983 (see Franz 2005). He comes to the conclusion that only in few cases has the growth in minimum wages determined in the wage leading sector, been important for explaining the overall growth in minimum wages. Moreover, is the expected inflation rate and conditions on the labour market the most important determinants. However in the period 1975-1983 did the role of the wage leading sector seemingly become more important as it had significant impact on the outcome of about 50% of subsequent negotiations.(included 23.jan)
Laws regulating wage contracts and how the unions are organized, lead to restrictions for individual firms. The fact that workers who are not a party in a wage bargaining in Germany do not have the right to a minimum wage has in reality no effect. One reason for this is that in almost every contract, the wage reached in tariff agreements for similar jobs are used. Another reason is that the minister of labour in each state can declare that everyone in a specific sector/region should be guaranteed the minimum wage reached in the wage settlements (‘Allgemeinverbindlicherklärung’). This is done when a council consisting of both parties, has given its approval of it.

2.3 Tendencies and future of the German wage bargaining system
During the last years has the number of broad wage settlements (more than one company) decreased in Germany. According to data from the IAB-datapanel\(^3\) was 72% of the workforce in West-Germany covered by broad branch/region wage agreement in 1996, while the number was down by 10% to 62% in 2003. For the former DDR-states the coverage decreased from 56% in 1996 to 43% in 2003. The share of firms covered by these negotiations was somewhat smaller, indicating that larger companies are more likely to be covered by broad agreements.

Several factors may have contributed to this development the last years and Ochel (2005) highlights many of them. One important source is likely to be the increased globalization that has happened the last couple of decades. For firms competing in world markets this means increased competition and as a consequence a demand for a more flexible wage system. Broad wage settlements are now to a larger extent not able to reflect the interest of individual firms as they once were. Maybe as a result it has been observed that firms have left employers associations or not joined them in the first place, in order to avoid area wide wage arrangements. A more diversified labour force may also have contributed to this. And even though the wage agreements in the short run may seem good, what matters is the long run and how the demand will look like in the future. Also emphasized is the fact that the numbers of people actually being members of a union have gone down. The table below shows the development in the number of union members in percent. Here this is calculated by dividing people in the union who actually have a job, by the total workforce.

\(^3\) See Ochel (2005)
Table 1: Union density

<table>
<thead>
<tr>
<th></th>
<th>Former BRD-states</th>
<th>Former DDR-states</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>32.7</td>
<td>28.7</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>39.6</td>
<td>36.0</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>20.3</td>
<td>18.5</td>
</tr>
</tbody>
</table>

As one can see the numbers have clearly gone down. This is something that is not unique for Germany, but has been observed for most West-European countries.

What Ochel calls the inner erosion has also contributed to the reduced importance of the broad wage settlements. According to the law regulating tariff agreements, can a wage under the negotiated minimum only come about when it either clearly benefits the employees, or when it is actually agreed upon in the agreement that changes during the period is allowed, so called ‘opt-clauses’, something that has since the middle of the 90’s played an increasingly important role. These ‘opt-clauses’ make it possible for firms to deviate from the minimum wage as long as both parties have given their approval. The regulations are somewhat less restrictive for individual enterprises, giving small units a larger scope for deviating from minimum wage, in case of solvency problems for instance (Ochel 2005). According to a survey by WSI (Wirtschafts- und Sozialwissenschaftlichen Instituts in der Hans-Böckler-Stiftung, see Ochel 2005) did 22% in 1999/2000 and 35% in 2002 of firms make use of ‘opt-clauses’. In addition to this it has been observed that wages under the negotiated minimum have been paid without any formal acceptance from all parties. Research done by Bahnmüller (2005) shows that of the managers and boards he asked, did 10% said that they had broken with the wage agreement to a considerable extent, 37% admitted a breach but considered this to be unimportant while 50% strictly obeyed the agreements.

---

4 Source: Franz (2005)
3 Theories explaining wage levels

This section presents some selected theories for explaining wage levels. The main focus is on degree of centralization in wage negotiations and how that is likely to affect the bargaining outcome. It will be shown is that also looking at what happens at the micro level is important in explaining feasible wages.

3.1 The hump-shaped relation between real wages and unemployment

Calmfors and Driffill (1988) published an article that has since then become a heavily discussed in the economic literature. Their main hypothesis was that there exists a hump-shaped (see figure 1) relation between how centralized wage settlements are and real wages. Since employment is expected to depend negatively on the level of real wages, it therefore also implied a hump-shaped relation between the unemployment rate and the degree of centralisation. Problems arise of course with regard to the term centralization, and researchers have opposing view as to what one should emphasize when measuring it (see for instance Kenworthy 2001). The ranking that Calmfors and Driffill came up with is based more on behavioural patterns than formal institutions and norms in wage negotiations. Franz (2005), for instance, claims that it pays too little attention to the political regime. Especially he points to the time when a social democratic government came to power in Germany at the beginning of the 70’s, something which allegedly partly explained the major wage increases observed during that period. Degree of coordination between various parties may therefore be a more proper term. Calmfors and Driffill however define centralization as the extent of inter-union and inter-employer cooperation in wage bargaining with the other side (p.17).

**Figure 1:** Relationship between degree of centralization and real wages according to Calmfors and Driffill.
Empirical support for their hypothesis is found by looking at how countries with different degree of centralization perform with regard to some selected macroeconomic indicators. The conclusion they draw naturally depends on whether they have classified the countries in the right way. It is for instance shown that including Switzerland gives weaker results.

3.1.2 Corporatism

A concept termed corporatism has received much attention in earlier research on the wage theory area, and was seen as one of the main explanations for real wage rigidity. The problem with this concept is that there exist many definitions and opinions of it. It is therefore hard to measure the real impact such a concept. One definition is for instance ‘cases in which a centrally coordinated union movement has developed within a political system responsive to labour demand’ (p.24, Crouch 1985). The main belief was that more corporatism always works in favour of lower real wages and unemployment. As pointed out by Calmfors and Driffill whether there is a clear link between centralization and corporatism is not clear and a ranking of countries based on the two concepts could therefore differ.

3.1.3 The theory behind

The theory developed by Calmfors and Driffill tries to explain why there seems to be a hump-shaped relation between real wages and centralization. And a similar model that confirms their main results is provided by for instance Moene et al (1991). The model Calmfors and Driffill use consists of 64 separate industries each producing two to some extent substitutable products (actually the article shows how the degree of elasticity of substitution affects the results). With fixed capital stock and an entirely symmetric economy the world looks exactly the same for each firm, sector and union. In equilibrium, wages, prices and the value of output will therefore be the same in all sectors and firms. The economy can now in the most decentralized case consist of 64 unions and therefore 64 separate wage negotiations. At the next stages we would have 32, 16, 8 and so on until we reach the completely centralized case where the wage is decided in only one settlement.

5 See Calmfors and Driffill (1988)
When first considering the monopoly-union outcome, the case where the unions unilaterally decides wages with the firms adjusting labour input, the logic behind the hump-shape is provided. For a complete analysis of monopoly-union bargaining, see for instance Franz (2005). The fully decentralized and the completely centralized case are seen to outperform the intermediate case in terms of real wages. The intuition behind is that while medium sized unions have larger possibilities to push up wages without affecting the overall price level this no longer holds when large unions dominate the wage negotiations. A wage increase here would only, ceteris paribus, lead to higher prices and therefore unchanged real wages. In the completely decentralized case can a wage increase not lead to higher prices because the competition is assumed to be intense and higher wages would therefore have to be met by layoffs. So we have two effects working in opposite directions, namely market power and the effects of wages on prices.

The bargaining case, the situation where firms also bargain over wages, should according to Calmfors and Driffill lead to the same conclusions. The reason for this is that the unions also here take into account the consequences of its actions on the economy.

3.1.4 Fiscal externalities
The fact that participants of wage settlements also have to contribute to unemployment benefits to those without jobs is also likely to lead to more moderate wage claims in the completely unionized case. This happens because higher wages means less profitable businesses and therefore more unemployment. With more people receiving unemployment benefits this must be financed by higher taxes, which are paid by no one else than the employees.

3.1.5 Increased globalisation
Critics have claimed that the model will loose its power as the world becomes more competitive and globalised. In an open economy one normally assumes that the price level is given and unaffected by conditions within a country. Also Calmfors and Driffill mention this
in their analysis, but claims that in a more realistic setting, one where the economy consists of a large non-tradable sector the basic results still hold.

3.1.5 The hump-shape and the time after 1988

After the hump-shape hypothesis was published in 1988 much has happened, but it seems like many of the same trends in Europe have been persistent. The Scandinavian countries, which were, in addition to Austria, categorized as being the most centralized, are still outperforming countries with medium centralized bargaining systems with respect to most macroeconomic indicators. But as other and newer empirical studies fail to confirm the superiority of especially the decentralized compared to industry level bargaining, the hump-shape hypothesis stands on weak grounds (see OECD 1997, Soskice1990, Gurtzgen2003).

3.2 Alternative views

According to among others Gürtzgen (2003) is the fact that workers can be organized in separate craft-unions with members working in different industries or sectors highly relevant in explaining the wage levels. The hump-shaped model did as we remember not take into account such conditions explicitly, often termed horizontal relations in the literature, as each industry dealt with only one wage settlement. But as suggested this point together with the wage bargaining regime are likely to affect the wage outcome. The question then is how a system in which wages are bargained along craft lines as in the U.K. performs in comparison to industry-level and national-level bargaining.

Gürtzgen (2003) shows that within a model with two firms and two types of workers the wage outcome of the four possible bargaining scenarios depends on whether the products produced are complements or substitutes in demand. The unions utility functions are assumed to be on the following form (where \( w_{ik} \) is the wage level for the worker-type \( i \) in firm \( k \)):

\[
U^{ik} = U^{ik}(w_{11}, w_{21}, w_{12}, w_{22}), i, k = 1, 2
\]
By investigating the first order condition it is found that when assuming the workers are complements in production (both have skills that are necessary for the production, implying that increased demand for one of them leads to higher demand for the other) the cooperation between two types of workers within a firm leads to lower wages than in the completely decentralized case. A consequence of the fact that unions in the industry level case is internalising the employment effects of a wage increase for both workers. This result holds regardless whether the products produced are substitutes or complements.

Regarding the performance of the industry level bargaining in comparison to two other levels, namely the centralised and the craft-union case, Gürtzgen finds that the outcome depends on demand characteristics. Specifically she finds that when the products are substitutes, industry level bargaining leads to lower wages than in both the centralized and the craft-union case. This happens because the industry union here internalizes the negative effect on the product demand a wage increase has, while the craft-union on the other hand would internalize the positive demand spill-over effects a wage increase has for the two workers (both firms rise prices in response of a wage increase). With products being complements it is shown that completely centralised bargaining performs better than both craft specific and industry level bargaining, but with no clear conclusion as to which one of these last two regimes giving the lowest wage outcome.

3.3 The Insider-Outsider theory

The insider-outsider model tries to explain wage levels and thereby persistence of unemployment by human-capital and layoff costs. As firms employ new persons there are certain costs associated with teaching them the required skills so that they can become productive. Some of these skills can be general and can be made useful in more than one firm while others may be more firm-specific as for instance the acquisition of unique production techniques. Common for both of these is that they increase the value the worker has for the firm Franz (2005).

Also adding to the human capital component are the costs of firing people. These occur when laws and contracts regulate the way layoffs should be conducted. With these two factors in
mind will employees, according to the insider-outsider hypothesis, push up-wages above the market clearing level up to the point where their own jobs are at risk. In other words, there may well be excess supply of labour at the prevailing wage, but because of costs related to finding and teaching new workers the required skills in addition to legal regulations, are the insiders likely to demand wages over the market clearing level. The unemployment rate then has no effect (pure insider) since it is assumed that the insiders demand a wage that makes it profitable for the firm not to reduce its labour force. Fluctuations in the level of employment can therefore only be explained by shocks not accounted for in the wage negotiations.

Hansen’s study (2000) finds significant effect of unemployment on wages both before and after the unification. The effect is shown to be stronger after the unification indicating that more attention was paid to those without jobs in the nineties. Based on this can pure insider behaviour be rejected.

3.4 Bargaining between the representative firm and union

Layard et al. (2005) provides a framework for analyzing a union’s impact on the wage in a closed economy environment. In their model, which deals with many of the aspects that seem relevant for explaining the wage outcome, a representative firm and a union are the two bargaining units. The bargaining outcome is shown to be what maximizes a Nash-bargaining maximand of the form: \( \Omega = (W_i - A)\beta S(W_i)\beta \Pi'(W_i) \).

Here the first term on the right hand side stands for the gap between wage \( W_i \) paid by firm \( i \) and some alternative income \( A \) that can be achieved outside the firm. This alternative income depends positively on what the workers can expect to get in other firms, unemployment benefits and the turnover rate. The term \( S \) stands for the likeliness of being employed and depends on the wage. Certainly, a higher wage will lead \textit{ceteris paribus} to a higher probability of being unemployed. The interpretation of the discount rate is analogous to a game where two players have to decide how to share a cake and where the game ends when both parties accept the outcome. When the two players have different discount rates (\( \beta \) is defined as the discount rate of the firm divided by the one of the union) it can be shown that the one with the highest discount rate ends up with the lowest share of the cake (see Layard et al. 2005).
So, with wage bargaining in mind, the discount rates are interpreted as bargaining power. This implies that a relatively powerful union will have a relatively low discount rate. The union’s power is most importantly related to its financial strength and its right to strike. The wage outcome from a bargaining is then higher the greater the union power is, the greater market power the firms has (low elasticity in demand), the fewer workers and insiders (persons employed in last period minus quitters) there are relative to capital and the greater the firm’s demand is relative to its capital stock. When assuming that all firms are identical the aggregate wage is then in addition to these variables expected to depend positively on unemployment benefits, negatively on unemployment and wage surprises (in the stationary long run case we expect that the wage surprise sum up to zero on average so that it does not have an effect). The model also shows why unemployment in the long run is independent of technological progress as long as the ratio of unemployment benefits to real wage is exogenous.

3.4.2 Degree of centralization

Layard et al. (2005) argues that in the case of a single encompassing wage negotiation, where all employers and all employees participate, the probability of achieving full employment increases. The reason for this is that while employees in the decentralized case have the option of receiving an alternative income that depends on wage outside the firm and unemployment benefits (see above), this argument becomes unimportant in the fully centralized case. This however rests on the assumption that the bargaining encompasses all firms and employees. The only alternative to work is therefore life on benefit, which again is paid by no one else than the union members themselves. The union then takes, in contrast to the decentralized case, into consideration the fact that their actions will ultimately have consequences for themselves only, making wage moderation and full employment a natural outcome. In this sense it is in line with Calmfors and Driffills (1988) reasoning.

While relatively decentralized versus centralized bargaining clearly performs worse in a closed economy the argument for the superiority of centralized bargaining becomes weaker in a highly competitive world with integrated markets. In fact, in the case of industry level bargaining (as most researchers characterizes the German economy to be) the solution will probably turn out with only a bit higher real wage and unemployment level, than in the fully
decentralized case. This result naturally depends on the demand elasticities for the products and labour. For instance will there, in an industry with no close substitutes and an inelastic demand for its products, be much easier to push up prices in response to a wage increase. But in an increasingly competitive world the competition between firms across the boarders are likely to intensify so that this option no longer seems so preferable. It is perhaps in this respect we should see the demand for a more flexible wage system in Germany during the last years.

3.4.3 The concept of staggering wages

Staggering wages can according to Layard et. al (2005) explain the slow adjustment of real wage levels to shocks hitting the economy. Although it is hard to find any good evidence for it, it may seem relevant for Germany, although the coordination in the wage settlement process there is said to be relatively high (see for instance Kenworthy 2001). Staggering happens when different workers negotiate at different dates during the year. An example illustrating this phenomenon is a situation where we have two unions each bargaining at two different dates. Since the members are expected to care about relative wages, e.g. their wage relative to others, the lowering of real wages that are demanded in case of for instance a shock in productivity is not likely to adjust as fast as the case where we have one single bargaining unit. The possible consequences of staggering wages can best be seen when considering an economy that is hit by a shock that requires a 10% reduction in nominal wages in order for the real side of the economy to be unchanged. With both of the unions bargaining at say two different dates in a year with 6 months between each bargain, no one of them would be willing to lower their wages since this would mean a loss of relative purchasing power. A possible development could instead of an immediate adjustment to the new economic conditions be that each union lower its wage annually by 1% under the wage of the other. This would ultimately mean that it would take 5 years for the economy to fully recover from the shock. This phenomenon resembles envy effects something that has also been focused on for explaining wage cut resistance.

3.5 A macroeconomic perspective on wage levels

Layard et al.(2005) presents a macroeconomic framework for analyzing unemployment, price- and wage-inflation in a world with identical firms all supplying the same good on
markets with identical demand elasticities (each firm has some market power, in other words, the competition is assumed to be imperfect). The prices that each firm sets are therefore of the mark-up kind, meaning above the marginal cost, and dependent upon demand characteristics. Other things equal, will reduced competition (lower elasticity) mean higher prices and therefore lower production (for an illustration see figure 2). This will in turn affect unemployment since we know from microeconomics that the input factors must go down at lower production levels when the relative price of input factors remains constant. The elasticity of demand is expected vary around a constant with the variation being dependent upon the ratio of expected demand over full utilization of all resources. This means that the price mark-up depends on whether expected demand is different from full utilization of all resources. The deviation here can either be pro- or counter-cyclical meaning that the mark-up could just as well increase as decrease in case of a boom (where a boom is defined by expected demand being above the capacity of the economy).

**Figur 2**: Output produced under imperfect competition with different demand characteristics.

Wages are in the closed economy model assumed to be a weighted sum of insider and outsider factors. Outsider factors that are assumed to affect the average wage outcome negatively are higher level of unemployment in addition to whether unemployment is decreasing or increasing. But here it is also worth noting that the higher the employment is, the more employees will be party to a wage bargaining and, ceteris paribus, this leads to
workers tending to modify their wage claims in fear of losing their jobs (insider effects). On aggregate it is however assumed that the outsider effects dominate so that wage claims are moderate in case of high and increasing unemployment levels.

The alternative income, achieved outside the firm, is expected to depend positively on the aggregate wage level in addition to how generous the unemployment benefits are. The actual wage outcome is then in addition to the above mentioned factors assumed to depend positively on the firms technological progress, prices and the voluntarily turnover rate (with this number high employees will be less worried about being fired). In addition do conditions on the labour market (for instance employment protection), the wedge between product wages and net consumption wages, here stemming from taxes on labour, lead most likely to real wage resistance. When looking at the aggregate economy the wage mark up on value added prices that would prevail is then in addition to the above mentioned factors seen to depend positively on wage surprises in the short run (this effect is in the long run expected to sum up to zero).

Extending the model to an open economy with international trade leads to a mark-up that depends in addition on the real exchange rate. Now decreased foreign price level or a strengthened currency for given domestic prices means lower consumer prices and this will tend to lower wage claims. However a permanent effect of a country’s competitive position cannot lead to higher real wages in the long run since domestic prices also depend on the real exchange through the above mentioned mark-up.

Since changes in technology leading to higher productivity have an equal impact on the wage outcome as prices, a stationary level of unemployment is shown to depend especially on the price mark-up (indicating that we will see less unemployment with well-functioning markets), exogenous wage pressure variables (as for instance strong employment protection) and the production function. This implies that, as in aggregate supply and demand models, conventional fiscal or monetary policy is not able to alter the stationary long run level of unemployment (often termed ‘NAIRU’ or ‘natural rate of unemployment’).\(^6\)

\(^6\) See for instance Burda & Wyplosz (2001)
3.6 The wage wedge

That the wage wedge, the difference between product wages and the net consumption wages, can affect the macroeconomic outcome deserves some closer attention. Since what the firms are interested in are gross wages in relation to what prices (producer prices) they can charge, while the consumer is mostly interested in the net consumption wage (net wages in relation to consumer prices), this raises some interesting questions. From microeconomics we know that taxation leads to an efficiency loss (in this case unemployment) since the two sides, the demand and supply sides, have to make their decision based on two different concepts. Rødseth (1999) however claims that the suggested increase in wage pressure stemming from taxes on labour, or deviation between producer and consumer prices, is not likely to be the case as long as the alternative income also depends on these variables. The long run consequences of a wage wedge are therefore assumed to be insignificant. This is also in line with the theoretical model of Layard et.al.(2005) discussed in 2.4.1.

The potential importance of the wedge can be seen by looking at the period after the unification in Germany (see for instance Hansen 2000). One of the consequences of this event was higher taxes on labour and larger social security contributions imposed on the firms in the West-German states. Employees on the other hand did not agree on lowering net wages so that the profitability in the firms could remain the same. Wage negotiations in East Germany were in addition directed against giving employees the same conditions as in the West-German states within a five year period without paying enough attention to the low productivity in these areas. So while the economic conditions after the unification demanded moderate wage claims, was the union’s aim the opposite, and can probably explain some of the observed increase in unemployment in the early nineties.

When looking at wages in the Norwegian manufacturing sector, it has been found that the wage-wedge does not have a significant effect on nominal wages (Bjørnstad and Nymoen 1999). Empirical investigation of industry data in Germany from 1977 to 1994 by Thomas Bauer and Regina Riphahn (1998) also reaches similar conclusion, or more precisely that payroll taxes do not have a significant effect on employment. Hansen (1996) however gets support for an effect of the wage wedge on economic indicators using a structural cointegrated model. When investigating the period 1980 to 1993 in West-Germany, a period
with a very generous welfare system, he finds that a 10% smaller wage wedge would have given on average a gross real wage decrease by 5.6% and a net real wage increase by 5% compared to the observed data. A wage wedge reduction would also lead to higher economic growth and lower unemployment something that, in his opinion, speaks in favour of reducing taxes on labour and contributions to social security by the firms.
4 Empirical analysis

The first section in this chapter first gives a brief introduction to systems with stationary variables (VAR models). As the variables of interest are assumed to be non-stationary with a common stochastic trend, a model where this trend is captured is presented. Using industry data from Federal Statistics Germany and OECD, the last section tries to come up with some answers with respect to the workings of wage formation. The analysis there draws on earlier work, done by Bjørnstad and Nymoen (1999), on wages and profitability in the Norwegian manufacturing sector.7

4.1 VAR systems

In analyzing and forecasting developments in time series of economic data vector autoregressive (VAR) and vector error correction (VECM) models have gained considerable importance during the last two decades.

On a general form a vector autoregressive process, VAR(p), can be written on the following form (Lütkepohl 2005)

\[ y_t = \mu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \]

Here the vector(y) is explained by its own lagged values and an intercept term, (\( \mu \)), which allows the process to be non-zero. The \( u_t \)'s are assumed to be a stochastic independent vector of white noise errors, \( u_t \sim (0, \Sigma_u) \). The covariance matrix \( \Sigma_u \) is assumed to be non-singular.

When this process is stationary the first and second moments are seen to be (for more details see Lütkepohl 2005):

\[ E(y_t) = \mu \quad \text{for all } t \]

and

\[ \Gamma_y(h) = E(y_t - \mu)(y_{t-h} - \mu) \]

7 The main difference here is that the value of fixed capital (rate of return) as an endogenous variable is left out of the analysis.
\[ = \lim_{i \to \infty} \sum_{i=0}^{\infty} A_i^{i+1} \sum_{u} A_i^c \]

So the mean and the covariance matrix of \( y \) have to be time invariant.

The process \( \text{VAR} (p) \) is stable if its reverse characteristic polynomial has no roots in or on the complex unit circle. Formally:

\[(4) \det(I_k - A_i z - \cdots - A_p z^p) \neq 0 \quad \text{for} \quad |z| \leq 1\]

So when the stationarity and stability conditions are satisfied will a process such as (1) show values that fluctuate around a constant value with no significant covariance between the error-terms.

4.1.2 Integrated variables I(1)

Sometimes economic time series show an upward trending behaviour as for instance gross domestic product and consumption. A formal criterion for a process to be non-stable is that they have one or more roots on the complex unit circle. A process that has one root on the complex unit circle is said to be integrated of order 1, I(1), and can be made stable by differentiating one time. As an example of an I(1) process, consider a univariate autoregressive process with one lag:

\[(5) y_t = \alpha y_{t-1} + u_t\]

When \( \alpha = 1 \) this process is integrated of order one, I(1), and has a random walk representation (Lütkepohl, 2005):

\[(6) y_t = y_{t-1} + u_t = y_{t-1} + u_{t-1} + u_t = \cdots = y_0 + \sum_{i=0}^{t} u_i\]

The process is now seen to depend on all the innovations starting from period zero up until period \( t \).
4.1.3 Systems with cointegrated variables

When we have a system such as (1) that consists of variables integrated of order one there is a possibility that they are driven by a common stochastic trend. In the literature two time series are classified as cointegrated if there is an equilibrating relationship between them that is stationary.

In a general K-dimensional VAR(p) process such as (1) the process is unstable when one or more roots of its determinantal polynomial equals one while all the others lie outside (Lütkepohl 2005). We would then have that \( |I_k - A_1 - \cdots - A_p| = 0 \).

The matrix
\[
\Pi := -(I_k - A_1 - \cdots - A_p)
\]

is now singular with reduced rank \( r \). In other words, there will be \( r \) linearly independent relations in the system. Now suppose that \( rk(\Pi) = r < K \). \( \Pi \) can then be decomposed as \( \Pi = \alpha \beta' \) where \( \alpha \) and \( \beta \) are \((K \times r)\) matrices and refers to the loading matrix and the cointegration matrix respectively.

As mentioned can time series integrated of order one be made stable by differentiating once. When subtracting \( y_{t-1} \) on both sides of the K-dimensional system (1) it has the following representation:
\[
\Delta y_t = \alpha \beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t
\]

Where \( \alpha \beta' = \Pi \), with rank \( r < K \), and represents the long run part while the \( \Gamma_i \)'s represent the short run part of the process.

The \( \beta' \)'s can now be interpreted as the relationships between the variables of the system in equilibrium while the \( \alpha \)'s are called loading matrices (or vector in case of rank 1) and can be interpreted as the speed of convergence towards equilibrium. Systems of this kind are termed vector error correction models (VECM), or sometimes vector equilibrium correction models (VEqCM).

4.1.4 Including exogenous variables

Extending equation (8) by including exogenous variables is often desirable as what we want to examine usually depends on a number of factors. But problems for inference and analysis could arise if the variables we want to include do not satisfy exogeneity requirements
Following Lütkepohl et al. are weakly exogenous variables desirable if estimation is the purpose of the analysis. If forecasting or policy analysis is the objective are strongly and super exogenous variables respectively the relevant requirements.\footnote{For more on exogeneity, see Harris and Sollis (2003)}

Since estimation is the purpose of the following analysis, the focus is on the weakly exogenous concept. Following Lütkepohl et al. is a variable, say \( z \), weakly exogenous for a parameter vector of interest \( y \), if including \( z \) in the estimation of \( y \) does not lead to a loss of information relative to estimating \( y \) without including \( z \).

### 4.2 Data

The quarterly data used in the analysis are gathered from Federal Statistics Germany and the OECD-database. For productivity, wages and producer prices they refer specifically to the German industry sector (see appendix for more details). We use gross nominal wages per hour paid to all employees. Producer prices refers to prices charged (minus taxes) by firms in the same sector. Productivity in constant prices is calculated by deflating gross value added output per hour by producer prices. It is in addition to wages not seasonally adjusted. The period 1970(1)-1990(4), with the exception of unemployment rates, cover only West-Germany, while the period afterwards, up until 2004(4), contains the unified Germany. As a measure of the overall price level we use the consumer price index. The unemployment rate is defined as the number of registered unemployed divided by the total workforce. For the period 1970(1) -1991(4) it refers only to West-Germany (see appendix).
**Figur 3**: Productivity in constant prices in the German industry sector (2000=100)

**Figur 4**: Producer prices in the industry sector (2000=100):
**Figur 5:** Gross nominal wages paid per hour (2000=100)

**Figur 6:** Unemployment rate in the period 1970-2004
4.3 The model

In what follows a model that tries to explain nominal wage growth in the German industry sector is presented. We know that wages in the long run have to be in line with growth in profitability for firms not to become insolvent. If this is not the case, investors will see that the return they can yield from their investments decrease. The final effect would then be that less is invested and as a consequence an increase in unemployment. As a measure of the profitability we use gross value added output per hour in constant prices together with producer prices. The endogenous variables explained by the model are now wages, producer prices and productivity. Since the world is complex, the key to clear insight is to make some simplifications. This is done by considering unemployment and changes in consumer prices as determined outside the system, meaning that they are decided by other values than what they try to explain\(^9\). Following the discussion on the possible effects of a wage wedge we have not considered deviation between producer and consumer prices and taxes on labour and income in the following, so that question is in other words left open (corrected 23.january).

In the discussion above we showed how a general VAR-model can be transformed to have a VECM representation when there are linear relationships between the variables that are stationary. When including additional explanatory variables that are assumed to be weakly exogenous, the system has the following representation (notation borrowed from Lütkepohl et.al. 2003):

\[
(9) \Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + CD_t + Bz_t + u_t
\]

Where the \(u_t\)'s are assumed to be white noise error terms. \(\Delta y_t\) is the vector of endogenous variables and consists of the logarithmic values of hourly nominal wages, producer prices and gross value added output per hour in constant prices: \(\Delta y_t : [\Delta w_t, \Delta ppi_t, \Delta productivity_t]\). \(D\) consists of regressors associated with deterministic terms and includes a constant, seasonal dummies in addition to two impulse dummies (\(D1990\)) and (\(D1991_1\)) that were included to try to capture the effect of the unification. Non-modelled variables are captured by the \(z\) matrix with corresponding regressor matrix \(B\). We allow one of the variables in \(z\), namely the logarithm of the unemployment rate at lag one (\(LgU_{t-1}\)) to enter the cointegration relation.

---

\(^9\) See discussion in section 4.1.4 on exogeneity.
Note that because of the logarithmic form it implies that one percentage point of increase in unemployment should gradually become less effective in lowering wages as the unemployment level gets higher. The other variables in this matrix are logarithmic changes in consumer prices \( \Delta \text{LgCPI}_t \) and unemployment rates \( \Delta \text{LgU}_t \) (for a complete description of these variables see appendix).

### 4.3.2 Integration properties of the series

For further analysis, and for investigating whether the process in question can be treated as being cointegrated, an Augmented-Dickey-Fuller (ADF) test is applied to the individual time series. When looking at equation (5) we saw that the process was said to be I(1) when \( \alpha = 1 \). For a univariate time series with more than one lag the test procedure for investigating its integration properties has the following form (Lütkepohl 2003):

\[
(10) \quad \Delta y_t = \phi y_{t-1} + \sum_{j=1}^{p-1} \alpha_j \Delta y_{t-j} + u_t.
\]

\[H_0 : \phi = 0 \quad \text{vs.} \quad H_1 : \phi < 0\]

So what we want to test is the null-hypothesis of a unit root against the alternative of stationarity. Deterministic terms can also be included in the equation above. And as some of the time series we want to look at show clear seasonal patterns we account for that by including seasonal dummies. A constant is also included since all data have nonzero values at the beginning of the period and for those of the series that show a trend this is also accounted for. When now applying an ADF test we get the following results (see also appendix):
The results clearly support the null-hypothesis of a unit root in the three endogenous variables. For unemployment the results seem sensitive to lag order and whether a trend is included. In the following we will however treat unemployment as I(1). Based on this we can expect the system to generate at least one cointegration relation.

4.3.3 Determining the lag order

In deciding the autoregressive order, which is the number of lagged values of the endogenous variables used in the analysis, we consider (9) on level form. Considering the seasonal fluctuations apparent in the series, four lags seem to be a minimum. An alternative in deciding the order could be to use a sequential testing of the significance level of the lagged endogenous variables (Lütkepohl 2003). In the following we will however, make use of the information criteria proposed by Akaike (AIC). With \( m \) being lag order, \( T \) sample size and \( K \) the dimension of the system, this criterion has the following form:

\[
AIC(m) = \ln \left( \sum_{x} e^{-2}(m) \right) + \frac{2mK^2}{T}
\]
The lag order is now chosen so that this criterion is minimized. Applying the Akaike-Information-Criterion on our model leads to the conclusion that including eight lags gives the best fit. Some signs of misspecification occur as can be seen in the from the table in appendix A.5. Especially are normal distributed residuals in the single equation for producer prices and in the vector normality test rejected. Although uncorrelated errors would be desirable it is not a precondition for the validity of a cointegration rank test (see Brüggemann 2003). We therefore continue our analysis using equation (9) on level form with eight lags.

4.3.4 Choice of cointegrating rank

For investigating the rank, or number of cointegrating relations, in the system between wages, producer prices, productivity and unemployment, we consider equation (9) on level form and use the number of lags suggested by AIC. From economic theory we would expect the process to at least generate a wage setting relation, saying that in the long run, growth in nominal wages has to be in line with the growth of the value in gross value added product (a constant wage share).

The rank test we use is based on the maximum likelihood method proposed by Johansen\(^\text{10}\). (Level shifts in the variables due to the unification are not accounted for as PcGive does not provide that function):

**Table 3**: Results from the trace test.

<table>
<thead>
<tr>
<th>Trace test</th>
<th>Alternative</th>
<th>Test value[t-prob]</th>
</tr>
</thead>
<tbody>
<tr>
<td>H(_0)(0): r = 0</td>
<td>H(_1)(0): r &gt; 0</td>
<td>43.845 [0.001] **</td>
</tr>
<tr>
<td>H(_0)(1): r = 1</td>
<td>H(_1)(1): r &gt; 1</td>
<td>11.257 [0.199]</td>
</tr>
<tr>
<td>H(_0)(2): r = 2</td>
<td>H(_1)(2): r &gt; 2</td>
<td>4.1852 [0.041] *</td>
</tr>
</tbody>
</table>

**:** significant on 99% level  
*: significant on 5% level

\(^{10}\) See http://www.pcgive.com/pcgive/index.html
The test clearly supports the notion of a cointegrated system since a rank of zero is strongly rejected. A t-prob of 0.199 for r=1 seems to confirm the already mentioned hypothesis of a wage setting relation in the data generation process. It should however be kept in mind that the inclusion of non-modelled variables can, according to Harbo (1998)(see Bjørnstad and Nymoen 1999), be problematic for inference in a cointegration rank test.

4.3.5 Estimation of the vector error correction model (VECM)

We now go further and estimate equation (9) with seven lags and a cointegration rank of one imposed, based on the results from the cointegration test. The results obtained are presented in table 4.

Table 4: Relationships between the variables in equilibrium with corresponding loading matrix ($\hat{\beta}'_1$ normalised to minus one):

$$
\begin{pmatrix}
\hat{w}_{t-1} \\
\hat{ppi}_{t-1} \\
\hat{productivity}_{t-1} \\
\hat{LgU}_{t-1}
\end{pmatrix} =
\begin{pmatrix}
0.06 \\
0.00 \\
0.06 \\
0.019
\end{pmatrix}
\begin{pmatrix}
-1 & 1.400 & 1.290 & 0.062 \\
0 & [0.451] & [0.180] & [0.114] \\
0 & [0.006] & [0.006] & [0.006] \\
0 & [0.019] & [0.019] & [0.019]
\end{pmatrix}
\begin{pmatrix}
\hat{w}_{t-1} \\
\hat{ppi}_{t-1} \\
\hat{productivity}_{t-1} \\
\hat{LgU}_{t-1}
\end{pmatrix}
$$

The error correction term, the stationary long run relation between the variables, can be interpreted as a wage setting relation. The unemployment rate seems to be insignificant in explaining wage growth in this model and it also has a counterintuitive sign. In order to reach some better conclusions we therefore go further and impose restrictions on the cointegration relation and the loading vectors. These are a constant wage share (increases in nominal wages stand in a one to one relation to increases in current value of productivity), which is in line with the theoretical wage bargaining model discussed in section 2.4.1. There it can be shown
that also including bargaining over profit-sharing yields the same wage level\textsuperscript{11}. Moreover, we test if producer prices and productivity can be treated as weakly exogenous:

**Table 5:** Results for the stationary long run part of the model with restrictions imposed on producer prices and productivity. The zeros in the loading matrix imply weak exogeneity assumptions:

\[
\begin{pmatrix}
\hat{\alpha} \\
\hat{\beta}
\end{pmatrix} =
\begin{pmatrix}
\begin{bmatrix}
\hat{w}_{t-1} \\
\hat{ppi}_{t-1} \\
\text{productivity}_{t-1} \\
LgU_{t-1}
\end{bmatrix} & \begin{bmatrix}
0.078 \\
0
\end{bmatrix}
\end{pmatrix}

\begin{pmatrix}
-1 & 1 & 0.099 \\
0 & 1 & [0.049]
\end{pmatrix}

\begin{pmatrix}
\begin{bmatrix}
\hat{w}_{t-1} \\
\hat{ppi}_{t-1} \\
\text{productivity}_{t-1} \\
LgU_{t-1}
\end{bmatrix}
\end{pmatrix}
\]

With these restrictions imposed, we get a likelihood-ratio-test statistic of $\chi^2(4) = 8.5362 [0.0738]$, a result we see as evidence in support of a constant wage share during the period. It also gives justification for treating producer prices and productivity as weakly exogenous (see Lütkepohl 2005, ch.10). A single equation estimation for change in wage should therefore be sufficient. That especially producer prices can be treated as weakly exogenous, may reflect the large degree of openness in the German economy, implying that companies in the country have little scope for unilaterally raising prices. Regarding the discussion in sections 2.1.5 and 2.5, especially on the curvature of the hump-shape, these findings should confirm the already mentioned hypothesis of a less profound relation between degree of centralization and real wages in an open economy. That productivity can be said to be decided outside the system, does not come as a surprise, as the main driving force behind it is advances in technology. A loading parameter value of -0.08 indicates the speed from disequilibria values towards the stationary equilibrium state. The restricted cointegration vector $\hat{\beta}$ is interpreted as a wage setting relation in the long run (standard error in parenthesis):

\begin{equation}
(12) \quad w_{t-1} = ppi_{t-1} + \text{productivity}_{t-1} - 0.099 \, LgU_{t-1}
\end{equation}

\textsuperscript{11} For a formal exposition see Layard et al. (2005)
We see that nominal wages stand in a one to one relation to gross value added output in current prices, given by producer prices and productivity. That the variables are on logarithmic form imply that the coefficients can be interpreted as elasticities. A 1% increase in productivity or producer prices should therefore induce a 1% increase in wages. The now intuitively correct sign in front of the unemployment coefficient indicates that higher unemployment reduces wage pressure. Based on this result we find no evidence that supports the hypothesis of (pure) insider behaviour in wage negotiations as the unemployment level seems to have a significant negative impact (test value of 2.01).¹²

These findings are also in line with a structural vector error correction analysis, where all sectors in Germany is included done by Brüggemann (2003).

### 4.3.6 Single equation estimation

Based on the results in the previous section where evidence for treating producer prices and productivity as weakly exogenous was found, a single equation relation is estimated for explaining percentage changes in nominal wages:

\[
\Delta w_t = \psi (w_{t-1} - (ppi_{t-1} + productivity_{t-1})) - \varphi \text{Lg}U_t \\
+ \sum_{i=1}^{7} d_{1i} \Delta w_{t-i} + \sum_{i=1}^{7} d_{2i} \Delta ppi_{t-i} + \sum_{i=1}^{7} d_{3i} \Delta productivity_{t-i} + v P_t + \xi C_t + u_t
\]

This is the single equation representation of equation (9) when producer prices and productivity are treated as weakly exogenous. The first two terms are the ones that entered the stationary long run relation in the previous section. Deterministic and other non-modelled variables are represented by the two terms before the white noise error term, \( u_t \). The other terms measure the impact of percentage changes in wages, producer prices and productivity up to lag 7.

¹² See section 2.3 and 2.5
4.3.7 Estimation results

What is of interest now is whether there can be found an impact of the wage share and the unemployment level in equation (13) that is consistent with the analysis in section 3.5.5. In doing so we estimate (13) with the same data as previously used and reduce the model in such a way that variables showing insignificant coefficients are excluded.\(^\text{13}\)

The following model tries to capture the same mechanisms for explaining wage growth as the VECM model used in the previous section (for a complete description of the variables see appendix):

\[
\Delta w_t = \Delta w_{t-1} + \gamma_2 \Delta w_{t-4} + \gamma_3 \text{cons tan } t + \gamma_4 \text{seasonal}_t + \gamma_5 \text{seasonal}_{t-2} \\
+ \gamma_6 \Delta \text{productivity}_{t-1} + \gamma_7 \Delta \text{productivity}_{t-2} - \gamma_8 (w_{t-1} - (\text{ppi}_{t-1} + \text{productivity}_{t-1})) \\
\gamma_9 \text{LgU}_t + \gamma_{10} D1991_1 + \gamma_{11} \Delta \text{cpi}_{t-1} + u_t
\]

Here \( u_t \) is the disturbance term assumed to be white noise. The two seasonal dummies take the value one in quarter \( t \) and \( t - 2 \) respectively and zero elsewhere. The impulse-dummy \( D1991_1 \), which takes the value one only in the first quarter of 1991, tries to capture the effect of also including data for East Germany.

Results from running an ordinary least squares regression on equation (13) are shown below.

**Table 6:** Results from OLS-regression:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>Test value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta w_{t-1} )</td>
<td>-0.17</td>
<td>0.064</td>
<td>-2.68</td>
</tr>
<tr>
<td>( \Delta w_{t-4} )</td>
<td>0.52</td>
<td>0.061</td>
<td>8.55</td>
</tr>
<tr>
<td>( \text{cons tan } t )</td>
<td>-0.33</td>
<td>0.196</td>
<td>-1.66</td>
</tr>
<tr>
<td>( \text{seasonal}_t )</td>
<td>-0.09</td>
<td>0.018</td>
<td>-5.25</td>
</tr>
<tr>
<td>( \text{seasonal}_{t-2} )</td>
<td>-0.06</td>
<td>0.020</td>
<td>-3.07</td>
</tr>
</tbody>
</table>

\(^{13}\) See [http://www.pcgive.com/pcgive/index.html](http://www.pcgive.com/pcgive/index.html)
The results confirm some of the findings from the VECM analysis in section 3.5.5. Most importantly, the wage-share coefficient has the same coefficient as the loading parameter. A direct comparison would however be misleading as the two models include different variables. The value -0.08 can here be interpreted as the elasticity of relative changes in wages with respect to the wage-share. Note however that both producer prices and wages in period $t-1$ affect wages two places. Contrary to the results in section 3.5.5, is this model not able to reject the hypothesis of insider behaviour in wage negotiations. Although the coefficient is negative it does not seem to have had a significant impact.
Concluding remarks

The German wage bargaining system has come under attack from different viewpoints during the last decade. The industry level settlements in the country have often been criticized for being too generous and for not paying enough attention to low profitability in especially smaller firms. Also criticized is the way minimum wages agreed upon in one area or sector have been extended by government intervention to cover more employees in other sectors or areas. From a microeconomic perspective it is not hard to understand this criticism.

The industry level bargaining system in Germany is characterized as being relatively coordinated in the way that wage negotiations in a wage leading sector (metal industry in Nordwürtemberg/Nordbaden) form the basis for subsequent negotiations other places. However, as the number of union members has decreased, something which is common for most West European countries, this together with the fact that it is now easier for firms to deviate from tariff wages have led to what many scholars term the ‘outer’ and ‘inner erosion’ of the German wage bargaining system.

After having discussed the proposed hump-shaped relation between degree of centralization and possible deficiencies with it, I looked at what happens in a bargaining situation where employees and a firm meet. It was shown that with a powerful union, stemming from for example extensive employment protection, the outcome would be higher wages. Moreover, did this model and others discussed not deal explicitly with what would happen if measures with respect to more untraditional labour market policies had been taken. This could for instance be improving the skills of the unemployed. In other words, looking for answers on the solution of the unemployment problem by solely looking at wages is far from being sufficient.

The empirical analysis tried to come up with some conclusions with respect to wages in the German industry sector. A three dimensional cointegrated VAR system where wages, producer prices and productivity were treated as endogenous, was estimated. It was shown that the data support the notion of a constant wage share implying that a percentage increase in gross value added output should induce a percentage increase in nominal wages. A significant negative effect of the unemployment rate in the restricted VECM model was also found, indicating that outsiders (unemployed) have an impact on the growth in wage levels.
References:


Appendix

A.1: Data sources

Data for gross value added in current prices, hours worked, and gross nominal wages in the production industry sector are gathered from the “Volkswirtschaftliche Gesamtrechnung” series and can be downloaded from the web-pages of Federal Statistics Germany (www.destatis.de). They are all seasonally unadjusted and refer to West-Germany in the period 1970(1)-1990(4) while unified Germany is covered afterwards until 2004(4).

Data for consumer prices (CPI), producer prices in the industry (PPI) and unemployment rates are gathered from the web-pages of OECD (www.sourceoecd.org). There it is also possible to see how these numbers are calculated in detail. CPI and PPI are indexed with 2000 as the base year and cover the same period as wages and gross value added output. Regarding PPI we have no indication that it does not cover the same branches as gross value added product in current prices, hours worked and wages. The unemployment rate refers to West Germany from 1970(1) to 1991(4) while unified Germany is covered from 1992(1) up until 2004(4). It is calculated by dividing registered unemployed by the total civilian workforce. It is therefore not the standardized unemployment rate. The reason for not using the standardized unemployment rate is that OECD does not provide data on this specific rate for the whole period.

The fact that the unemployment rate does not cover the same area in 1991 as the other data is of course, not optimal for the analysis. Since it is likely that wage negotiators had some notion of how the labour market in this area was working, this leads to a small bias in the estimation of the unemployment effect.

**Calculation of index for productivity in constant prices:**

Gross value added output per hour (nominal) is found by dividing gross value added output in current prices by the number of hours worked in the industry:

\[
\frac{\text{GrossValueAddedOutput}}{\text{NumberOfHours}}
\]

Gross value added output in constant prices used in the analysis, is then calculated by dividing gross value added output per hour by PPI:
**Calculation of index for hourly nominal wages:**

Gross hourly wages paid in the industry is found by dividing gross wages paid to all employees divided by number of hours worked:

\[
\frac{GrossWagesPaidToAllEmployees}{NumberOfHours}
\]

Both hourly wages and productivity are indexed with 2000 as the base year.

---

**A.2: Variables used in the analysis**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ppi_i )</td>
<td>Logarithmic value of the producer price index</td>
</tr>
<tr>
<td>( w_t )</td>
<td>Logarithmic value of hourly wages</td>
</tr>
<tr>
<td>( productivity_t )</td>
<td>Logarithmic value of productivity in constant 2000 prices</td>
</tr>
<tr>
<td>( LgU_t )</td>
<td>Logarithmic value of the unemployment rate</td>
</tr>
<tr>
<td>( cpi_t )</td>
<td>Logarithmic value of the consumer price index</td>
</tr>
<tr>
<td>( D1990 )</td>
<td>Impulse dummy that takes the value one in the first quarter of 1990 and zero elsewhere</td>
</tr>
<tr>
<td>( D1991_1 )</td>
<td>Impulse dummy that takes the value one in the first quarter of 1991 and zero elsewhere</td>
</tr>
<tr>
<td>( seasonal_t )</td>
<td>Seasonal dummies</td>
</tr>
<tr>
<td>( (w_{t-1} - (ppi_{t-1} + productivity_{t-1})) )</td>
<td>Wage share</td>
</tr>
</tbody>
</table>
A.3: Integration properties

More results from ADF-tests on the data.

C:Constant
T:Trend
S:Seasonal dummies

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lags</th>
<th>Deterministic term</th>
<th>Test value</th>
<th>Critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$w_t$</td>
<td>6</td>
<td>C,t,s</td>
<td>-1.967</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>C,t,s</td>
<td>-1.944</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>C,t,s</td>
<td>-2.216</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C,t,s</td>
<td>-3.345</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C,t,s</td>
<td>-1.929</td>
<td>-3.44</td>
</tr>
<tr>
<td>productivity$_i$</td>
<td>6</td>
<td>C,t,s</td>
<td>-3.274</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>C,t,s</td>
<td>-3.348</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>C,t,s</td>
<td>-3.094</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C,t,s</td>
<td>-2.118</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C,t,s</td>
<td>-2.568</td>
<td>-3.44</td>
</tr>
<tr>
<td>$ppi_i$</td>
<td>6</td>
<td>C,t</td>
<td>-2.350</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>C,t</td>
<td>-2.105</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>C,t</td>
<td>-1.934</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C,t</td>
<td>-2.246</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C,t</td>
<td>-2.216</td>
<td>-3.44</td>
</tr>
<tr>
<td>$LgU_t$</td>
<td>5</td>
<td>C,t</td>
<td>-3.164</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>C,t</td>
<td>-4.277**</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C,t</td>
<td>-3.126</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C,t</td>
<td>-2.786</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>C,t</td>
<td>-3.031</td>
<td>-3.44</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>C,t</td>
<td>-2.421</td>
<td>-3.44</td>
</tr>
<tr>
<td>$LgU_{t-1}$</td>
<td>4</td>
<td>C</td>
<td>-3.324*</td>
<td>-2.88</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C</td>
<td>-5.118**</td>
<td>-2.88</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C</td>
<td>-3.720**</td>
<td>-2.88</td>
</tr>
</tbody>
</table>
### A.4: Information criteria

Results from applying the Akaike Information Criterion (AIC) on equation (9) on level form:

\[
AIC(m) = \ln \left( \sum_{m} \frac{2mK^2}{T} \right) + \frac{2mK^2}{T}
\]

<table>
<thead>
<tr>
<th>Order</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>-26.0086</td>
</tr>
<tr>
<td>9</td>
<td>-26.0175</td>
</tr>
<tr>
<td>8</td>
<td>-26.0753</td>
</tr>
<tr>
<td>7</td>
<td>-25.8846</td>
</tr>
<tr>
<td>6</td>
<td>-25.9813</td>
</tr>
<tr>
<td>5</td>
<td>-26.0211</td>
</tr>
<tr>
<td>4</td>
<td>-25.8543</td>
</tr>
</tbody>
</table>

### A.5: Diagnostic tests on equation (9) on level form

**System tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector AR 1-5 F(45,241)</td>
<td>1.066 [0.3692]</td>
</tr>
<tr>
<td>Vector normality $\chi^2(2)$</td>
<td>61.228 [0.0000]**</td>
</tr>
<tr>
<td>Vector hetero F(300,259)</td>
<td>0.695 [0.9988]</td>
</tr>
</tbody>
</table>
## Single equation tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>$wage_t$</th>
<th>$ppi_t$</th>
<th>$productivity_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality  $\chi^2(2)$</td>
<td>0.172 [0.92]</td>
<td>57.708 [0.00]**</td>
<td>1.644 [0.44]</td>
</tr>
<tr>
<td>ARCH 1-4 F(4,90)</td>
<td>0.268 [0.90]</td>
<td>0.013 [1.00]</td>
<td>0.248 [0.91]</td>
</tr>
<tr>
<td>AR 1-5 F(5,93)</td>
<td>2.393 [0.04]**</td>
<td>0.195 [0.96]</td>
<td>0.195 [0.96]</td>
</tr>
<tr>
<td>Hetero F(50,47)</td>
<td>1.331 [0.16]</td>
<td>0.541 [0.98]</td>
<td>0.572 [0.97]</td>
</tr>
</tbody>
</table>