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Forecasting Employment for Germany

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Forecasting Employment for Germany*

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Abstract

This paper deals with the estimation of employment equations for Germany which are to be used for forecasting and simulation purposes. We estimate error-correction models for German working hours both in a single-equation and in a system estimation framework using quarterly raw data covering the period 1980:1-2004:2. Since we focus on the question whether German Reunification has affected or even modified the underlying economic relationships, we compare our results to those reported in previous studies for West-Germany and Germany respectively. We find that the elasticity of employment with respect to output is robustly estimated and can therefore be restricted to one. The elasticity of employment with respect to real wage however is affected by German Reunification and relative factor prices play no

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longer a significant role. The forecasting quality of our employment equation is satisfactory.

JEL: E24, E27, C22/C32/C53

Keywords: employment, forecasting, cointegration, Germany.

1 Introduction

Analysing the determinants of aggregate labour demand is an important task not only with regard to policy questions but also with regard to forecasting purposes. Standard macroeconomic theory suggests that in the short-run demand factors are the main determinants of aggregate labour demand, whereas in the long-run supply factors play a far more important role, since – according to the neo-classical approach – in equilibrium labour demand depends on production technology, real factor prices, relative factor prices, and conditions on the factor markets that determine the level of mark-ups.

In this paper we examine the German aggregate labour demand focussing especially on the effects of German reunification. Most of the existing studies on labour demand use the number of employees as a proxy for employment. Furthermore, they focus mainly on the West-German labour demand or their estimation samples include only few data points for the unified Germany. Consequently, figures for West-Germany dominate these samples. Our sample, however, covers the period 1980:1 to 2004:2 and gives much more weight to the data for the unified Germany. Moreover, we use hours worked as a proxy for employment. This variable is more appropriate since part-time and working-time effects are taken into account. Finally, we carefully check the stability properties of the estimated coefficients and the equation as a whole, since we will include the equation into the macro-econometric model of the IMK (IMK-Model) which is used for both short-term forecasts and economic policy simulations. Against this background, it is clear why we prefer a theory-guided modelling approach rather than a pure forecasting approach as for example factor models. In the following, we estimate error-correction models consisting of a long-run solution which can be interpreted as the mid-term trend and the short-run dynamics which improve significantly the fit of the equation and thus its forecasting quality.

Our paper is organised as follows: In the next section we outline the theoretical framework of our analysis and review existing studies dealing with German labour demand. In the third section we contrast results of the existing literature with different estimations and then discuss in more detail the results of our preferred estimation equation. Section 4 concludes.

2 Review of literature

Before presenting our econometric analysis, we briefly describe in this section how labour demand equations are derived in the mainstream and which empirical results are found in the literature. We focus only on macroeconomic studies since we are interested in estimating labour demand on an aggregate level. Most of the articles we refer to are based on error-correction equations. The long-run relationships should be related to the theory of labour demand, and this is why we will focus almost exclusively on those in the empirical parts.

2.1 Macroeconomic theory of labour demand

Most of the macroeconomic studies start their analyses with a profit-maximizing or equivalently a cost-minimizing representative firm. This approach is extensively and well documented in textbooks like those of Varian (1992), Hamermesh (1993) or Layard, Nickell & Jackman (1991). The latter put more emphasis on a monopolistic competition context for their derivation.

In this context, employment is always a function of real output and real wage costs (w), and eventually of real user costs of capital (r), whereas the latter can be combined with the real wage costs (w/r). Consequently, our explanatory variables are the real output, the real wage costs and the relative labour to capital costs[1].

Working hours are the appropriate variable to measure employment. Econometric studies, however, mostly use the number of employees as a proxy for employment, as time series for working hours are still unavailable for many OECD countries and cross-country comparisons are therefore often impossible. Since we focus exclusively on Germany, this restriction is not binding in our case. Consequently, we use working hours[2] which is a more appropriate measure for employment because changes in working-time and the development of part-time work are likely to change output elasticity. As working hours include these changes, we expect the estimated output elasticity to be more stable over the years.

2.2 Estimation with working hours as dependent variable

As mentioned, most of the studies measure employment as the number of persons employed. Their results are therefore not comparable to ours. Nevertheless, we report the main results of this literature in the annex (see section 5.1). We find, however, two studies that measure employment as the volume of hours worked: one is Barrell, Pain & Young (1996), the other is the macro-model documentation of the Deutsche Bundesbank (Bundesbank 2000). These two studies are of special interest for several reasons. First, Barrell et al. (1996) estimate a broader equation in including

[1] We have to choose two variables out of the three mentioned (w, r and w/r, in logarithms) because of evident estimation problems.

[2] For the exact definition of working hours, we refer to the german Federal Statistical Office: http://www.destatis.de/presse/deutsch/abisz/arbeitszeit_arbeitsvolumen.htm and Bach & Koch (2002).

the relative factor price. We will estimate a similar equation for comparison purposes. Hence, we will check if their interpretation also holds after the German Reunification. Second, the Bundesbank targets pretty much the same objective as we do: estimating a macro-econometric model. Moreover, the Bundesbank uses exactly the same data (quarterly raw data, West-Germany until 1990:4 and reunified Germany from 1991 onwards). The comparison with our results will be straightforeward even if we do not use the same variables for real output and wages. The results of the two studies are summarized in the Table (1).

Table 1: *Review of the estimated (aggregate) labour demand for Germany, in terms of the volume of hours worked.*

<table>
<tr><th>Study</th><th>real output</th><th>real wage,
rel. fact. price</th><th>loading
coeff.</th><th>deter-
ministic</th><th>sample
range</th></tr>
<tr><td rowspan="2">Barrell et al.
(1996)</td><td>1
(restr.)</td><td>w/p: -0.09
(-1.36)
w/r: -0.41
(-3.28)</td><td>-0.26
(-5.53)</td><td>T,
SD(91:1)</td><td>1972:2
-1991:4</td></tr>
<tr><td colspan="5">Quarterly seasonally adjusted data. Real output is the EC*-aggregate real GDP. p=deflator of EC-real GDP, w=wage costs and r=capital user costs measured by the non-residential private investment deflator. Estimation is proceeded for France, the UK and Germany together by 3-SLS.</td></tr>
<tr><td rowspan="2">MEMMOD
(2000)</td><td>0.52
(10.78)</td><td>-0.72
(-13.40)</td><td>-0.29
(-3.85)</td><td>SD(90:3)</td><td>1974:1
-1997:4</td></tr>
<tr><td colspan="5">The data are raw quarterly data, concerning Reunified Germany from 1991 onward. The equation is estimated in a ECM** single-equation. Real output is measured as the real final demand (real GDP+real imports) and real wages as gross wages deflated by the final demand deflator corrected for the effective indirect tax rate.</td></tr>
<tr><td colspan="6">Source: Barrell et al. (1996) and Bundesbank (2000). *EC= European Community.
** ECM=Error correction.</td></tr>
</table>

Barrell et al. (1996) interpret their coefficients as follows. They call competitiveness effect the real wage elasticity and substitution effect the relative factor price elaticity. They argue that a country possessing some degree of economic leadership – like Germany – cannot sustain competitive advantages through adjustments in its prices and wages. The reason for this is that the other countries will always adjust their nominal terms to those of the leader economy. In other words, Germany will never improve its competitive position in just changing its wages and/or prices. Additionally, Germany was characterized as a relative stable macroeconomic area, enhancing firms to rely on the information from relative factor prices to make their production decision. Thus a small real wage elaticity and a big relative price elasticity is interpreted as an indicator of economic leadership.

As can be seen in Table (1), Barrell et al. (1996) find a strong substitution effect ($w/r : -0.41$) and a small – even insignificant – competitiveness effect ($w/p : -0.09$), concluding that Germany had an economic leadership in Europe. These authors estimate their equation but only for West-German data that did not go far beyond the Reunification. We will test in the empirical part of the paper if this hypothesis can be maintained for the reunified Germany as well as in the context of the Monetary Union and its preparation. Indeed, with the Reunification, Germany seems to have lost its role as European economic locomotive (German macroeconomic developments lie behind the European average since the 90's[3]). Furthermore, in the context of the Monetary Union, the other member countries cannot make use of real depreciations anymore to adjust their relative competitiveness as they might have done in the past. The nominal adjustment of the other countries to the German anchor should happen much more slowly now. Our intuition is thus that the substitution effect should loose some importance in the benefit of the one of the real factor price.

Turning to the results of the Bundesbank, we think that the estimation done by this institution is not compatible with theory. The overall labour costs should play a role in the demand for labour, thus the wage costs should enter the equation or the gross wage plus the wage wedge. Since the costs of Reunification were mainly financed by the social security system, it is legitime to ask if this could have played a role for the labour demand. This

[3]This is well documented in the OECD Economic Survey on Germany (OECD 2003) or in the EU-Country report (DG-ECFIN 2002).

is equivalent to investigate whether firms succeeded to fully shift their social contribution costs on the employees. If the Bundesbank is right then the answer is yes. The Bundesbank corrects its output deflator for the effective indirect tax rate, estimating labour demand implicitly with the consumer price deflator. We think also that this is not in line with theory. We consider the GDP-deflator as a better proxy for producer prices than the consumption deflator[4]. This raises the question if firms can fully pass through an increase in the value-added tax to the employees. The Bundesbank estimation answers implicitely with "yes".

2.3 Reunification and estimation outcomes

One remark has to be made about the influence that Reunification may have on the estimated equation and on the way the estimated correlations can or cannot be intrepreted as causal ones. Since the start of the German Monetary Union on the 1^{st} of July 1990, the East-German economy faced several shocks (among other things): an exchange rate shock, a demand shock and a wage shock that persisted far in the subsequent years.

- Through the monetary union with West-Germany, East-Germany experienced de facto a very sharp appreciation of its currency from one day to the other (about 400%).
- Together with the end of the Soviet Union and the increasing demand of Eastern consumers for Western products, the domestic market collapsed almost immediately: the level of industrial production in the years 1991-93 dropped to about one third of that of 1989 and the unemployment rate (for the Eastern part) which had achieved already 10% in 1991, rose to 16% in subsequent years.
- At the same time wages increased sharply driven by the social and

[4]We want to take variables only from the National Account statistics, thus we cannot take the producer price index directly.

political movements toward equality of living standards between the East and the West: +34,1% in 1992 (Eastern Länder without Berlin. In the Western Ländern without Berlin the wage increase was +6,5%) and +12,6% in 1993 (West: +2,5%).

As such, wage increases were indeed important but cannot explain exclusively the sudden break down of the East-German domestic demand. This should be kept in mind when interpreting the real wage coefficient in the labour demand equation.

3 Estimation results

3.1 Data

The data we use are quarterly, non-seasonnally adjusted and taken from the National Account Statistics (NA) of the German Federal Statistical Office (thereafter FOS). The estimation sample ranges from 1980:1 to 2004:2, albeit for comparison purposes we will consider also data from 1970:1 onwards. The data prior to 1991 concern only West-Germany. These data were recently reestimated for the price basis of 1995 and according to the new NA definition. Thus, data prior and posterior to the German Reunification are consistent in this dimension. The data from 1991 onwards concern Germany as a whole, including East-Germany, explaining that almost all series have a jump in 1991:1. Thus, two dummy variables are especially considered for the estimation: a (step) dummy variable that takes the value 0 for the period between 1970:1 and 1990:4 and the value 1 from 1991:1 onwards and an (impulse) dummy variable that takes the value 1 in 1991:1 and 0 elsewhere.

The data are denoted as follows:
-*hwee*: Number of hours worked by employees in million and in logs (FOS

and own calculations prior 1980[5]).

-*p*: GDP-deflator in logs, 1995=100 (FOS).

-*pc*: Deflator of private consumption in logs, 1995=100 (FOS).

-*pcc*: Deflator of non-residential private investment in logs, 1995=100 (FOS). This is a proxy for the user costs of capital.

-*price wedge*: p-pc.

-*i3m*: Nominal 3-month interest rate (Bundesbank, series SU0107).

-*i10y*: Nominal 10-year interest rate (Bundesbank, series WU8608).

-*w*: compensation of employees per hours worked in €/hours and in logs. They include income tax and social security taxes of both employees and employers (FOS, own calculations).

-*gw*: gross wages of employees per hours worked in €/hours and in logs. They include income tax and social security taxes of employees only (FOS, own calculations).

-*wage wedge*: gw-w.

-*y*: real GDP in billion of constant € (1995 prices) and in logs (FOS).

-*days*: Number of working days per quarter (FOS) and in logs. They measure the influence that holidays have when they fall e.g. on a monday rather than on a sunday[6].

-$iYYqQ$: impulse dummy that takes the value one the Q^{th} quarter of the year YY and zero elsewhere.

-$sYYqQ$: level shift dummy that takes the value one from the Q^{th} quarter of the year YY onwards and zero before.

-*z1, z2, z3*: centered seasonal dummies.

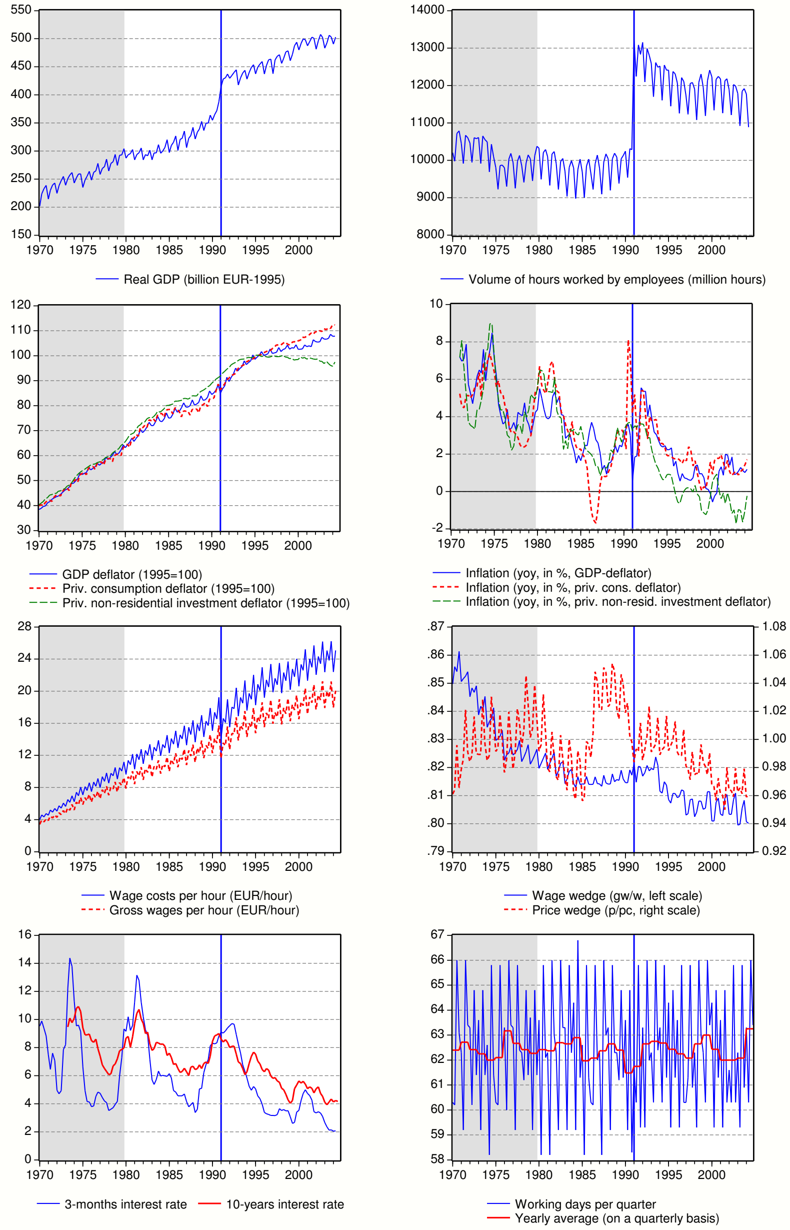
In Chart (1 and 2) the data used for the estimation are presented. In

[5] At the time when this paper was written, official data for this series were available only from 1980 onwards. Thus, we had to estimate our own data prior to this date, relying on older official databases.

[6] Because some of the holidays are not common to all the Bundesländer, this series is actually a weighted mean of the individual Länder series.

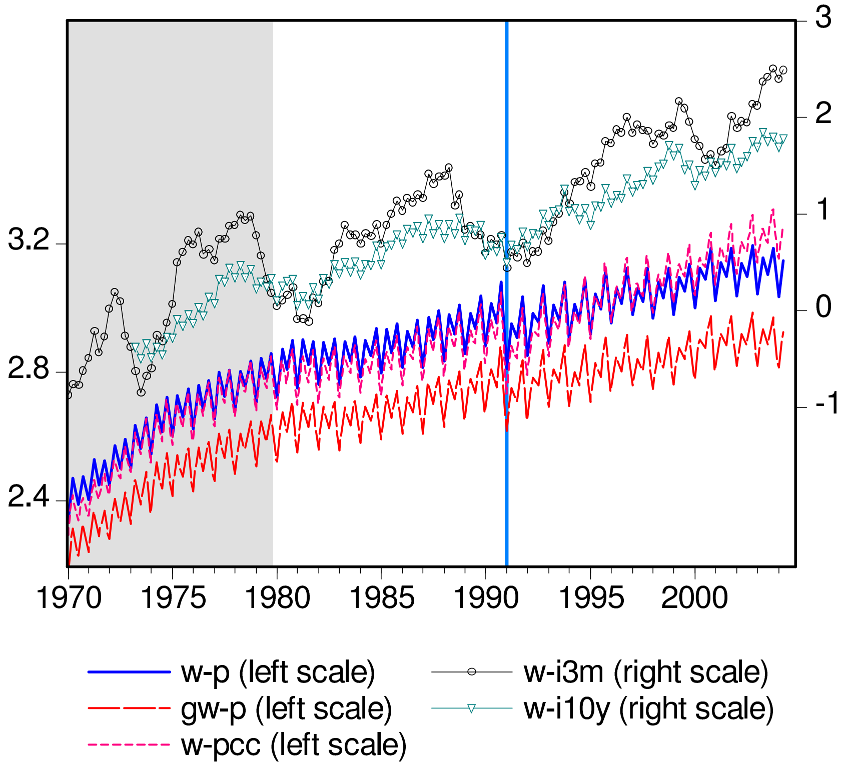
the annex (see section 5.2) the results for the integration tests are reported. The Perron-tests lead us to the conclusion that all series are I(1) with the exception of the working days and the wage series. For the working days series it not such a surprise, since holidays were not subject to major changes over the years; after Reunification the 17^{th} of June was replaced by the 3^{rd} of October as the national day and different weighting scheme between the Ländern were used, but this did not largely affect the yearly mean. More surprising are the results for the wage costs: the gross wages – found trend stationary – and the wage wedge – found stationary. We cannot interpret this results and therefore consider this series as I(1).

Chart 1: *Data used (1)*



Source: German Federal Statistical Office, Deutsche Bundesbank and own calculations. The vertical line signals the change from West-German data to reunified German data.

Chart 2: *Data used (2)*



Source: see Chart (1).

3.2 Single error-correction equation models for hours

We first estimate error-correction single-equation models. From a forecasting point of view this approach is not significant worse than the system approach (Clements & Hendry 1995). But it is clearly easier to implement, especially in the presence of a structural break. This is why we present the detailed analysis for this approach. We are however aware of the potential estimation bias that this single-equation approach can imply. Thus we will perform at the end of this section a system estimation to bannish these worries.

Our selection method is as follows: First the variables which enter the cointegration relationship are choosen, then the short-run adjustment is optimized (the insignificant variables are dropped). If some variables in the cointegration relationship are not significant, they are dropped and the whole process is started again. Thus, we do adjust short-term dynamic and cointegration relationship separately.

- First, we reproduce the results of Barrell et al. (1996) with our dataset. We took the same sample range from 1970:1 to 1990:4 (due to lags the estimation sample actually begins some quarters after 1970:1). The results can be reproduced quite easily even if our variables differ slightly from those of Barrell et al. (1996) and no panel regression is done: the cointegration relationship exists (significant negative loading coefficient) and the coefficients of the real wage (insignificant and small although positive) and of the relative price (-0.53) are similar to those of Barrell et al. (1996). The real GDP could enter the cointegration relationship with a coefficient of one (freely estimated it is 0.96, with a standard error of 0.08)[7]. The results are presented in column I of Table (2).

[7]Recall in Barrell et al. (1996): $hwee = y - \underset{(-1.36)}{0.09}(w-p) - \underset{(-3.28)}{0.41}(w-pcc)$.

Table 2: *Estimation of the labour demand for different samples and user costs of capital variables with the specification of Barrell et al. (1996).*

	estimation sample before adjusting points*:					
	1970:1-1990:4			1980:1-2004:2		
	I	II	III	IV	V	VI
cointegration vector:						
loading	−0.43 (−7.78)	−0.38 (−3.03)	−0.46 (−8.78)	−0.42 (−9.22)	−0.38 (−7.03)	−0.32 (−7.52)
y	1 (−)	1 (−)	1 (−)	1 (−)	1 (−)	1 (−)
w-p	0.13 (0.71)	−0.60 (−6.94)	−0.20 (−2.33)	−0.66 (−4.17)	−0.53 (−3.22)	−0.66 (−4.05)
w-pcc	−0.53 (−3.46)			−0.06 (−0.89)		
w-i3m		0.02 (1.75)			−0.001 (−0.19)	
w-i10y			−0.02 (−1.79)			0.02 (1.49)
trend	−0.003 (−11.18)	−0.002 (−4.96)	−0.004 (−8.26)	−0.004 (−3.74)	−0.002 (−3.99)	−0.002 (−3.30)
adj. R^2	0.988	0.963	0.994	0.992	0.994	0.994
AIC	-7.249	-6.168	-7.908	-7.429	-7.586	-7.702
SC	-6.770	-5.811	-7.262	-6.810	-6.834	-7.099
LM(1)	0.165	0.661	0.451	0.608	0.161	0.457
LM(4)	0.463	0.225	0.126	0.392	0.358	0.672
LM(8)	0.263	0.277	0.097	0.056	0.179	0.138
Prob. White	0.760	0.869	0.734	0.796	0.706	0.831
Prob. J.-B.	0.140	0.229	0.661	0.964	0.495	0.786
Prob. Reset	0.244	0.159	0.140	0.346	0.734	0.556
free estimated y	0.96 (s.e=0.08)	0.77 (s.e=0.20)	0.82 (s.e=0.07)	0.99 (s.e=0.06)	1.05 (s.e=0.04)	1.05 (s.e=0.05)

t-stat are in parenthesis. Blue numbers are not significant.

Critical values for the loading (and thus for the test if the cointegration relationship exists) at 5/10% level with two regressors and a trend are -3.62/-3.91 (Banerjee, Dolado & Mestre 1998, cited by Hassler (2004)). Critical values for the coefficients inside the cointegration relationship are the usual ones (at the 5% level: 1.96).

* The samples after adjusting points are not the same between the equations (I, II and III on the one hand and IV, V and VI on the other). The equations were re-estimated for the smallest common sample. No deviation from the results reported here is worth to mention. Only equation III was not re-estimated because the long interest rate (i10y) is available only from 1973:2 onward. This would have shortened the common estimation sample too much for the first two equations. Equation III is thus only to some extend comparable to equations I and II.

- Second, we estimate the same cointegration relationship with our sample (1980:1-2004:2). Here we find completely different results (column IV of Table (2)). The coefficient of real GDP can still be equal to unity but the relative weight of the other explanatory variables reverse: The real wage costs now play the major role (-0.66 with a t-stat of -4.17) and the relative price is insignificant. Hence if we follow the interpretation of Barrell et al. (1996), Germany did loose its economic leadership in the 90's. It support the view that other countries are not able to adjust their nominal prices so quickly anymore, so that Germany can achieve competitive advantages by varying its nominal prices. Even if one thinks that the shock of Reunification has been overcome in the begining of the XXI-century, we cannot expect the old scheme, as estimated by Barrell et al. (1996), to be restored with the entry in the European Monetary Union (EMU). The reason is that even if Germany should regain its leading role, the ability of the other countries to adapt their nominal outcomes quickly via depreciation is no longer possible because of the common currency.

- However – as mentioned in Barrell et al. (1996) – the results are very sensitive to the choice of the variable used for the user costs of capital. We try two other specifications: a short-term interest rate (3 months) and a long-term interest rate (10 years). Both yield in the two samples to insignificant coefficients for the relative factor price variable and to a significant coefficient for the real wage variable[8]. The real wage elasticity was estimated by -0.5 to -0.7 in all cases but for the long-term interest rate for the first sample (-0.20)[9]. For the second sample – the one we will focus on – the cointegration relationship exists for all kind of user costs variables and the coefficient of the real wage is estimated quite robustly around -0.6. The results are reported in columns II,

[8]Note that the loading for the estimation with the short-term interest rate in the first sample is insignificant and thus no cointegration relationship can actually be found.

[9]This does not lie on the restricted coefficient for output that cannot be actually accepted. Indeed if this coefficient is not restricted, the coefficient of real wage is insignificant and equal to 0.12 (the one of the relative factor price is then significant with -0.02 and a t-stat=-2.33).

III, V and VI of Table (2). This allows us to continue our estimation procedure only in terms of the real wage.

- These last results lead us to focus on the estimation of the Bundesbank which do not involve relative factor prices. As said before, we think that the estimation as done by this institution is not compatible with theory. The whole labour costs should play a role in the demand for labour and the GDP-deflator rather than the consumption deflator. Thus we will estimate an equation in terms of the gross wages deflated by the GDP-deflator with two additional variables: the wage wedge and the price wedge. The wage wedge is defined as the gross wages divided by the wage costs (measuring the relative weight of the employers' social contribution). If the view of the Bundesbank is right, the coefficient of the wage wedge should be insignificant. If ours is right, it should be significant. The price wedge is defined as the ratio of the GDP-deflator to the private consumption deflator. Thus, if our view is right, the coefficient of this wedge should be insignificant. Results of our estimations are reported in Table (3).

Table 3: *Estimation of the labour demand for Germany (1980:1-2004:2) with the different specifications regarding the wage and price variable.*

estimation sample after adjusting points:			
	1981:2-2004:2		
	I	II	III
cointegration vector:			
loading	−0.55 (−5.92)	−0.56 (−6.31)	−0.34 (−9.51)
y	0.68 (9.75)	0.67 (10.78)	1 (−)
w-p			−0.61 (−3.73)
gw-p	−0.30 (−2.26)	−0.28 (−2.44)	
wage wedge	1.99 (4.04)	2.12 (4.72)	
price wedge	0.01 (0.13)		
trend	−0.002 (−2.73)	−0.002 (−3.08)	−0.002 (−3.72)
s91q1	0.08 (5.41)	0.08 (6.48)	
adj. R^2	0.992	0.992	0.994
AIC	-7.340	-7.334	-7.596
SC	-6.577	-6.680	-6.996
LM(1)	0.486	0.376	0.312
LM(4)	0.836	0.654	0.362
LM(8)	0.433	0.191	0.053
Prob. White	0.204	0.297	0.411
Prob. J.-B.	0.620	0.651	0.908
Prob. Reset	0.533	0.979	0.380
free estimated y			1.04 (*s.e.*=0.04)

t-stat are in parenthesis. All variables are in logs.
w-p = compensation of employees per hours worked;
gw-p = gross hourly wages;
wage wedge = gross wages/compensation of employees;
price wedge = GDP-deflator/priv. consumption deflator.

Critical values for the loading (and thus for the test if the cointegration relationship exists) at 5/10% for equation I: -4.52/-4.18; for II: -4.30/-4.00 and for III: -3.91/-3.62 (Banerjee et al. 1998, cited by Hassler (2004)). Critical values for the coefficients inside the cointegration are the usual ones (for 5% 1.96).

From the estimations reported in the Table we can conclude that the GDP-deflator is more appropriate to enter the labour demand (the price wedge is insignificant, column I in Table 3). This result makes sense, since it is a better proxy for producer prices than the consumer prices. Consequently, in column II the price wedge was dropped. From the significant wage wedge coefficient it is clear that also employers' social security contributions play a role. In order to test whether a parted approach with gross wage + wage wedge or an aggregated approach with only the wage costs is better, another equation (column III) was performed. It should be noted at that point, that the level shift dummy was not significant and therefore dropped. This means that real output, real wages and employment are not only cointegrated but also co-breaking at 1991:1. Unsing the Akaike (AIC) and Schwarz (SC) criteria, the last equation (column III) is slightly better. This is also the approach preferred by Hansen (1998), where the wage costs enter the labour demand equation and the wage wedge[10] enters only the wage equation. In this last equation the output could enter with a unit coefficient (a free estimate yield a coefficient of 1.04 with a standard error of 0.04). Furthermore, the loading coefficient of equation II is very high and not in line with the main results found in the literature. At last, there is some difficulty in interpreting the coefficient of 2 for the wage wedge in this second equation (II). Therefore the last equation (III) is our favoured equation and we will present it in a more detailed manner in the next paragraph.

- Each equation was tested for breaks at 1991:1. It is not necessary that we find a level shift in the coefficients of the economic variables. As argued in Hansen (1998), it may be enough to add a level shift dummy to control for the Reunification effects.

[10]Defined broadly in this study as the ratio between product wage and consumer wage.

3.3 Forecasting performance of the favoured equation

In Table (4) we report the detailed statistics of our preferred estimation. Stability tests in form of the Cusum and Cusum^2 did not indicate structural breaks, especially not around 1991:1. It is noteworthy because a level shift dummy and a broken trend for that date were not found significant and thus do not enter the cointegration relationship. We also perform a stability test in form of a recursive regression for the cointegration coefficients. All the coefficients (also those of the short-run dynamics) are re-estimated for each sample. The results are shown in Chart (3). We can conclude that no non-modelled structural break can be identified.

Table 4: *The final labour demand equation for Germany.*

Dependent Variable: Δ hwee
Method: Least Squares
Sample(adjusted): 1981:2-2004:2
Included observations: 93 after adjusting endpoints
Convergence achieved after 32 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
loading	-0.343	0.036	-9.511	0.000
[**y**	**-1.000**	–	–	–
w-p	**0.609**	0.163	3.730	0.000
trend]	**0.002**	0.001	3.722	0.000
	cointegration: hwee = y - 0.61*(w-p) -0.002*trend			
intercept	0.863	0.122	7.055	0.000
z1	-0.086	0.008	-10.130	0.000
z2	-0.058	0.008	-7.615	0.000
i89q2	-0.015	0.005	-2.813	0.006
i94q1	0.020	0.005	3.817	0.000
i91q1	0.241	0.006	42.544	0.000
i91q1(-1)	0.099	0.014	7.168	0.000
i91q1(-2)	0.012	0.006	2.039	0.045
i91q1(-3)	0.095	0.013	7.310	0.000
i91q1(-5)	-0.043	0.012	-3.568	0.001
Δ hwee(-1)	-0.305	0.046	-6.633	0.000
Δ hwee(-3)	-0.305	–	–	–

—continued—

Table 4: *final estimation, following*

Δ hwee(-4)	0.082	0.021	3.900	0.000
Δ hwee(-5)	0.299	0.052	5.713	0.000
Δ y(-5)	-0.280	0.050	-5.597	0.000
Δ (w-p)(-1)	0.287	0.066	4.314	0.000
Δ (w-p)(-2)	0.245	0.047	5.208	0.000
Δ (w-p)(-3)	0.245	–	–	–
Δ days	0.402	0.032	12.569	0.000
Δ days(-1)	0.214	0.036	5.867	0.000
Δ days(-3)	0.214	–	–	–
Δ days(-2)	0.087	0.046	1.909	0.060
General statistics				
R-squared	0.995	Mean dependent var		0.001
Adjusted R-squared	0.994	S.D. dependent var		0.062
S.E. of regression	0.005	Akaike info criterion		-7.596
Sum squared resid	0.002	Schwarz criterion		-6.996
Log likelihood	375.195	Durbin-Watson stat		2.154
Residual tests				
Prob LM(1)	0.312	Prob LM(5)		0.472
Prob LM(2)	0.190	Prob LM(6)		0.579
Prob LM(3)	0.303	Prob LM(7)		0.438
Prob LM(4)	0.362	Prob LM(8)		0.053
Prob ARCH(1)	0.805	Prob Jarque-Bera		0.908
Prob White	0.411	Prob Reset(1)		0.380
In-sample forecasts (dynamic, 1980:1-2004:2)				
Root Mean Squared Error	54.849	Theil Inequality Coefficient		0.002
Mean Absolute Error	43.281	Bias Proportion		0.002
Mean Absolute % Error	0.390	Variance Proportion		0.009
		Covariance Proportion		0.989

– : restricted coefficient

We turn now to the forecasting ability of our equation. We performed four out-of-sample forecasts for 10, 14, 18 and 22 quarters ahead. Each time the equation is re-estimated from 1981:2 to the last quarter before the forcasting sample begins. Chart (4) reports graphically the obtained results and Table (5) the related statistics. The forecasts are satisfying: the actual values are always within the confidence bounds. Because the seasonality is quite strong we report in Table (6) the actual and forecasted value of the growth rates based on the annual data. We also report statistics from two naive forecasts (t-1 and t-4) for comparison purposes in Table (5).

Chart 3: *Stability of the cointegration coefficients for the preferred equation from a recursive estimation*

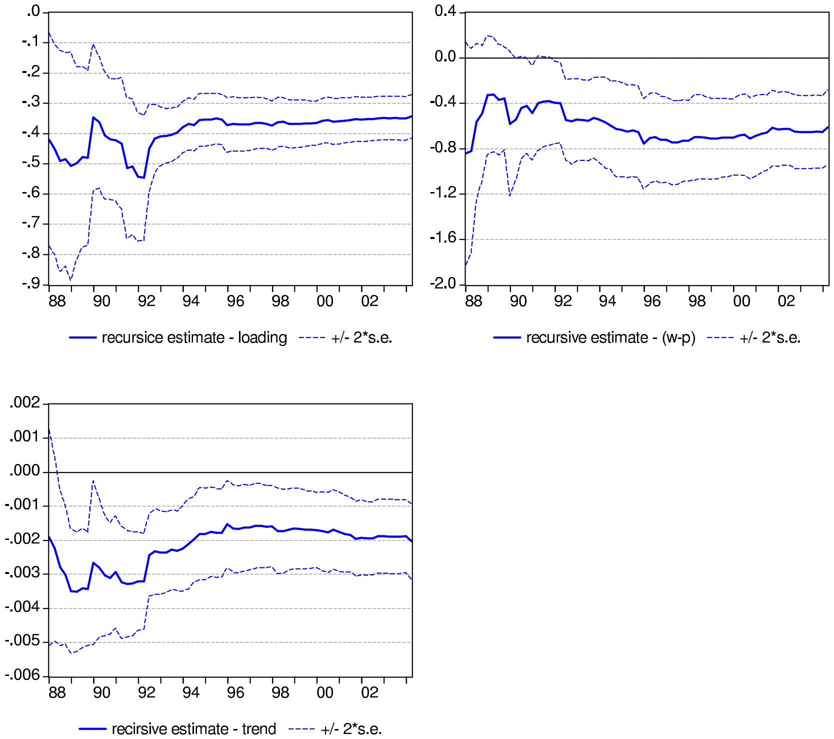


Table 5: *Statistics for the out-of-sample forecasts*

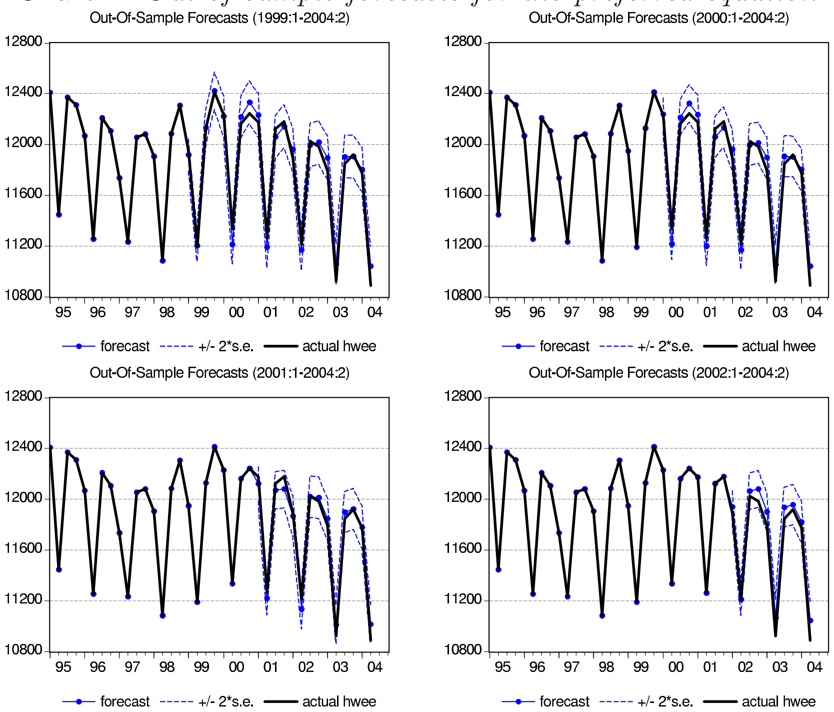
Out-of-sample Forecasts (dynamic)	1999:1-2004:2	2000:1-2004:2	2001:1 2004:2	2002:1 2004:2
Root Mean Squared Error	**70.038**	**75.406**	**62.329**	**90.930**
	619.283	*613.568*	*612.794*	*605.898*
	140.292	*150.312*	*140.728*	*162.178*
Mean Absolute Error	**56.330**	**64.396**	**50.557**	**77.206**
	556.750	*549.875*	*568.167*	*614.750*
	123.600	*135.875*	*128.500*	*163.625*
Mean Absolute Percentage Error	**0.486**	**0.556**	**0.439**	**0.673**
	4.356	*4.225*	*4.233*	*4.301*
	0.955	*1.027*	*0.945*	*1.127*
Theil Inequality Coefficient	**0.003**	**0.003**	**0.003**	**0.004**
	0.026	*0.025*	*0.023*	*0.021*
	0.006	*0.006*	*0.005*	*0.006*
Bias Proportion	**0.064**	**0.088**	**0.000**	**0.716**
	0.011	*0.019*	*0.025*	*0.045*
	0.095	*0.213*	*0.613*	*0.651*
Variance Proportion	**0.004**	**0.004**	**0.213**	**0.053**
	0.003	*0.003*	*0.006*	*0.007*
	0.000	*0.000*	*0.000*	*0.007*
Covariance Proportion	**0.932**	**0.907**	**0.787**	**0.231**
	0.986	*0.978*	*0.969*	*0.947*
	0.905	*0.787*	*0.387*	*0.341*

The first number (bold) refers to the out-of-sample forecasts based on our preferred equation. The second number (italic) refers to a (static) naive out-of-sample forecast based on the actual value in t-1. The third number (italic) refers to a (static) naive forecast based on the actual value in t-4.

Table 6: *Statistics for the out-of-sample forecasts of the preferred equation*

		out-of-sample forecast for the sample:			
growth rates in % (based on yearly means)	actual	1999:1-2004:2	2000:1-2004:2	2001:1-2004:2	2002:1-2004:2
1999 over 1998	0.63	0.62	–	–	–
2000 over 1999	0.61	0.65	0.65	–	–
2001 over 2000	-0.49	-0.76	-0.76	-1.00	–
2002 over 2001	-1.31	-1.01	-1.02	-0.96	-0.93
2003 over 2002	-1.34	-0.81	-0.80	-0.76	-0.91
root mean squared error		0.30	0.34	0.49	0.41

Chart 4: *Out-of-sample forecasts for the preferred equation*



3.4 System estimation

In this section, a system estimation is performed. The single-equation approach or partial system estimation carried out till now is only valid if real GDP and the wage costs variable are weakly exogenous. Thus a system approach should be preferable. The Johansen cointegration test is performed with the following specification[11]: the endogenous variables are the hours worked (hwee), real GDP (y) and real hourly wages (w-p). The exogenous variables that enter only the cointegration space are a trend (t), a level shift dummy (s91q1) and a broken trend (st91q1). A constant, centered seasonal dummies, impulse dummies (especially i91q1) and the differenced logarithms of the working days (Δdays) are included in the VAR as unrestricted exogenous variables.

For the estimation of the unrestricted VAR, a lag-length of 5 is choosen. The Akaike- (AIC), the Schwarz- (SC) and the Hannan-Quinn- (HQ) criteria gave very different results (resp. 8, 1 and 5). A lag exclusion test (F-test) pointed to a lag-length of 5. After eliminating an outlier in the output equation (i87q1) and not significant unrestricted deterministic, the residuals behave well. In the Table (7) we give some diagnostic tests for this VAR estimation. It is worth noting at this stage, that the usual F-tests (exclusion tests) conclude that the trend was not significant (F-stat=2.019, prob=0.121), whereas the level shift dummy (F-stat=2.657, prob=0.056) and the broken trend (F-stat=3.745, prob=0.016) are significant at the 10% level. We do not think that it makes much sense to eliminate only the trend. We estimate also a VAR without broken trend (II) and a VAR without trend but with broken trend (III). For both of them the lag length was selected at 5 and no major problem can be detected in the residuals. We report the cointegration tests for the three VARs in Table (8).

Model III would be the model that we should choose, because the trend seems to be insignificant. But the Johansen test indicates three stationary

[11] The Johansen procedure is conducted with the sofware PcGive, whereas the single error correction equations were estimated with EViews.

variables or no cointegration at all. It is not in line with the results obtained using the Perron test and the single equation. Model II seems to yield to a more reasonable conclusion; one or two cointegration relationships. Model I has the same problem as model III: no conclusion about the rank can be reasonably drawn from the Johansen test. Thus we continue the analysis with model II and report the β- (cointegration coefficients) and α- (loadings) coefficients of the cointegration relationship in Table (9). The choice between r=1 and r=2 is difficult. The first cointegration relationship is the labour demand. The second one could be interpreted as the labour supply, because the real wage has a positive coefficient. Labour supply is usually derived from utility maximization and depends also from real wages. However most empirical studies on labour supply find however a low elasticity of real wages on labour supply (Wagner & Jahn, 2004, p. 22 and Franz, 2003a, pp. 64-74). Thus we tested both possibilities.

By the estimation of the VECM with r=1, the cointegration relationship found in the one-equation-section was confirmed. We do not present the results however, because the estimation was not stable. Indeed we always found one eigenvalue outside the unit circle additionally to the two that are restricted to one (because of r=1). Thus, we turned to r=2, which yields to stable results. Some of the restrictions are reported in Table (9). The labour demand relationship is the first one, the labour supply the second one. The same restrictions as in the one-equation-section were found for the labour demand. For the labour supply we could restrict the influence of real GDP to be zero. One explanation for this is that discouragement effects somehow compensate offsetting effects[12].

The last panel of Table (9) gives us the labour demand relation: $hwee = y - 0.61(w-p) - 0.002t$ and the labour supply relation: $hwee = (w - p) - 0,003t + 0.177s91q1$. The loading of the labour demand cointegration

[12]Discouragement effects refer to discouragement of unemployed due to bad perspectives on the labour market that leads to resignation and withdraw from job-seeking activities. Offsetting effect refer to the fact that if the head of the household looses his/her job, secondary household members get incentives to prospect for jobs in order to overcome the loss in revenue.

relationship has the wrong sign in the y-equation. But no eigenvalue – beside the one that is restricted from r=2 – could be found outside the unit circle. Thus the system is not explosive. The loading coefficient for the labour demand in the hwee-equation has the right sign and is significant, whereas it is insignificant for the labour supply.

Table 7: *Residual tests for the VAR(5) with (hwee, y, w-p) as endogenous and t,s91q1 and st91q1 as restricted exogenous (sample: 1982:1-2004:2).*

equation	test	distribution	statistic	probability
LM-Test (autocorrelation)				
hwee	AR 1-1 test	F(1,61)	1.9546	[0.1672]
y	AR 1-1 test	F(1,61)	0.44885	[0.5054]
wp	AR 1-1 test	F(1,61)	0.79154	[0.3771]
hwee	AR 1-2 test	F(2,60)	2.6234	[0.0809]
y	AR 1-2 test	F(2,60)	0.99516	[0.3757]
wp	AR 1-2 test	F(2,60)	1.7708	[0.1790]
hwee	AR 1-3 test	F(3,59)	1.7262	[0.1714]
y	AR 1-3 test	F(3,59)	0.68155	[0.5668]
wp	AR 1-3 test	F(3,59)	1.3994	[0.2519]
hwee	AR 1-4 test	F(4,58)	1.333	[0.2686]
y	AR 1-4 test	F(4,58)	0.5032	[0.7335]
wp	AR 1-4 test	F(4,58)	1.518	[0.2089]
hwee	AR 1-5 test	F(5,57)	1.2017	[0.3201]
y	AR 1-5 test	F(5,57)	0.41412	[0.8370]
wp	AR 1-5 test	F(5,57)	1.2496	[0.2983]
hwee	AR 1-8 test	F(8,54)	2.3914	[0.0276]*
y	AR 1-8 test	F(8,54)	0.89821	[0.5246]
wp	AR 1-8 test	F(8,54)	1.5713	[0.1553]
JB-test (normality)				
hwee	Normality test	$Chi^2(2)$	0.065247	[0.9679]
y	Normality test	$Chi^2(2)$	0.23022	[0.8913]
wp	Normality test	$Chi^2(2)$	3.2492	[0.1970]
ARCH				
hwee	ARCH 1-1 test	F(1,60)	0.24604	[0.6217]
y	ARCH 1-1 test	F(1,60)	0.89751	[0.3473]
wp	ARCH 1-1 test	F(1,60)	0.45749	[0.5014]
hwee	ARCH 1-4 test	F(4,54)	0.12618	[0.9724]
y	ARCH 1-4 test	F(4,54)	0.37027	[0.8288]
wp	ARCH 1-4 test	F(4,54)	0.74983	[0.5625]
Heteroscedasticity				
hwee	hetero test	F(35,26)	0.42735	[0.9902]
y	hetero test	F(35,26)	0.33362	[0.9986]
wp	hetero test	F(35,26)	0.45792	[0.9841]

Table 8: *Residual tests for the VAR(5) with (hwee, y, w-p) as endogenous and t,s91q1 and st91q1 as restricted exogenous (sample: 1982:1-2004:2).*

VAR(5)	I		II		III	
restricted deterministic:						
trend	x		x			
s91q1	x		x		x	
s91q1*trend	x				x	
	stat	prob	stat	prob	stat	prob
Trace test						
r=0	71.99	[0.000]**	78.69	[0.000]**	59.41	[0.000]**
r=1	42.57	[0.000]**	30.51	[0.011]*	27.91	[0.000]**
r=2	15.68	[0.013]*	3.81	[0.767]	8.35	[0.004]**
Trace test (T-nm)						
r=0	59.99	[0.013]*	65.58	[0.000]**	49.51	[0.000]**
r=1	35.47	[0.002]**	25.42	[0.055]	23.26	[0.002]**
r=2	13.07	[0.013]*	3.17	[0.846]	6.96	[0.008]**
Max test						
r=0	29.42	[0.000]**	48.19	[0.000]**	31.5	[0.001]**
r=1	26.88	[0.002]**	26.7	[0.002]**	19.56	[0.005]**
r=2	15.68	[0.039]*	3.81	[0.769]	8.35	[0.004]**
Max test (T-nm)						
r=0	24.52	[0.072]	40.16	[0.000]**	26.25	[0.007]**
r=1	22.4	[0.015]*	22.25	[0.016]*	16.3	[0.021]*
r=2	13.07	[0.038]*	3.17	[0.848]	6.96	[0.008]**
at 5%	Trace: r=3; Max: r=0/3		Trace: r=1; Max: r=2		Trace: r=3; Max: r=3	
at 1%	Trace: r=0/2; Max: r=0/2		Trace: r=1/2; Max: r=1/2		Trace: r=3; Max: r=1/3	
NB	trend is not significant		trend is not significant			
	prob(F-test) 0.121		prob(F-test) 0.284			

Table 9: *Cointegration coefficients. VAR(5) with (hwee, y, w-p) as endogenous and t and s91q1 as restricted exogenous (1982:1-2004:2; r=2).*

	beta					alpha			χ^2-prob
	hwee	y	wp	Trend	s91q1	hwee	y	wp	
Coeff	1	-1.515	1.772	0.0003	0.092	-0.194	-0.207	-0.222	-
Coeff	1	-0.314	-0.825	0.004	-0.147	-0.174	-0.111	0.197	
s.e.									
t-stat									
Coeff	1	-1	0.718	0.002	0	-0.321	-0.337	-0.293	0.573
s.e.						*0.098*	*0.154*	*0.126*	
t-stat						*-3.29*	*-2.18*	*-2.33*	
Coeff	1	-0.045	-1.319	0.005	-0.191	-0.019	0.034	0.261	
s.e.						*0.042*	*0.067*	*0.054*	
t-stat						*-0.45*	*0.52*	*4.79*	
Coeff	1	-1	0.71821	0.002	0	-0.322	-0.336	-0.281	0.573
s.e.			*0.1834*	*0.001*		*0.096*	*0.152*	*0.124*	
t-stat			*3.92*	*2.68*		*-3.35*	*-2.21*	*-2.27*	
Coeff	1	0	-1.415	0.005	-0.200	-0.018	0.033	0.249	
s.e.			*0.548*	*0.002*	*0.023*	*0.040*	*0.064*	*0.052*	
t-stat			*-2.58*	*2.26*		*-0.45*	*0.52*	*4.79*	
Coeff	1	-1	0.617	0.002	0	-0.341	-0.259	-0.213	0.617
s.e.						*0.055*	*0.087*	*0.113*	
t-stat						*-6.21*	*-2.98*	*-1.88*	
Coeff	1	0.335	-2.356	0.006	-0.254	0	0	0.167	
s.e.								*0.035*	
t-stat								*4.72*	
Coeff	1	-1	0.617	0.002	0	-0.341	-0.259	-0.269	0.617
s.e.			*0.188*	*0.001*	*0*	*0.055*	*0.087*	*0.123*	
t-stat			*3.29*	*3.14*		*-6.21*	*-2.98*	*-2.19*	
Coeff	1	0	-1.610	0.005	-0.190	0	0	0.223	
s.e.			*0.615*	*0.002*	*0.024*			*0.047*	
t-stat			*-2.62*	*2.25*	*-7.85*			*4.72*	
Coeff	1	-1	0.609	0.002	0	-0.339	-0.258	-0.305	0.598
s.e.				*0.000*		*0.054*	*0.086*	*0.132*	
t-stat				*28.29*		*-6.26*	*-3.00*	*-2.31*	
Coeff	1	0	-1	0.003	-0.177	0	0	0.253	
s.e.				*0.000*	*0.015*			*0.055*	
t-stat				*9.93*	*-11.74*			*4.56*	

4 Conclusions

From our estimated specifications of the German labour demand in terms of working hours, we can draw several conclusions:

- Labour demand estimations for Germany yield very different results regarding the elasticity w.r.t. real wage costs, depending on whether data for reunified Germany are included or not. Whereas estimations with solely West-German data yield low or even insignificant elasticities, estimations with half West-German and half reunified German data yield quite consistenly to an elasticity of about -0.6.

- Relative factor prices do not play a role for the sample 1980-2004. Following the interpretation of Barrell et al. (1996), this means that Germany did loose its economic leadership in the 90's. It ascertains also that other countries are no longer able to adjust their nominal prices so quickly, so that Germany can achieve competitive advantage by varying its nominal prices. Even if one thinks that the shock of Reunification has been overcome in the begining of the XXI-century, with the European Monetary Union (EMU), we cannot expect the old scheme, as estimated by Barrell et al. (1996), to be restored. The reason is that even if Germany should regain its leading role, the other countries cannot longer adapt their nominal outcomes quickly via depreciation because of the common currency.

- Elasticity w.r.t. output is robustly estimated to be one and does not appear to have changed after the Reunification.

- Single equation and system estimations yield the same elasticities. The level shift dummy for 1991:1 in the favoured equation turned out to be insignificant, implying co-breaking between employment, real wages and real output for that date.

- Forecasting quality of the preferred equation is good.

However, there are some points still unanswered which will be considered in a next working paper of the same series:

- First, with the introduction of chained prices for the National Account Statistics, our database for Reunified Germany will not be elongated in the future. It will be interesting to see, to which extent the elasticities are affected by the new methodology. If theory holds, this should not, however, affect the results to a great extend.
- Second – and more important as we pointed out in the paper – the special context of Reunification should be considered before drawing conclusions from the elasticities estimated above. Especially, it should be analysed if a more subtile deterministic or in addition of other exogenous variables integrating the specific Reunification effects better than the dummy variables would change the presented results.
- Third, the rising globalization may have some influence – at least at the end of the sample and thus for the near future – on the elasticity, esp. w.r.t. output. It would be interesting to introduce a possibility for differing elasticity depending on the composition of real GDP.

5 Annex

5.1 Estimations of the German labour demand measure as the number of employees in the literature

Table 10: *Review of the estimated (aggregate) labour demand for Germany, in terms of the number of employees.*

Study	*real output*	*real wage (or rel. fact. price)*	*loading coeff.*	*deterministic*	*sample range*
Horst (2003)	0.77 LR=7.38	-0.48 (8.0)	-0.33 (-3.3)	T,T^2, SD(1991-94)	1962-1994
	Yearly West-German data. Cointegration estimation within 2 steps (Engle-Granger). SD(1991-94) is a level shift dummy for the years 1991 to 1994 to control for Reunification effects. The LR-stat did reject a unity coefficient for output measured as real GDP. Wages are measured as wages costs/GDP deflator.				
IAB (2004)	0.58 n.a.	-0.48 n.a.	-0.08 (-3.36)		1991:1-2003:4
	Quarterly seas. adj. data, reunified Germany. The t-stat are not available. Real output=real GDP, real wages=gross wages/producer price index.				
Smolny(2003)	1 restr.	-1.78 (-3.6)	-0.28 (-4.1)		West 80's
	1 restr.	-0.46 (-1.5)	-0.48 (-4.8)		West 90's
	1 restr.	-1.22 (-1.9)	-0.16 (-3.0)		West 90's new NA
	1 restr.	-2.02 (-16.5)			East 90's
	1 restr.	-1.92 (-38.4)			East 90's new NA

—*continued*—

Table 10: *Review of literature, following*

Study	*real output*	*real wage (or rel. fact. price)*	*loading coeff.*	*deter-ministic*	*sample range*
	Yearly data, 80's=1980-89, 90's=1990-97 for West-Germany, 1992-97 for the East and 1991-2002 for both parts according to the new National Account (NA) definitions. Panel cointegration (Western Länder vs. Eastern Länder). Output is the real value added, real wage are measured in terms of wage costs/value added price. The output elasticity is restricted to one. The equations are estimated in levels for East-Germany.				
Hansen (1998)	1 restr.	wp: -0.58 (-13.8)	n.a.	T	1966:1 -90:2 West
	VECM with (y-l, wp, wnpc, u, l), where y=real GDP, l=employees, wp=wage costs/GDP defl., wnpc=net wages/priv. cons. defl. and u=unemployment rate. The data are quarterly and seasonally adjusted. Two cointegration relationships are identified: a labour demand and a wage equation.				
	1 restr.	-0.59/-0.61 (-10.34/ -10.61)	0.07 (0.55)	T	1966:1 -94:4 West
	Same VECM but with an extended sample (Reunification years are included). A level shift is introduced in the wage equation for the constant and the wage wedge (wp-wnpc). No Reunification effect was found in the Western labour demand equation.				
	1 +0.005*SD restr. (5.0)	-0.50 (-33.2)	-0.69 (-0.55)	T, ID(89:3)	1966:1 -95:4, West+East
	Same VECM but with an extended sample and from 1990:3 onward data for reunified Germany were taken. A impulse dummy (ID) and a changing coefficient for the output (SD) after Reunification are introduced in the labour demand equation.				
Franz (2003)	0.72	-0.83	n.a.		1953-1983
	chap.4, p.164. From Bean, Layard & Nickell (1986), yearly data, West-Germany. Real output is de-trended.				
	0.66	w/r: -0.14 w/pm: +0.01	-0.12 (-3.2)	T	1964:1 -86:4

—continued—

Table 10: *Review of literature, following*

Study	*real output*	*real wage (or rel. fact. price)*	*loading coeff.*	*deter-ministic*	*sample range*
	chap.4, p.165. From Flaig & Steiner (1989, p.405). Single ECM-equation (Engle/Granger) for the West-German manufacturing sector. The real wage (w/p) elasticity is thus -0.13, the one of the real interest (r/p) rate is +0.14 and of the relative import price (pm/p) +0.01.				
Source: van der Horst (2003), Bach, Gaggermeier, Pusse, Rothe, Spitznagel & Wanger (2004), Smolny (2003), Hansen (1998) and Franz (2003b).					

5.2 Stationarity tests (Perron-tests)

Table 11: *Integration tests*

variable name	test type	model type (Perron)	lag-length	determi-nistic	test-stat	conclusion
y	Perron	C, s9101	1,4	c,trend	-3.87	I(1)
gw	Perron	C, s9101	1,4,5,7	c,trend	-6.35	I(0) TS
w	Perron	C, s9101	1,4,5,7	c,trend	-5.98	I(0) TS
hwee	Perron	C, s9101	1,2,3,4	c,trend	-2.65	I(1)
price wedge	Perron	A, 8601	1,2,5,7	c	-0.32	I(1)
wage wedge	Perron	A, 9401	1,2,3,8	c	-4.78	I(0)
pc	ADF		4,6	c,trend	-3.16	I(1)
pcc	ADF		4	c,trend	-1.96	I(1)
p	ADF		4,6	c,trend	-2.24	I(1)
days	ADF		4,5,6,7	c	-10.64	I(0)
i10y	ADF		1,5,8	c	-2.12	I(1)
i3m	ADF		1,6	c	-1.68	I(1)

Conclusions are drawn from the critical values of Perron (1989) for the Perron-tests and Dickey & Fuller (1979) for the other tests.

Model A: model with a level shift dummy; Model C: model with a level shift dummy and a broken trend.

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