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Reaction Patterns of German Regional Labour Markets to Macroeconomic and Policy-induced Shocks—— A Comparative Analysis[1]

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Abstract: This paper analyses labour market reactions of three representative German federal states to economic and policy-induced shocks. The magnitude of the reactions of the states to an equally strong shock on labour demand, labour supply and unemployment are observed. Differences in the structural composition of the states' economies and flexibility of the states' labour markets lead to distinct reaction patterns over time. The reaction patterns of all states are dominated by labour demand effects in the short term, whereas labour supply effects are propagated over time and, hence, from the medium term onwards dominate the development of the unemployment rate.

JEL Classifications: E24, O18, R23

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1. Introduction

The paper examines the short, medium and long-term reactions of regional labour markets to macroeconomic and policy-induced shocks in Germany. Its main hypothesis is that the structural economic composition of a region determines its reaction to such shocks. Mainly the interaction between labour demand, labour supply and the institutional setting impacts on the magnitude and the duration such shocks have on the unemployment rate of regions. Using regional data, while considering the institutional framework of the labour market while analyzing such shocks, is the main contribution.

Experiencing the same macroeconomic shocks, the regional impact is often diverse. These diverse effects and influences can be particularly well observed in Germany with its federal states showing very distinctive differences in economic activity, sectoral composition, unemployment rates, and level of innovation. Pronounced differences are in the Western German states of Baden-

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Wuerttemberg, North Rhine-Westphalia and Schleswig-Holstein.[2] They serve as representative study objects.

We use a labour market model as tool for modelling macroeconomic and policy shocks and observe their effects on employment. Our model builds on Minford et al (1994) and Baussola (2007). It extends those by the national institutional setting and by a higher degree of detail in its structure. Our model's structure is unique in the German context.[3] Even though on a much smaller scale, it follows the large econometric models for impact analysis such as the Bank of Italy (1986) for central banks, Bergin et al. (2009) for government research units, the IMF (1998) for international organizations, Roeger & Veld (1997) for the European Commission, or Pesaran et al (2004) for bargaining parties and many other institutions. Our modelling strategy fills the gap between those comprehensive traditional models and models investigating more specific supply-side and economic dynamic issues. The model also incorporates a dynamic setting as prerequisite for analysing dynamic responses to shocks.

Bean (1994) provides background for investigating the sources of shocks. He finds that labour demand shocks depend mainly on nominal inertia in prices and wages; that means their transmission depends on the reaction patterns of employment and wages to changes in inflation. High nominal inertia in prices and wages – i.e. prices and wages are preset to a large extent – impacts highly on unemployment. If the slopes of the price-employment and wage-setting schedules are steep, then a negative demand shock affects the unemployment rate only little. That a nominal demand shock triggers real effects in the long term, a mechanism that propagates the negative impact of the shock over time is needed, Bean (1994). Such a mechanism can be a slowdown in productivity, an increase in taxes and import prices, an increase in worker militancy, an increase in unemployment benefits, a continuing mismatch between vacant jobs and unemployed workers. These factors influence unemployment by effects on the labour demand and on the labour supply side. Further mismatch can come from labour market regulation and inflexibility. Labour market regulation increasing minimum wages[4] or increasing employment protection reduces flexibility of labour demand and supply and hinders the match of jobs and workers. Lazear (1990) finds for 22 OECD countries that severance pay reduces employment and raises unemployment.[5] A further shock can be an increased mark-up induced by sector concentration or by an increase of the real interest rate. An increased mark-up leads to a downward movement in the price-employment schedule and an increase in the unemployment rate. As already noted, movements of the price-employment schedule and the wage-setting schedules can transmit these shocks. This is why one can expect shocks to have an impact over time, even if the shock was a fleeting event in the past.

Möller (2001) provides the most important adjustment mechanisms of a region in response to a shock, such as a decrease in demand. He mentions first a low degree of labour mobility - in the form of commuting and migration- that lowers labour outflows and hence, pre-shock employment might not be restored. As Europe generally shows lower labour mobility than the US, we can expect negative shocks to have a large and long-lasting effect in Europe (Blanchard & Katz, 1992, and Decression & Fatas, 1995). With low labour mobility the reaction to a shock in Europe and

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2 Even though the differences between Eastern and Western German states would be more pronounced, we only include Western German states in our analysis. We exclude Eastern German states, as we lack data before 1990.

3 An inclusion of the national institutional setting also allows for structural comparisons of regions beyond national boundaries as the differences in national labour market institutions can be accounted for.

4 Brown (1988) reviews studies on minimum wages. The studies reviewed find that a ten percent increase in the minimum wage reduces teenage employment by one to three percent on average.

5 Lazear's regression analysis, however, includes little else that could explain the rise in unemployment so that the relevance of his result is not straightforward.

Germany, takes place through changes in the labour participation rate. Empirics often find the discouraged-worker effect dominating so that participation declines as a response to a negative economic shock. Second, in response to higher unemployment, real wages decline as do product prices. Workers are less likely to find a job particularly if they are not mobile. In this case they reduce wage aspirations which lead to lower labour costs and allow firms to reduce prices. Third, the effect on capital flows is positive if main input prices of production – such as real wages of workers - decrease. However, if the economic shock negatively affects the expectation of economic development of the region, capital outflows might increase. Fourth, productivity should be negative in the short term and as economic development picks up, positive in the long term. Möller (2001) finds that adjustment mechanisms are generally slow and better measured in decades than years. He also states (2001, 32) that "[…] regional production and the potential labour supply [...] are influenced by the initial conditions and, therefore, by temporary shocks. In other words, these variables are path-dependent [...]. More specifically, it can be shown that temporary shocks in the price level, in labour supply and unemployment can affect the economic power of the region in the long term, while temporary wage and production (demand) shocks are irrelevant in this respect."

Regional transfer payments may further delay regional adjustment processes, Obstfeld & Peri (1998). The speed of adjustment does depend on the institutional setting of the country, Bayoumi (2004). Monperrus-Veroni *et al.* (2008) show that Germany's unemployment rate shows high sensitivity to shocks. Scarpetta (1996, 71) adds: "High levels of unemployment benefit entitlements are likely to lead to higher levels of unemployment and reduce the speed of labour market adjustment after an exogenous shock." Hence in the shock exercise we expect high initial reaction and slow adjustment thereafter.

The labour market model is presented in section 2. Section 3 contains a dynamic deterministic simulation of the labour market model in order to analyse its fit to the data. In the second part of section 3 we then model economic and institutional shocks. The results of the shocks are provided in section 4, including policy implications for each of the three investigated German states. Finally, section 5 presents the conclusion.

2. The Labour Market Model

While developing the labour market model we take the goods market as exogenous. The labour market model adopts an error correction mechanism (ECM) and has the form of a simultaneous equations model. ECM captures dynamic issues while incorporating long-term relationships which are ideal for modelling shocks and observing dynamic reactions. Choosing a top-down rather than a bottom-up approach enables us to confront the responses of the regions to supply and demand shocks.

The labour market model comprises three blocks of equations: one for identities (equations 1-5), one for labour demand (equations 6 and 7) and one for labour supply (equations 8 and 9). The model identities close the model and contain aggregates like the unemployment rate, total labour demand (called total employment) and total labour supply (called labour force). The model has four stochastic equations, and five identities. Small letters denote the log-value of a variable. Log-values allow for some basic form of non-linearity in the estimating relationship. Some variables are denoted in differences (Δ) and all are either current values (t) or one year lagged (t-1) according to the economic theory and their statistical significance.[6] Endogenous variables are described in the model and their values are obtained by calibration. The values of exogenous variables are taken as such from data sets.

[6] The exact meaning and source of the variables can be found in Appendix A.

We explain the model from an aggregate to a detailed perspective and, hence, start with the identities.

$$ur_{i,t} \equiv \frac{100*(lf_{i,t} - te_{i,t})}{lf_{i,t}} \tag{1}$$

$$lf_{i,t} \equiv pr_{i,t} * pop_{i,t} \tag{2}$$

$$te_{i,t} \equiv e_{i,t} + se_{i,t} \tag{3}$$

$$e_{i,t} \equiv eind_{i,t} + eser_{i,t} + eagr_{i,t} \tag{4}$$

$$profse_{i,t} \equiv \frac{prof_{i,t}}{se_{i,t}} \tag{5}$$

The identities (equations 1 - 5) provide the connections between the endogenous and exogenous variables. The final result of the model, the unemployment rate (equation 1), is endogenously determined by the aggregates of labour force (lf) and total employment (te). Labour force is our measure for labour supply and total employment for labour demand. Labour force (equation 2) is defined by the endogenous variable participation rate (pr, equation 8) and the exogenous variable population (pop). The total employment variable (te, equation 3) consists of the endogenous dependent-employees-variable (equation 4) and the endogenous self-employment-variable (se, equation 9). The dependent-employees-variable is split into the endogenous variables of employees in industry (eind, equation 6), employees in services (eser, equation 7) and the exogenous variable employees in agriculture (eagr). The last of the identities (profse, equation 5) provides a proxy for the profits of the self-employed, used in the self-employment equation (se, equation 9).

Labour demand - employees in industry and services (equation 6 and 7)[7] - depends on real value added (vaind/p, vaser/p) and real wages (wind/p, wser/p).

$$\begin{aligned}\Delta \mathrm{eind}_{i,t} = {} & c_i(1) + c_i(2) * \Delta \mathrm{eind}_{i,t-1} + c_i(3) * \frac{\Delta \mathrm{vaind}_{i,t}}{p} + \\ & c_i(4) * \frac{\Delta \mathrm{wind}_{i,t-1}}{p} + c_i(5) * \Delta \mathrm{lhind}_{i,t} + c_i(6) * \Delta \mathrm{ltax}_{i,t} + \\ & c_i(7) * \mathrm{eind}_{i,t-1} + c_i(8) * \frac{\mathrm{vaind}_{i,t-1}}{p} + c_i(9) * \frac{\mathrm{wind}_{i,t-1}}{p} + \\ & c_i(10) * \mathrm{uc}_{i,t-1}\end{aligned} \tag{6}$$

[7] Data availability only from 1995 onwards restricts further disaggregation of labour demand into highly, average and less innovative industry and highly, average and less knowledge intensive services.

$$\begin{aligned}\Delta eser_{i,t} &= c_i(11) + c_i(12) * \Delta eser_{i,t-1} + c_i(13) * \frac{\Delta vaser_{i,t}}{p} + \\ & c_i(14) * \frac{\Delta wser_{i,t-1}}{p} + c_i(15) * \Delta lhser_{i,t} + c_i(16) * \Delta ltax_{i,t} + \\ & c_i(17) * eser_{i,t-1} + c_i(18) * \frac{vaser_{i,t-1}}{p} + c_i(19) * \frac{wser_{i,t-1}}{p} + \\ & c_i(20) * uc_{i,t-1}\end{aligned} \tag{7}$$

Our specification for the industry and services sector follows Pesaran et al, 1994. We take employees in agriculture as exogenous because of substantive market bias, i.e. by EU subsidies. By taking real values (GDP deflator) the specification accounts for changes in prices. The inclusion of value added and wages corresponds to the ingredients of a standard inverted Cobb-Douglas production function and is similar to the model of Pesaran et al. (1994). They also adopt a general log-linear dynamic specification where labour demand - expressed as the log of man-hours employed in sector i at time t – depends mainly on a lagged employment variable, the log of output of sector i at time t, the log of average product real wage per man-hour employed in sector i at time t. We use value added as proxy for output. According to the neoclassical profit maximisation condition, real wages reflect labour productivity. As factor shares for land, natural resources and other production inputs (Jones, 2002) decline we only include real wages as cost of production. Besides the cost of production, the number of employees also depends on how intensively labour is used over the business cycle, captured by the labour hoarding variables (lhind and lhser) in equations (6) and (7). De Koning (1989, 155): "Confronting strong output fluctuations, companies are in no position to adjust their labour volume instantly to the technically efficient level. Because of that, they may find themselves with an internal labour reserve at one moment, and be short of labour at another. This phenomenon is called labour hoarding." Hamermesh (1993, 205) describes labour hoarding as: "…a less than proportionate decrease of worker hours in response to a negative demand shock." We follow Hamermesh's (1993) proposition and measure labour hoarding – a proxy for fluctuations in labour productivity- as average hours worked in difference terms.

For factors influencing the matching process and capturing the institutional setting, we refer to Nickell (2003). According to the most probable direction of their effect we divide them between the labour demand side (equations 6 and 7) – labour taxes (ltax) and union coverage (uc) – and labour supply side (equations 8 and 9) – expenditure on active labour market policy (almp).[8]

Labour supply consists of equations (8) and (9) as following.

$$\begin{aligned}\Delta pr_{i,t} &= c_i(21) + c_i(22) * \Delta pr_{i,t-1} + c_i(23) * \Delta(\frac{se}{pop})_{i,t} + c_i(24) * \Delta(\frac{e}{pop})_{i,t} \\ & + c_i(25) * \Delta\frac{imig}{pop}_{i,t} + c_i(26) * \Delta\frac{emig}{pop}_{i,t} + c_i(27) * pr_{i,t-1} + \\ & c_i(28) * \frac{se}{pop}_{i,t-1} + c_i(29) * \frac{e}{pop}_{i,t-1} + c_i(30) * \frac{imig}{pop}_{i,t-1} + \\ & c_i(31) * \frac{emig}{pop}_{i,t} + c_i(32) * almp_{i,t}\end{aligned} \tag{8}$$

[8] Nickell (2003) proposes seven institutional variables; however, we only include the three significant variables in our model specification. The labour tax variable (ltax) is also included as it has been significant in the OLS Ordinary Least Squares) (case- which is not presented here.

$$\Delta se_{i,t} = c_i(33) + c_i(34) * \Delta se_{i,t-1} + c_i(35) * \Delta(profse)_{i,t} + c_i(36) * \Delta(\frac{eind}{e})_{i,t} + c_i(37) * se_{i,t-1} + c_i(38) * profse_{i,t-1} + c_i(39) * (\frac{eind}{e})_{i,t-1} + c_i(40) * almp_{i,t} \quad (9)$$

Equation (8) explains the participation rate of the labour force (pr). It includes a ratio of the self-employed (se/pop) and also of the dependent employees (e/pop). Equation (8) is a modified version of the discouraged-worker hypothesis. The hypothesis says that fluctuations in labour supply are triggered by fluctuations in labour demand: A decline in employment (e/pop) decreases labour force participation, while an expanding job market encourages workers to join the active labour force - increasing the participation rate. The same argument can be applied to emigrants (emig/pop) and immigrants (imig/pop): An expanding job market attracts immigrants while a tight job market increases emigration.

The second equation on the labour supply side, equation (9), describes self-employment (se). Modelling self-employment allows for setting-up one's own business. The first variable of self-employment (profse) is a proxy for profits per head of the self-employed. Using the proxy - set out in equation (5) – becomes necessary, as data for profits of the self-employed is unavailable. Including profits as an explanatory variable is based on the neoclassical argument that people's decisions to set-up a company depends mainly on per-head profits of the self-employed. As a structural variable, the number of employees in industry divided by total employees (eind/e) is included.[9] It captures the marginal component of workers who eventually decide to set up an independent activity. They do so in response to adverse job market opportunities especially in the industry sector.

3. Results of Simulation

Annual data on a NUTS 1 level from 1975-2005 for three German states Baden-Wuerttemberg (BW), North Rhine-Westphalia (NW), Schleswig-Holstein (SH) and the Western German average (DE) is used to simulate the model. The Western German average (DE) comprises data from ten Western German states excluding Berlin.[10]

The reason for the three federal states is that their innovation, economic structure and openness is distinct. BW is an innovative state, where industry remains strong and export and import rates are high. In NW, traditional industry has been strong, private services dominate today and openness is medium. SH has had very little industry historically. Recently, some innovative industries have emerged but it still depends highly on – also public- services. Germany's (DE) average values are displayed for information only.[11] With respect to the estimation approach, we adopt an unstructured time series estimation approach and estimate the model using OLS and SUR

[9] Experiences of the past decades show that for employees in the services sector (eser/e) this is less the case.

[10] Data for Berlin are excluded as after 1992 data for Berlin is West and East Berlin together, whereas until 1992 data is only West Berlin.

[11] Eurostat (2007) confirms the leading position of BW in innovativeness, as all NUTS 2 regions within BW (Stuttgart, Karlsruhe, Tuebingen, Freiburg) are ranked ahead of the regions of NW and SH. BW is particularly strong in innovation in industry – in employment and value added but also leads in employment and value added in knowledge intensive services relative to NW and SH. NW reduces the deviation to BW in employment and value added in knowledge intensive services. SH increases its lead relative to NW in employment and value added in innovative industry (see information and data provided by the Regional Statistical Office, Baden-Wuerttemberg).

methodology.[12] The dynamic deterministic simulation is based on SUR results. This is because the Chi² test rejects equal residuals in the states' regressions and, thus, indicates SUR methodology to be more adequate than OLS.[13]

The next section provides the results of the dynamic deterministic simulations that show the fit of the model to the data. Section 3.2 then presents the simulated shocks and their outcomes.

3.1 Dynamic deterministic simulation

The dynamic deterministic simulation comprises the entire data period from 1975 until 2005. Besides the figures – not provided here as space is limited- also the Root-Mean-Square-Error (RMSE) and Theil's Inequality Coefficient (TIC) confirm a good fit of the SUR estimates to the real data.

Table 1. TIC and RMSE values

	Baden-Württemberg (BW)		North-Rhine Westphalia (NW)		Schleswig-Holstein (SH)		Germany (West) (DE)	
	TIC	RMSE	TIC	RMSE	TIC	RMSE	TIC	RMSE
EIND	0,0068	26638,5	0,0090	49923,3	0,0071	4048,8	0,0076	150922,4
ESER	0,0036	18073,1	0,0042	37237,0	0,0038	5556,0	0,0042	137093,5
PR	0,0025	0,0027	0,0039	0,0038	0,0024	0,0024	0,0029	0,0029
SE	0,0060	6470,1	0,0075	10843,8	0,0059	1665,2	0,0058	37558,0
TE	0,0037	37138,6	0,0050	79203,2	0,0033	7807,6	0,0043	255036,0
UR	0,0472	0,5119	0,0398	0,6464	0,0373	0,6297	0,0417	0,5887
	MZ[1]	Wald[2]	MZ[1]	Wald[2]	MZ[1]	Wald[2]	MZ[1]	Wald[2]
EIND	1,0223	0,6549	0,9655	0,2065	0,9386	0,0725	0,9731	0,4395
ESER	1,0018	0,9550	1,0051	0,7883	1,0015	0,9887	1,0059	0,7458
PR	1,0309	0,2018	**1,0532**	**0,0328**	**1,0321**	**0,0081**	1,0367	0,0538
SE	0,9686	0,6514	0,9945	0,9793	0,9877	0,9488	0,9689	0,5895
TE	1,0157	0,5143	1,0514	0,1184	1,0261	0,1677	1,0295	0,2707
UR	1,0669	0,4770	1,0993	0,1934	1,0858	0,2840	1,1153	0,1396

Note: [1] Coefficient of the Mincer-Zarnowitz regression
[2] Probability of the f statistic of the Wald test

The TIC reveals the good fit of the estimates showing values at the third decimal only, except for the unemployment rate (ur). Unemployment rate estimates are about ten times less precise than the estimates of the other variables. As the unemployment rate is endogenously determined – equation (1) - all estimation errors add up. It can be further observed from table (1) that the RMSE values reach up to 255 036 in the case of total employees in Germany (DE). In Schleswig-Holstein (SH) the RMSE of the same variable adds up to 7 807 only. The example

12 Barbieri (2007) obtained best results in a similar setting for twenty Italian regions.

13 In contrast to OLS estimation, SUR methodology assumes dependence between the estimated equations. Dependence between the equations of a single Land ("regional SUR model") or between the same type of equation – eind, or eser, or pr, or se – between the three states ("equation SUR model") could be possible. Following a graphical inspection of the residuals, we calculated a correlation matrix of them, once for the "regional SUR model" and once for the "equation SUR model". The Chi² test then revealed the "equation SUR model" to be superior to the OLS model. Hence, we used the "equation SUR model" as estimation framework.

clearly demonstrates that the RMSE complements the TIC by providing absolute numbers. The Mincer-Zarnowitz test indicates – at the 95% level of confidence - for labour supply (pr) in NW and SH a timid estimation, overestimating downturns and underestimating upturns.

3.2 Simulation of exogenous economic shocks and policy measures

The diverse feedback mechanisms make it difficult to evaluate the impact of shocks, in general. We reduce complexity by modelling only one shock at a time through an increase of a single variable by 1%.[14] Once a shock is induced, it is held constant – in absolute terms before the log transformation- over the simulation period of 15 years. We further rely on the ceteris paribus assumption.

The simulated shocks affect demand and supply of the labour markets. Demand shocks – in our case value added shocks- directly affect the level of activity, whereas supply shocks – in our case real wage shocks- affect the level of relative prices, and thus, the level of activity of capital and labour. Both shocks have the potential, however, to impact on employment immediately as well as in the long-term. A third kind of shock comprises a productivity shock. Increasing productivity does not increase or decrease production inputs at once. However, relative to the change in output and the elasticity of output, it changes the effect production inputs can have.[15]

Policy-induced shocks constitute a fourth category of shocks. Examples in our case comprise a change in labour taxes, in union coverage and in expenditure on active labour market policy. Policy shocks often affect the matching between labour demand and supply and hence, can also impact on both sides.

The impact of each shock will be assessed by looking at the participation rate (pr) for the labour supply side, total employment (te) for the labour demand side and the unemployment rate (ur) as result of the interaction between labour demand and labour supply. Limited by space, we provide a description of the value added shock and present the results of the other shocks as part of section 4.

3.2.1 Value added shocks

The positive shock in value added in industry - exogenous demand shock induced by, for example, an increase in exports - increases sectoral employment and total employment as well as the participation rate.

As can be observed from the figure 1, in the case of a value added shock in industry (vaind)- see left side of the figure- NW shows the strongest increase in labour demand (te) in the short term. Then employment declines sharply in the medium term to reach the average after about eight to twelve years. BW shows the least pronounced reaction where labour demand (te) only increases about 0.1% above pre shock level before slowly declining to reach pre shock employment after about eight years. In SH employment increases at the beginning, then falls sharply to below pre-shock levels between years two and six before being slightly above the national average DE's level after seven years.

The labour supply side (pr) reacts more slowly than the labour demand side (te). It reaches its peak with a delay of one to two years. Again, NW shows the strongest reaction, where pr increases about 0.65% after one year. Then it declines strongly until the 5th year before the decline fades out. At the end of the simulation period - after 15 years - it still remains 0.17% above pre-

[14] For simplicity we label the shocks i.e. vaind for vaind/p.

[15] According to (Blanchard 2006) a historic example is provided by the 1970s when Harrod-neutral technological progress (division of the Solow residual by the labour share) declined from about 5% in the 1950s and 1960s to about 2% and unemployment increased.

shock level. The strong reaction in NW shows a high discouraged-worker effect in a positive way.[16] In SH, the participation rate increases by a maximum of 0.2% after one year before it declines while still fluctuating. The decline is less pronounced than in NW so that it remains at about 0.1% above pre-shock level after fifteen years. Again, BW shows the least reaction. Its pr reaches a peak of 0.06% after three years and then declines slowly and smoothly to reach pre-shock level after only six years.

The labour demand (te) and labour supply (pr) developments are reflected in the development of the unemployment rate (ur). Again, we observe the most distinct reaction - highest decrease – in NW followed by SH and BW. As labour demand declines much faster than the induced increase in labour supply, the decrease in unemployment is strongest immediately after the shock for NW and SH. The average of DE lies between the reactions of SH and NW. The unemployment rate of SH increases immediately. The maximum of 0.3% above pre shock level is reached after three years. Thereafter, it declines to remain 0.06% above pre-shock level after fifteen years. NW follows a more hump shaped development and reacts more slowly than SH, such that from year four onwards NW shows the highest unemployment rate with a peak in year six and 0.16% above pre-shock level after fifteen years. BW reacts differently. A slight increase right after the shock is followed by a below shock unemployment rate with a minimum in year two. From year two onwards, it bounces back to reach and retain the pre-shock unemployment level for the entire simulation period.

The reaction pattern to the value added shock in services (vaser)- see right side of figure 1- resembles that of the value added shocks in industry (vaind) with the following distinctive feature: The reaction in the unemployment rate is slightly stronger for NW, remarkably stronger for SH and less strong for BW. Especially in the medium term, SH shows a stronger reaction than in the case of a value added shock in industry. Whereas the labour supply (pr) of SH remains above the average (DE) in industry after seven years, it behaves like DE – gradually declining at the same velocity- in the services case after eleven years. The increase in the unemployment rate for SH's services is more pronounced than in the industry case and highest of all the three states between years one and four.

4. Regional Reaction Patterns

In the last sections we focussed on reaction patterns to specific exogenous labour market shocks. In this section we look at how each state reacts to shocks in general. We start with the most innovative region BW, followed by NW and SH.

As a reaction to a positive shock- increase of the respective variable, **Baden-Wuerttemberg (BW)** shows after an initial phase with modest increase in labour demand (te) and a decline thereafter until year six, a third phase, characterised by phasing out towards the pre-shock level. In general, BW shows the second smallest increase in labour demand (te) with SH showing the smallest, the average of DE the second highest and NW the highest.

[16] In literature, the discouraged-worker effect describes the phenomenon that low labour demand leads to low labour supply. This is because workers see low labour demand or a high unemployment rate as a signal for low chances to become employed. In our case the argument stays the same, even though the situation is the opposite. Higher value added leads to higher labour demand that signals higher chance for workers to find a job, and hence, labour supply increases.

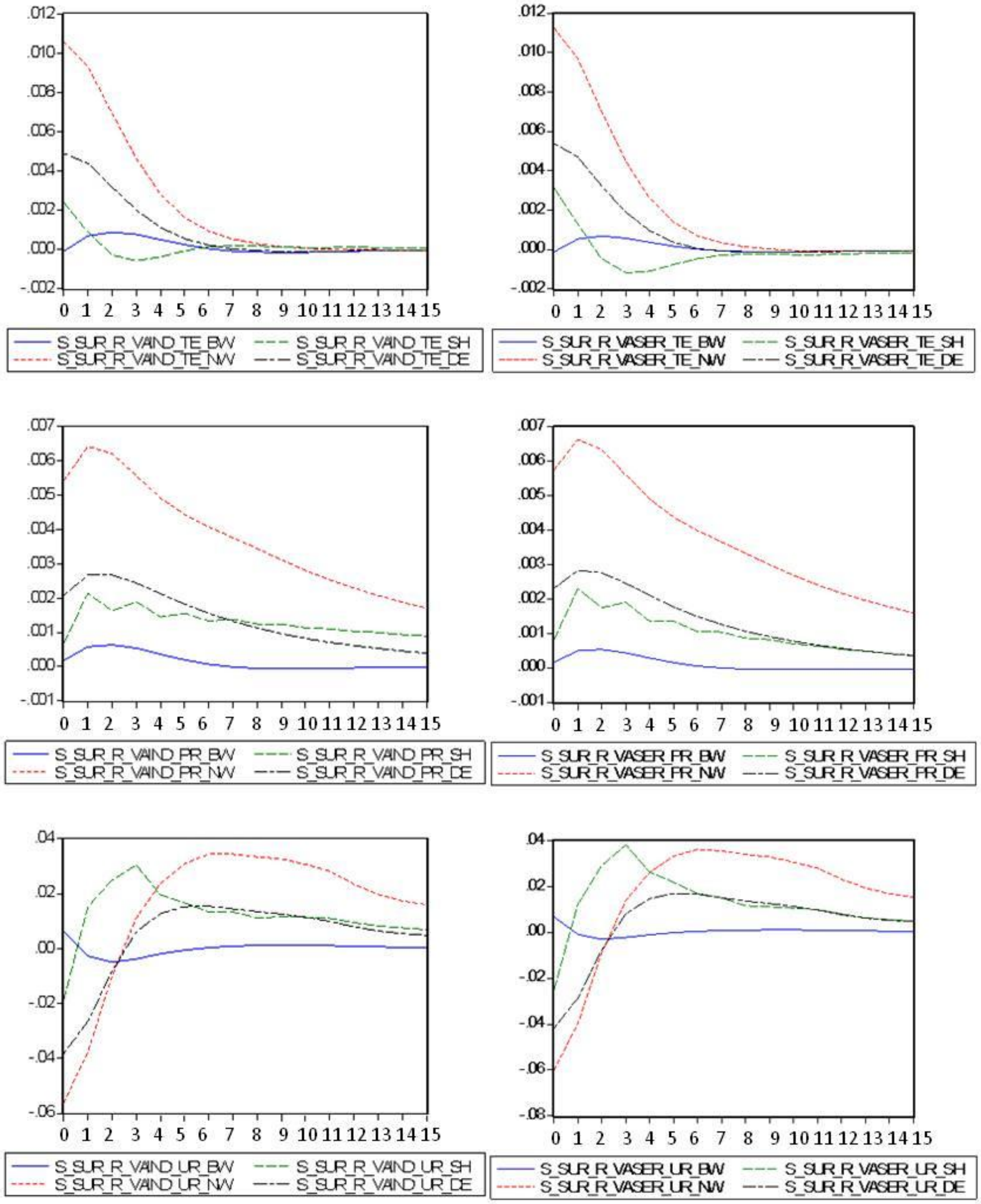

Figure 1. Reactions of the labour demand (te), the labour supply (pr) and the unemployment rate (ur) of BW, NW, SH, DE to a shock in real value added in industry (vaind) – see left side and in real value added in services (vaser)- see right side

The reaction pattern of labour supply (pr) is similar to that of labour demand; the peak is also reached after two years, however, pre-shock levels are then reached after seven years, only. The lowest labour supply (pr) reaction of all the three states - also lower than that of the average DE - indicates the lowest discouraged-worker effect[17] in BW of all the units in the sample. BW occupies the lowest values in labour demand (pr) except for the union coverage (uc) and active

[17] See explanation in section 2.

labour market policy (almp) shock, where it manages to remain at pre-shock level in contrast to NW, SH and DE.

BW shows the strongest reaction in the unemployment rate (ur) for the first year after the shock, only. Then the unemployment rate (ur) declines until it reaches its minimum value after two to three years. After two to three years, BW's unemployment rate remains at the lowest level of all the three states. An exception to the rule is, once again, the reaction to the active labour market policy shock where BW's unemployment rate is highest after eleven years of all states, as labour supply does not decrease as in the case of SH, NW and DE. Higher labour supply and decreasing labour demand lead to higher unemployment.

*In total, **BW**, the most innovative Land of the sample reacts in the most robust manner to all macroeconomic shocks. It shows the least variation, and pre-shock levels are reached after about six years – not only in labour demand (te) but also in labour supply (pr) and the unemployment rate (ur). Its biggest advantage is obviously that in the medium and long term, the unemployment rate is at or below pre-shock levels. This means that BW quickly absorbs shocks. It could gain most from a productivity increase in services. BW's relatively biggest weakness constitutes the low reaction in labour demand also to advantageous effects.*

North Rhine-Westphalia (NW) shows the strongest reaction of all states and the average of DE to most of the simulated shocks.

The reaction of labour demand (te) is strongest right after the shock and then declines sharply before reaching pre-shock level after year eight to ten. From year ten onwards, it behaves like the German average (DE) and remains at pre-shock level until the end of the simulation period.

The strong reaction of labour supply (pr) signals a high discouraged-worker effect. After an initial peak, labour supply declines sharply in the medium term and from year six onwards more slowly. At the end of fifteen years labour supply (pr) still remains above pre-shock level and also significantly above the average (DE).

The reaction of the unemployment (ur) is worst of all states and DE after about four years. Right after the shock the unemployment rate is below pre-shock level. Afterwards, however, it increases steeply before it peaks after six years. In the remaining nine years it decreases very slowly so that after 15 years it still stands 1.5% above pre-shock level.

*Macroeconomic shocks affect **NW** highly in the short, but also in the medium and long term. It manages to reach pre-shock level only in labour demand (te) after about ten to twelve years. The pronounced increase of labour demand, surprisingly to any shock, is a positive starting point for the development of NW. The most negative feature of NW characterizes the instantaneous drop of labour demand right after an initial strong increase; this is paired with a less pronounced decline in labour supply (pr). As a consequence, the unemployment rate (ur) remains at very high levels in the medium and long term. Decreasing labour supply following an increase in expenditure on active labour market policy constitutes a further negative point. In total, NW seems to have great difficulties in coping with macroeconomic shocks – particularly in the medium and long term. This might reflect its dependence on traditional industries.*

The reaction of **Schleswig-Holstein (SH)** to most shocks results after a peak in the first phase in a declining unemployment rate (ur) in the medium and long term. However, the decline is not strong enough to reach the level of the pre shock unemployment rate fully, not even at the end of the simulation period.

SH's labour demand (te) decreases immediately to reach its minimum value after three years. From year three until year eight it then increases until it reaches the pre-shock level. From year nine onwards, labour demand (te) remains at pre-shock level and the impact of the shock fades out. The decrease in labour demand and the following bounce back is unique among the three states.

The reaction of labour supply (pr) consists of only two phases and is - after BW- the second weakest. The first phase reaches the maximum value and ends after one year. From then on, labour supply (pr) declines in a fluctuating pattern and behaves, after about eight years, like the average of all German states (DE). Labour supply (pr) remains above pre-shock level also after fifteen years. The response to a productivity shock in industry (lhind) constitutes the exception when labour supply of SH declines more strongly than in BW and NW and reaches pre-shock level after fifteen years. Further exceptions are the reaction to a shock in union coverage (uc) and expenditure on active labour market policy (almp) where labour supply deteriorates to levels below pre-shock.

The reaction of the unemployment rate (ur) consists of two main phases: Starting at an unemployment rate (ur) below the pre-shock level it rises instantaneously and peaks at the beginning of year three. After the peak, phase two begins and the unemployment rate declines steadily; it remains, however, above pre-shock level after fifteen years. In year two to four SH has the highest unemployment rate of all German states! From year five onwards it develops like the German average (DE). In industry, it shows a lower unemployment rate than DE, in services it shows a higher unemployment rate than DE. This reflects its recent competitiveness in some industrial sectors. The reaction to an increase in expenditure on active labour market policy (almp) is again the exception. Here the unemployment rate (ur) of SH declines to -4.5% relative to pre-shock level after fifteen years!

***SH** shows a strong reaction pattern to shocks in the short term and is relatively robust against shocks in the medium and long term. Overall, it shows the second weakest reaction to shocks of the three states and reaches pre-shock level in labour demand (te) mostly after eight periods. The unfavourable, negative reaction of labour demand to positive shocks up to period five constitutes a big weakness. A further big weakness is the reduction in labour supply (pr) as a reaction to an increase in expenditure on active labour market policies! Its biggest strength is its ability to absorb the initial macroeconomic shocks gradually so that after a peak in year five the unemployment rate (ur) falls in the long term. This may be a consequence of its bigger SME base relative to the dominance of big companies in NW.*

5. Summary, Conclusion and Policy Implications

For analysing labour demand, labour supply and unemployment reactions of regional labour markets to macroeconomic and policy-induced shocks, we developed a labour market model. It is a simultaneous equations model that estimates labour demand and labour supply including exogenous macroeconomic and policy variables that are taken as shock variables. The error correction mechanism allows distinction between short term and long term impacts of such shocks.

Using a simulation approach we observe how dynamic labour demand, labour supply and the unemployment rate of the three German Federal States Baden-Wuerttemberg (BW), Schleswig-Holstein (SH) and North Rhine-Westphalia (NW), as well as the Western German average (DE), respond to various economic and policy-induced shocks, such as increases of 1 % in value added, wages, productivity, labour taxes, union coverage or expenditure on active labour market policies.

The dynamic responses of labour demand, labour supply and the unemployment rate of the three states to macroeconomic and policy-induced shocks differ significantly in magnitude, direction and duration. Whereas Baden-Wuerttemberg, as the most innovative state is most robust against all shocks, North Rhine-Westphalia is highly affected in magnitude and duration. Schleswig-Holstein is also highly affected in the short term, but shows relatively robust reactions in the medium and long term. The general results obtained from simulating the shocks are summarized as in the following table 2.

Table 2. Short und long run reactions of the three German states

	Short run (SR)	Long run (LR)
BW	robust, showing little reaction	unemployment rate at or below pre-shock level
NW	not robust, showing very high reaction	unemployment rate still above pre-shock level
SH	not robust, showing medium high reaction	unemployment rate at pre-shock level
DE	not robust, showing high reaction	unemployment rate at pre-shock level

More in detail, the labour demand reaction in NW and BW (and also in DE) is similar in shape to the labour supply reaction, even though, after an initial increase the decline in labour demand is much steeper and hence the impact of the shock is much shorter than in the case of labour supply. In SH, in contrast, labour demand often decreases after one year and then bounces back to the initial level relatively fast. In all of the three states (and DE) labour supply reacts with a short increase before a decline follows. The magnitude of the labour supply reaction is strongest in NW, second strongest in SH and weakest in BW. Taken together, the overall impact of positive shocks on the labour demand side is much shorter than on the labour supply side. These results in a decreasing unemployment rate in the short term and in an above pre-shock unemployment rate in the medium and long term. The magnitudes are very different again: Whereas the unemployment rate of NW remains far above its pre-shock level even in the long term, the adjustment mechanisms in SH lead to a faster decrease of its unemployment rate after a peak in year three. DE's average unemployment rate lies between that of NW and SH. BW shows the least variation and the fastest adjustment, resulting in an unemployment rate below or at pre-shock level immediately after the shock.

Looking at the political shocks, a decreasing unemployment rate can be best reached by BW and NW through a decrease (!) in active labour market policy. For SH an increase in active labour market policy would decrease the unemployment rate most strongly. For DE a decrease (!) in union coverage or a decrease (!) in labour tax would lead to an equally strong decrease in the unemployment rate.

Furthermore, the states show different reactions not only to different shocks, but also to the same shocks in different sectors. For example, the unemployment rate of BW , which is a state that is very competitive in the industry and less competitive in the services sector, reacts to a positive productivity shock in industry with a smaller decrease than in the case of a productivity shock in services. This implies that, in general, an increase in productivity of a sector, where the regional economy is not that competitive, decreases the unemployment rate more strongly than an equally strong increase in productivity in a sector where the regional economy is already very competitive, ceteris paribus.

The shock exercise also revealed that labour demand depends most strongly on value added. These two findings – increasing productivity leading to a decreasing unemployment rate in a competitive region and the importance of value added for labour demand - confirms the finding of Palazuelos & Fernàndez (2009). They observe a trade-off between labour productivity and employment creation only as long as domestic demand does not increase dynamically as well.

Our findings imply that, first, we have to pay particular attention to the labour supply side when analysing policy-induced shocks. The reactions of labour supply to changes in union coverage and expenditure on active labour market policies are the most distinct of all shocks between the states. A reduction in the unemployment rate in NW and SH comes at the cost of lower labour demand and hence indicates lower economic activity. Second, as labour supply reacts to labour demand with a time lag, the evaluation of the efficacy of a labour market policy only makes sense in the medium term, i.e. after four or five years. It implies that the time dimension in the reaction of regional labour markets to shocks is pivotal. Third, according to our sample, regions with a more innovative economic structure react to the same shock less strongly and shocks are absorbed more quickly and more completely than in regions with less innovative economic structures.

The dynamic analysis shows that regional labour markets differ substantially even within a relatively homogenous economic structure such as Western Germany. It further points to the significance of labour demand and labour supply when analysing the resulting reaction of the unemployment rate.

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Appendix A: Data sources and definitions

The data stems from the six sources below, with the majority of data taken from regional accounts. The time series constitutes 30 annual average values from 1975 until 2005. Real values are calculated by GDP deflators at 1995 prices. Employees refers to dependent employees, employment also includes self-employed. NIC (2006) variables are composite measures.

- MIK (2008): Mikrozensus- the continuous household survey capturing population and the labour market, involving 1% of all households in Germany every year; provided by the National Statistical Office: Bevölkerung nach Beteiligung am Erwerbsleben und Laendern, Ergebnisse des Mikrozensus, Wiesbaden, 2008
- NIC (2006): The CEP – OECD Institutions Data Set (1960-2004) William Nickell, Centre for Economic Performance, LSE, September, 2006
- RA (2007): Regional Accounts dataset (Volkswirtschaftliche Gesamtrechnung der Laender, VGRdL).
- IAB (2008): Data exclusively provided by the Research Institute of Occupation and Labour Market (IAB Nürnberg).

- SBA (2000): Data obtained from the National Statistical Office (from various Statistical Yearbooks).
- SBA (2008): Provided by the National Statistical Office, Wiesbaden, 2008: Gesamtwanderungen nach Bundeslaendern, Statistisches Bundesamt, VI A, Wanderungsstatistik, Wiesbaden, 2008

The following table displays from which data sources the variables stem from. The sources are listed in alphabetical order, as in the list above, and not in accordance with the number of variables extracted from each source. Again, for the model the variables are transformed into logs and hence, are listed below in small letters.

Source	Variable	Definition of variable
MIK (2008)	ur	Unemployment rate
MIK (2008) RA (2007)	lf	Labour force
MIK (2008) RA (2007)	pr	Participation rate
NIC (2006)	almp	Expenditure on Active Labour Market Policy as a % of GDP
NIC (2006)	ltax	Labour taxes: payroll taxes, income taxes, consumption taxes; ancillary labour cost
NIC (2006)	uc	Union coverage
RA (2007)	e	Total employees
RA (2007)	eagr	Dependent employees in agriculture
RA (2007)	eind | eser	Employees in industry | services
RA (2007)	p	Price level, GDP deflator
RA (2007)	pop	Population
RA (2007)	se	Self-employed
RA (2007)	te	Total employment
RA (2007)	vaind| vaser	Nominal value added in industry | services
RA (2007)	wind | wser	Nominal per capita labour cost in industry | services
RA (2007) IAB (2008)	lhind | lhser	Labour hoarding in industry | services (proxy for fluctuations in labour productivity)
RA (2007) SBA (2000)	prof	Nominal total profits
SBA (2008)	emig	Emigration out of the region
SBA (2008)	imig	Immigration into the region
	i	Area index, here: Baden-Wuerttemberg / North Rhine-Westphalia / Schleswig-Holstein / West Germany
	t	Time index, here: years 1975 -2005

Appendix B:

The following formula defines the RMSE:

$$RMSE = \left\{ \frac{1}{T} \sum_{t} (y_t - \tilde{y}_t)^2 \right\}^{1/2} \qquad \text{(C.1)}$$

Here y_t refers to the values from the data sources of the examined variables (e.g. eind, eser, pr, se, te, ur), to the $\tilde{y}_t$ simulated values of these variables, T to the dimension of the time series (31, adjusted 29) and finally, the sum is taken over the simulation period (t=1977, 1978, …, 2005) before taking the root of the result.

Theil (1961) provides the TIC index, with 0 $\leq$ TIC $\leq$ 1:

$$TIC = \frac{\left\{ \frac{1}{T} \sum_{t} (y_t - \tilde{y}_t)^2 \right\}^{1/2}}{\left\{ \frac{1}{T} \sum_{t} y_t^{\,2} \right\}^{1/2} + \left\{ \frac{1}{T} \sum_{t} \tilde{y}_t^{\,2} \right\}^{1/2}} \quad \text{(C.2)}$$

The TIC provides rescaled and comparable values in a range between zero (perfect fit) and one (worst fit). The main use of the TIC in the analysis stems from the fact that the fit between variables irrespective of their magnitudes can be compared. Therefore, all information about the magnitude of the measured error is lost. Hence, the RMSE complements the measure of goodness of fit as it keeps the information about the size of an error. Both measures apply to a univariate analysis, perfect to confront the fit of single variables to one another. TIC and RMSE capture correlations neither across simulation errors nor across different temporal horizons. We apply the measures to all three states and Germany as a whole. The application of the measures to the main variables allows for adequacy and clarity. In addition, we are interested whether the estimates are unbiased. To test for a possible bias in the error term we apply the widely used Mincer Zarnowitz test (Mincer & Zarnowitz, 1969) and Wald test (Wald, 1943) which controls whether the Mincer-Zarnowitz coefficient is significantly different from one.

The dynamic deterministic simulation shows an overall good fit based on the root mean square error (RMSE) and Theil's inequality coefficient (TIC). The variables like EIND have the same meaning as in the rest of the paper and are explained, as previously mentioned, in Appendix A.