Regional Origins of Employment Volatility: Evidence from German States

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Abstract

Openness for trade can have positive welfare effects in terms of higher growth. But increased openness may also increase uncertainty through a higher volatility of employment. We use regional data from Germany to test whether openness for trade has an impact on volatility. We find a downward trend in the unconditional volatility of employment, which has been interrupted by the re-unification period. Patterns are similar to those for output volatility. The conditional volatility of employment, measuring idiosyncratic developments across states, in contrast, has remained fairly unchanged. In contrast to evidence for the US, we do not find evidence for a significant link between employment volatility and trade openness.

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1 Motivation

There is wide-spread concern in the population and among policy makers that increased international integration could increase the uncertainty faced by workers. Globalization could then be a double-edged sword. On the one hand, international integration is associated with higher economic growth. On the other hand, employment conditions may become more unstable, thus aggravating the fear of workers to become unemployed.

Earlier empirical studies testing the link between trade openness and employment volatility use cross-country panel data. These studies have the disadvantage that countries may have different labor market institutions and different degrees of financial openness. This may affect the link between trade openness and employment volatility.

In this paper, we use regional data from Germany to show trends in employment volatility over the past 40 years, and we test whether openness for trade has had an impact on volatility. Using regional data from a single country has the advantage that differences in institutions do not affect our results. Also, macroeconomic developments are similar across the regions. Our study is motivated by a partial-equilibrium model of regional labor markets, which we adopt from Blanchard and Katz (1992). The model stresses the importance of structural and cyclical factors such as labor market regulations and the industrial structure determining the volatility of employment at the regional level.

Previous empirical literature has studied the link between openness and volatility from three different angles.

A first related set of studies has studied the long-run evolution of output volatility. The impact of the globalization process on the volatility of employment has been studied less

frequently. This literature finds evidence for a smaller volatility of output – the so-called 'Great Moderation' – across developed countries as a result of a combination of smaller shocks, better inventory management, and better monetary policy (Blanchard and Simon 2001, Stock and Watson 2004). Aßmann et al. (2006) and Buch et al. (2004) provide corresponding evidence for Germany. Generally, studies at the country- or sector-level find that greater trade openness tends to have increased output volatility (Easterly et al. 2000, Braun and Larrain 2004, Kose et al. 2003).

A second set of studies uses regional data to avoid the problem that outcomes across countries might be driven by differences in institutions. Carlino, DeFina, and Sill (2003) use a state-level panel dataset for the US to explain the post-war pattern of employment volatility. They find a decline in employment volatility, which is the result of two counterbalancing forces. On the one hand, the volatility of macroeconomic aggregates has declined and this has dampened the volatility of employment. On the other hand, greater openness to foreign trade has tended to increase employment volatility. Morgan, Rime, and Strahan (2003) find that the lifting of barriers to cross-state-border entry in US banking lowered fluctuations in employment growth. These results suggest that trade integration may increase while financial integration might dampen employment volatility. Owyang, Piger, and Wall (2006) look for evidence for the 'Great Moderation' at the level of US states. They find significant heterogeneity in the timing and the magnitude of reductions in state-level employment volatility. Hammond and Thompson (2004) study the impact of industrial and demographic characteristics for regional employment volatility in the US. Both papers do not address the impact of openness on volatility.

A third related strand of literature studies the link between openness and employment volatility by investigating the elasticity of labor demand. For a given macroeconomic shock, employment should fluctuate more if the labor demand elasticity of firms increases (Rodrik 1997). Fabbri, Haskel, and Slaughter (2003) analyze industry-level data for UK and US firms. They find that labor demand has become more elastic over time. Barba Navaretti et al. (2003) use firm-level data for Europe to show that multinationals adjust employment faster than national firms. However, the elasticity of labor demand is similar for multinationals and national firms. For Germany, results in Buch and Lipponer (2007) support this finding.

In this paper, we study the link between employment volatility and openness for a state-level dataset for Germany. For the eleven West German states, we have data for the years 1970-2005; data for the five East German states start in 1991. Our work differs from earlier studies along three dimensions. First, as in earlier studies for the US, the use of state-level data has the advantage that differences in institutions do not matter. Second, in contrast to firm-level studies on labor demand elasticities, we provide evidence on the aggregated implications of trade openness for employment volatility. Hence, we investigate not only whether employment has become more or less stable for particular firms but whether entire regions are affected. Third, we complement earlier evidence for the US using data for Germany. From a methodological point of view, we follow the literature in estimating the determinants of employment volatility in a panel framework. Additionally, we go beyond earlier literature and estimate a heteroscedastic regression model, which allows a simultaneous modeling of employment growth and the variance of employment growth.

In Part Two, we give a summary of the theoretical determinants of employment volatility, and we explain how we measure these. In Part Three, we discuss the measurement of employment volatility, and we provide stylized facts. In Part Four, we present our empirical model, regression results, and robustness tests. Part Five concludes. Overall, we do not find evidence for a link between employment volatility and trade openness at the state-level. This result is robust against using conditional and unconditional measures of employment volatility. While we find a positive link between openness and volatility in selected specifications, this result is driven by individual states hosting large international harbors. For the average German state, greater openness has not been associated with greater instability of employment. Moreover, our results suggest that a higher share of the services sector and more rigid labor markets lower the volatility of employment.

2 Determinants of Employment Volatility: Theory and Measurement

This section uses a model of regional labor markets to derive theoretical determinants of regional employment volatility. We then describe how we measure these determinants using German state-level data.

2.1 Theoretical Background

Regional characteristics, labor demand and supply shocks, and the response to these shocks affect the volatility of employment at the regional level. This can be shown using a model of regional labor markets as suggested by Blanchard and Katz (1992) and applied to an analysis of employment volatility by Hammond and Thompson (2004). In their model, regional labor demand is a negative function of wages:

$$w_{it} = -d\left(n_{it}^{*} - u_{it}\right) + z_{it} \tag{1}$$

where w_{it} denotes wages in region *i* relative to the national wage level, u_{it} is the unemployment rate, and n_{it}^{*} denotes the regional labor force. Unemployment falls in wages: $cw_{it} = -u_{it}$. Labor demand changes over time as new firms enter a region. Hence, z_{it} reflects the response of firms to the structural demand-side patterns of the regional economy (x_i^D) as well as shocks to labor demand ($\varepsilon_{i,t+1}^D$):

$$z_{i,t+1} - z_{i,t} = -aw_{it} + x_i^D + \varepsilon_{i,t+1}^D \tag{2}$$

In an open economy, shocks to labor demand can further be decomposed into a weighted average of domestic (*H*) and foreign shocks (*F*): $\varepsilon_{i,t+1}^D = \omega\varepsilon_{i,t+1}^{D,H} + (1-\omega)\varepsilon_{i,t+1}^{D,F}$ where ω is the weight of the home market in total sales. Foreign shocks are business cycle developments abroad which are, for instance, propagated through foreign trade links. The wage elasticity of labor demand (*a*) depends on factors such as the industrial structure of the regional economy, the ease with which capital can be substituted for labor, or labor market regulations. We take this wage elasticity as a parameter, but it could also vary with the degree of trade openness.

Growth in regional labor supply is given by:

$$n_{i,t+1}^{*} - n_{i,t}^{*} = bw_{it} - gu_{it} + x_i^S + \varepsilon_{i,t+1}^S \tag{3}$$

where structural factors are given by x_i^S , and shocks to labor supply are denoted by $\varepsilon_{i,t+1}^S$. In an open economy, we can again decompose these into a domestic and a foreign component: $\varepsilon_{i,t+1}^S = \lambda\varepsilon_{i,t+1}^{S,H} + (1-\lambda)\varepsilon_{i,t+1}^{S,F}$ where λ denotes the weight of the domestic labor

supply shock. International migration would be one channel through which foreign factors have an impact on the domestic labor market.

Solving the model, equilibrium mean employment growth can be written as the sum of an autoregressive process, of the long-run structural parameters of the economy, and of demand and supply shocks:

$$\begin{aligned}\Delta n^{*}_{i,t+2} = \frac{1}{1+cd}[\Delta n^{*}_{it+1}(1+cd+a-db-cdg)-(1+cd+a)\varepsilon^{S}_{i,t+1} \\ +(b+cg)(x^{D}_{i}+\varepsilon^{D}_{i,t+1})+ax^{S}_{i}]+\varepsilon^{S}_{i,t+2}\end{aligned} \tag{4}$$

or

$$\Delta n^{*}_{i,t+2} - \alpha_1 \Delta n^{*}_{it+1} = \alpha_2 \varepsilon^{S}_{i,t+1} + \alpha_3 (x^{D}_{i} + \varepsilon^{D}_{i,t+1}) + \alpha_4 x^{S}_{i} \tag{4'}$$

where the coefficients $\alpha_1 - \alpha_4$ summarize the model's structural parameters affecting labor demand and supply: $\alpha_1 = \frac{1+cd+a-db-cdg}{1+cd}$, $\alpha_2 = \frac{1+cd+a}{1+cd}+1$, $\alpha_3 = \frac{b+cg}{1+cd}$, and $\alpha_4 = \frac{a}{1+cd}$. Equation (4') can also be used to compute the variance of employment as a function of the underlying shocks:

$$\begin{aligned}\sigma^2(\Delta n^{*}_{i,t+2}) &= E[\Delta n_{t+1} - E(\Delta n_{t+1})]^2 \\ &= \alpha_2 \sigma^2(\varepsilon^{S}_{i,t+1}) + \alpha_3 \sigma^2(\varepsilon^{D}_{i,t+1}) + \alpha_2 \alpha_3 \sigma(\varepsilon^{D}_{i,t+2}) \sigma(\varepsilon^{S}_{i,t+2})\end{aligned} \tag{5}.$$

where σ^2 denotes the variance of the respective variable. Hence, the volatility of regional employment depends on the volatility of demand and supply shocks which, in turn, depend on domestic and foreign demand and supply conditions, and on the response of the regional economy to these shocks. Equation (5) – the variance equation – will be the basis for our empirical estimates below.

In our empirical model, we capture the exposure to foreign shocks through a region's degree of trade openness. Equation (4') also shows that the parameters of the model such as the wage elasticity of labor demand (*a*), the wage elasticity of labor supply (*b*), the response of unemployment to wages (*c*), the response of wages to employment (*d*), and the response of migration to unemployment (*g*) affect the volatility of employment. Since our main testing equation will be based on a reduced form model derived from (5), we will not estimate these parameters. However, we will control for the structural characteristics of the regional economies that affect these parameters. In the following, we describe the measurement of openness and regional control variables in more detail.

2.2 Trade Openness

In the context of the above model, trading more with the rest of the world can have a double-edged impact on employment volatility. On the one hand, countries or regions become exposed to foreign shocks, and volatility might increase. This effect might be aggravated by an increase in the wage elasticities of firms (*b*) (Rodrik 1997). On the other hand, $\sigma^2\left(\varepsilon^S_{i,t+1}\right)$ and $\sigma^2\left(\varepsilon^D_{i,t+1}\right)$ depend on the covariance of domestic and foreign shocks. If domestic and foreign shocks are imperfectly correlated, this might lower the volatility of employment.

To test the link between employment volatility and trade openness empirically, we compute the ratio of the sum of imports and exports and GDP. Since we have this information at the state-level, we can approximate the integration of the states into the world economy. By splitting openness into import and export openness, we also investigate the channels through which trade and employment volatility are linked.

2.3 Labor Market Regulations

Labor market regulations are likely to affect the elasticity of labor demand. Since we use regional data for Germany, we cannot test the effects of changes in labor market regulations that affect all states alike. However, there is evidence for a variation in the implementation of labor market regulations at the state-level due to a nomination bias of the judges to higher-level labor courts. According to evidence in Berger and Neugart (2007), the composition of higher-level labor courts affects the strategic behavior of workers and employers in their decision on taking a case to lower-level labor courts. The authors show that this has an impact on the unemployment rate in the respective state.

In this paper we proxy the degree of labor market rigidity across states using the share of long-term unemployment. A positive correlation between employment protection and long-term unemployment was shown by Jahn (2002). Several cross-country studies support this finding using panel data for OECD countries, using rankings of dismissal protection between countries as the dependent variable. For example, Nickell (1999) and Scarpetta (1996) show a positive effect of employment protection regulations on long-term unemployment. Nevertheless, this proxy is incomplete for two reasons. First, empirical research generally finds it difficult to establish a strong link between employment protection laws and the overall rate of unemployment (Freeman 2007). Second, long-term employment depends on both, structural features of the labor market as well as on demographic characteristics of the working age population. The time invariant component of demographic factors will be picked up by state fixed effects.

Moreover, from a theoretical point of view, the impact of employment protection legislation and union power on the volatility of employment is not clear-cut. On the one

hand, the degree of unionization could have an impact on employment volatility if unions try to preserve employment and to reduce the flexibility of labor markets. Thus, we expect a negative correlation between the degree of unionization and the volatility of employment. Longhi et al. (2005), for instance, show empirically that the variation of unemployment decreases in the degree of centralization of the system of wage bargaining. On the other hand, employment protection legislation increases the fixed costs of laying off workers. Hence, large adjustments of the labor force may become more likely, and employment volatility might increase.

To measure the importance of unions, we use the share of employees organized in German unions for every year from 1970–2005. Note that we can use this variable only if we do not include time fixed effects. Hence, this variable may also measure other omitted factors that follow a trend development over time. To account for the fact that the degree of unionization differs across sectors, we additionally include a proxy for the share of services in total output. The degree of unionization in the services sector is traditionally lower than in the manufacturing sector.

2.4 Industrial Diversification

The degree of industrial diversification captures the responsiveness of labor demand to shocks. Understanding the link between the regional industrial structure and economic stability has been an important research question in regional economics (Conroy 1975). This literature shows that specialization can be a double-edged sword. On the one hand, industry specialization along comparative advantages in certain industrial sectors might

increase growth. On the other hand, it could increase volatility by increasing the exposure to industry-specific shocks.

Empirical research provides mixed evidence on the volatility effects of specialization. Maliza and Ke (1993) and Simon and Nardelli (1992) find a stabilizing effect of industry diversification across US metropolitan areas. A study of Izraeli and Murphy (2003) confirms this result for US states. Attaran (1986) and Jackson (1984), in contrast, do not find any link between the industrial structure of a region and economic stability. Hammond and Thompson (2004) find that the impact of industrial structure weakens as demographic factors are included in the model.

Here, we follow earlier literature and use a Herfindahl Index as a measure of the degree of industrial diversification. We take the number of workers in 15 different sectors in every German state and create an annual Herfindahl Index for the years 1991-2004. We can use this variable for the final decade of our sample only.

2.5 Macroeconomic Developments

In standard open economy macro models, the link between openness and volatility depends on the nature of the underlying macroeconomic shock (see, e.g., Senay 1998). Since we are considering regions within one country, monetary developments are the same for all regions. The same holds true for international macroeconomic developments such as oil price shocks. These variables are captured through time fixed effects.

However, fiscal policy shocks may differ across regions. To account for the volatility of fiscal policy, we use data from the German Federal Statistic Office which gives aggregated government revenues and expenditures at the state level. We have this

information since 1985 for the West German states and since 1991 for the East German states.

2.6 Population Characteristics

Population characteristics that influence mobility of workers can be an important driver of regional differences in employment volatility. For example, workers who are attached to a specific region or who have more non-labour income will be less inclined to migrate due to a shock that influences labor markets (Hammond and Thompson 2004).

In general, the costs of migration between states could be a key factor determining employment volatility. Schöb and Wildasin (2007) show that greater integration between regions, measured in lower migration costs, leads to more flexible labour markets and increase fluctuations.

The most prominent result of the literature linking migration and employment volatility is the importance of population`s skill structure. Empirical literature on migration shows that the educational attainment of individuals is positively correlated with their propensity to migrate and therefore has a positive impact on employment volatility. High-skilled individuals can be expected to have lower migration costs than low-skilled workers. We have account for this by including the share of high-skilled workers within each German state in our regressions. Since the skill structure has been insignificant and since our main results do not change including this variable, we do not report these results though.

3 Employment Volatility: Measurements and Stylized Facts

3.1 Measuring Employment Volatility

To measure employment volatility, we use data on the annual average number of employees at the state level for the years 1970-2005. We cannot divide employees into full time and part-time workers since data are not available for a sufficiently long time period. Hence, every employee is weighted equally, independent of his or her numbers of hours worked.

We begin by calculating the growth rate of employment. As we are interested in the cyclical evolution of employment, we apply the Hodrick-Prescott-Filter to isolate the cyclical from the trend growth in employment. The relative importance of the trend and the cyclical component depends on the value of a smoothing parameter λ. We follow Ravn and Uhlig (2003) who suggest a value of 6.25 for annual data.

Using the growth of the cyclical component of employment, we compute the squared growth rates Δn_{it}^2 as a measure of unconditional employment volatility. Previous literature uses the rolling standard deviation over a five-years-window (see, e.g., Braun and Larrain 2004 or Carlino et al. 2003). The volatility $\sigma(\Delta n_{it})$ of the cyclical component of employment growth Δn_{it} in state *i* at time *t* is then given by

$$\sigma(\Delta n_{it}) = \sqrt{\frac{\sum_{k=0}^{4}\left(\Delta n_{i,t+k} - \Delta \overline{n}_{t+k}\right)^2}{5}}$$

However, this measure of volatility has the disadvantages that the 5-year window is chosen somewhat arbitrarily and that the measure of volatility is autocorrelated by

definition. Hence, we have checked the robustness of our results using the 5-year standard deviation only for successive five year periods to obtain a quasi panel.

In addition to the 'unconditional' volatility, we also compute the 'conditional' idiosyncratic volatility of employment growth in state *i* using the residuals (ε_{it}) of a regression of employment growth on a set of time fixed effects (to capture country-wide business cycle effects) and lagged employment growth in state *i*:

$\Delta n_{it} = \alpha_0 + \alpha_1 \sum_{k=1}^{5} \Delta n_{it+k} + \alpha_2 T_t + \varepsilon_{it}$ where T_t is a vector of time fixed effects. (See Blanchard and Simon (2001), Carlino et al. (2003), or Hammond and Thompson (2004) for similar approaches.) The correlation between conditional and unconditional employment volatility is 0.26. Hence, employment persistence and aggregated developments account for about two-thirds of the variation in employment growth across states. Again, we take the squared residual $\varepsilon_{it}^{\ 2}$ as a measure for the employment volatility in state *i* in period *t*.

3.2 Stylized Facts

Figure 1 plots the evolution of employment volatility at the state level. Using the unconditional volatility, we find a reduction of employment volatility, which was interrupted by the reunification period (see also Buch et al. (2004) and Aßmann et al. (2006), in all German states except *Berlin*. The conditional volatility does not show this clear pattern. There is a considerable reduction of volatility in some states (for example *Bayern* and *Saarland*) whereas employment in other states became more unstable over time (for example *Niedersachsen* and *Hamburg*). Unreported time series regressions of employment volatility for each West German state on its own five lags, a reunification

dummy, and a time trend support this. The time trend is negative and significant for four out of eleven states using the unconditional volatility. It is positive and significant for four states when using the conditional volatility. Hence, while the unconditional volatility mirrors the decline in aggregate volatility, idiosyncratic, state-level developments differ.

Differences in volatility could be driven by differences in trade openness. Figure 2 plots the degree of trade openness by state. While all states have become more integrated into the world economy over the sample period, the degree of this increase differs across states. Moreover, as hosts of seaports, the city states *Bremen* and *Hamburg* have above-average export and import shares. We will account for the possibility that these outliers drive our results by including interaction terms for *Hamburg* and *Bremen* and openness.

We have three more variables which vary over time and states. The first is the (unconditional) volatility of output growth, which shows similar patterns as the volatility of employment. The descriptive statistics in Table 1 also show that the mean volatility of output growth is higher than the mean volatility of employment growth. The second variable that varies across states and time is the importance of the service industry in terms of the share of employees in the service sector. This share has increased for all states. While, at the beginning of the sample, only slightly above 40% of all employees were occupied in services industries, this share had increased to about 70% towards the end of the sample. The increase in the importance of services has been particularly important in the East German states during the last fifteen years, reflecting the bias of the system of central planning towards manufacturing industries. Finally, across all German states, unemployment rates have been on a trend rise throughout the sample period.

4 Determinants of Employment Volatility

To analyze the determinants of employment volatility for a panel of 16 German states for the past four decades (1972-2005), we employ two different methodologies. First, we look at the determinants of conditional and unconditional employment volatility. Second, we use a heteroscedastic regression model to simultaneously estimate the mean and the variance equation derived above (see Section 2.1).

4.1 Regression Model: Determinants of Employment Volatility

Our first empirical model links the standard deviation of employment growth to openness and aggregated shocks:

$$\Delta n_{it}^2 = \alpha_{1i} + \beta_1 X_{it} + \beta_2 X_t + \beta_4 \Delta y_{it}^2 + \beta_5 Open_{it} + u_{it} \qquad (6)$$

where Δn_{it}^2 = squared cyclical component of employment growth in state *i* at time *t* , α_{1i} = state-fixed effects, X_{it} = time-varying explanatory variables at the state-level, X_t = time-varying explanatory variables at the country-level, Δy_{it}^2 = squared cyclical component of output growth, and $Open_{it}$ = trade openness of states. As an alternative to including the time-varying explanatory variables, we include a full set of time fixed effects (T_t). These account for business cycle effects such as changes in monetary policy and other aggregate shocks affecting all states alike. u_{it} is the error term.

We follow Arellano (1987) and compute robust standard errors which allow for both heteroscedasticity and autocorrelation of arbitrary form. In addition, we use a quasi-panel

with non-overlapping observations as a robustness test. (See Braun and Larrain (2004) for an application to industry-panel data.)

4.2 Regression Results: Employment Volatility

Regression results for the determinants of employment volatility at the regional level in Germany are reported in Table 2. We estimate the model separately for the full sample of 16 states (Table 2a) and for the sample of 10 West German states (excluding *Berlin*) (Table 2b). This accounts for the fact that the East German states might exhibit special characteristics due to the post-unification catching up process. Since most results are similar for the two specifications, we will report only the main differences below. Generally, a full set of time fixed effects is included. The exception is the specification in Column 7, which includes the long-term unemployment rate and the degree of unionization, which do not vary across the German states.

Our baseline specification includes the volatility of output growth, trade openness, a re-unification dummy, and time fixed effects as explanatory variables (column 1). We modify this specification splitting trade into imports and exports (columns 2 and 3), adding the volatility of government spending and revenues (column 4), adding a proxy for the degree of industry diversification (column 5), the state-level unemployment rate and the share of the services sector (column 6). In columns 8-10, we re-estimate the model for the conditional employment volatility and the three proxies for trade openness. In terms of the explanatory power, our model performs quite well with an adjusted R^2 of 0.29-0.74, depending on the specification chosen.

Our first finding is that we have a positive and significant coefficient of *output volatility.* We should be careful when interpreting this as a causal effect of output volatility on unconditional employment volatility because of the endogeneity problems which arise by using output volatility as an explaining variable for employment volatility. In fact, re-estimating the model and instrumenting output growth volatility by its own lags yields an insignificant coefficient. For the West German sub-sample, the coefficient on output volatility is insignificant if we use the conditional volatility of employment and output growth instead, suggesting that the unconditional volatility of output growth picks up the persistence and autocorrelation of employment volatility.

Trade openness, the main variable of interest in this paper, has no significant impact on the volatility of employment in the full sample. Considering import and export openness separately shows a weakly significant impact of export openness in the specification using the conditional employment volatility as the dependent variable. If anything, results for the West German states show a somewhat stronger positive impact of trade openness on employment volatility. However, as will be discussed in more detail below, this result is driven by one state – *Bremen* –, which hosts a large international harbor.

Fiscal volatility at the state level could affect the volatility of employment as well. Our data start in 1985 for West Germany and 1992 for East Germany. We find a positive link between the volatility of government spending and employment volatility for the full sample for the West German states. However, this effect is statistically significant only at the 10%-level.

Variables capturing the industrial structure and the regulation of the labor market have a mixed impact. The degree of *industry diversification,* measured through the Herfindahl

index, is insignificant. Note, however, that we have this information only for later sample periods. A higher share of employment in the *service sector* is associated with lower employment volatility (for the West German state, this variable is insignificant). This finding would be consistent with the hypothesis that the demand for services is more stable than the demand for manufacturing output. It could also reflect a lower degree of exposure of the services sector to foreign competition.

The state-level unemployment rate as a measure for the degree of labor market rigidities is insignificant. For two other measures for the rigidity of labor market regulations, the *long-term unemployment rate* and the *degree of unionization*, we have information only at the aggregated level. A higher long-term unemployment rate and a higher degree of unionization are associated with a lower volatility of employment in the West German sub-sample. This could be an indication that, the more regulated the labor market, the lower is the volatility of employment. Since the degree of unionization varies only over time and not across states – and thus drops out when time fixed effects are included – it might capture other, unobserved macroeconomic developments though and should thus be interpreted with caution.

4.3 Robustness Tests

In addition to the various modifications of the baseline specifications, we have also run our model as a quasi-panel on non-overlapping windows of employment volatility. Results are reported in Table 3 and are similar to those reported above. The main exceptions are that we now find a negative link between import openness and unconditional employment volatility, that the variables capturing structural characteristics

and labor market rigidities are now insignificant, and that higher volatility of government spending *and* revenues now increases employment volatility.

In a next step, we change the specification of employment volatility in our baseline regression. As in many previous papers in this literature, we use the standard deviation of employment growth as the dependent variable. In these specifications, the dependent variable is the volatility of employment growth for the five-year interval starting in period *t*. All other variables are measured in *t*. Hence, we test whether the explanatory variables have a statistically significant impact on *subsequent* employment volatility. In unreported regressions, we find qualitatively very similar results to those reported above.

One potential concern could be that our results are driven by individual states. As shown in Figure 2, trade openness increased in almost all German states. But the trade dynamics have been particularly pronounced in the city states *Hamburg* and *Bremen*, which host international sea harbors. In a robustness check, we thus estimate our baseline regressions without *Hamburg* and *Bremen* to check whether our results are driven by these two states. Results are reported in Table 4. They show that the results concerning the positive impact of openness on volatility are indeed driven by a single state – *Bremen*. We can corroborate this result if we introduce a new variable interacting a dummy for *Bremen* with our openness measures and estimate our baseline regressions for the whole sample (Columns 7 and 10 of Table 4). All openness measures become insignificant. We find a significant positive effect of our interaction term meaning that in this case, the pure variation of trade openness in Bremen almost drives the whole positive effect of trade openness on employment volatility.

4.4 Heteroscedastic Regression Model

As an alternative empirical model, we estimate a regression model with multiplicative heteroskedasticity as proposed by Harvey (1976). The advantage of this model is that we can simultaneously specify a 'mean' equation – explaining the growth of employment – as well as a 'variance' equation – explaining the residual variance. Hence, we can empirically model employment growth in close correspondence to our theoretical model above.

The heteroscedastic regression model has, to the best of our knowledge, not been applied to an analysis of macroeconomic volatility so far. Earlier applications use the model to model heteroskedasticity in the residuals, but most of these papers do not focus on the estimation of the variance equation. Two exceptions are a recent paper by Cerqueiro et al. (2007), who study the loan pricing decisions of banks. Ang and Peterson (1985) estimate a capital asset pricing model and study both, the determinants of rates of returns and of the variance of returns.

According to the heteroscedastic regression model, the mean equation gives the level of employment at a function of a set of explanatory variables X: $\ln \Delta n_{it} = X'_{it}\,\beta + \varepsilon_{it}$ where ε_{it} is the residual with $E[\varepsilon_{it} \mid X_{it}] = 0$ and $VAR[\varepsilon_{it} \mid X_{it}] = \sigma_{it}^2 = \exp\{Z'_{ij}\,\gamma\}$. The variance equation is given by $\ln \sigma_{it}^2 = Z'_{it}\,\gamma$. The coefficients β and γ can be obtained by maximizing a log-likelihood function. One advantage of this methodology is that the parameters of the mean and of the variance equation are uncorrelated.

By containing both a mean and a variance equation, the heteroskedastic regression model already filters the cyclical component out of the data. Hence, we report results using unfiltered data. Results using filtered data are very similar and are available upon request.

Our modeling strategy is to include as many variables as possible in the mean equation to predict employment as good as possible and to leave only the unexplained component of employment growth for the variance equation. In particular, our mean equation includes time dummies to account for aggregate fluctuations as well as state fixed effects to account for unobserved heterogeneity across states. In the variance equation, we likewise include a full set of time and state fixed effects. We again estimate the model separately for the full sample and for the West German states.[1] While, in principle, we use similar specifications as above, we restrict the robustness tests with regard to structural variables to the unemployment rate and the share of the services sector in each state, and we add the growth rate of nominal wages as an additional regressor. Note that, while real wages would be the preferred measure of factor costs, we lack information on regional price indices. This is addressed by including time and state-fixed effects.

Results of the mean equation show, not surprisingly, that higher output growth is associated with higher employment growth whereas higher wage growth tends to have a dampening impact on employment growth. Interestingly, trade openness does not have a significant impact on employment growth in the regressions using filtered data, and the impact is even negative in the specifications using unfiltered data for West Germany. In these specifications, higher unemployment is associated with lower employment growth.

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[1] Since the model including all fixed effects did not converge for all specifications for West Germany, regressions for this sub-sample are estimated without regional fixed effects.

This would be consistent with a negative impact of labor market rigidities on employment growth.

Turning next to the results of the variance equation, there is some evidence for a positive and significant impact of wage and output growth on the variance of employment growth. Higher growth would thus be associated with a higher volatility of growth. This would be at odds with the findings by Ramey and Ramey (1995), who find a negative correlation between growth and volatility across countries. Imbs (2007), in contrast, shows that the correlation between growth and volatility depends on the level of aggregation of the data. He finds a positive correlation between growth and volatility at the industry level. One explanation is that growth rates are imperfectly correlated across sectors. Our state-level data suggest a similar positive relationship.

In some specifications, there is evidence for a positive impact of trade openness on the variance of employment growth. This effect shows up in the full as well as in the West German sample. Moreover, the effect is driven by the degree of import openness.

Essentially, the finding that higher export openness is associated with a higher variance of employment growth corresponds to the findings using the panel and quasi-panel regressions above. Regressions using the residual volatility of employment growth as the dependent variables also showed a positive impact of trade openness on volatility, and this effect was driven by the degree of export openness. The dependent variable in the heteroscedastic regression model is similar to the dependent variable in these models, as it also captures the residual variance of employment growth.

5 Conclusions

This paper has used German regional data to test how employment volatility has evolved over time and which factors account for these changes. We find that employment volatility has declined through the past decades, thus mirroring changes in aggregated output volatility. This process has been interrupted only by the reunification period in the early 1990s. Once we isolate idiosyncratic developments at the state level from macroeconomic trends, we find some weak evidence for an increase in employment volatility.

Overall, a higher share of employment in the services sector, a higher share of long-term unemployment, and a higher degree of unionization are associated with lower volatility of employment. Most of these results are driven by the West German states. This is consistent with the hypothesis that production in services is less cyclical and that labor market rigidities lower employment volatility. Also, higher volatility of government spending is correlated with higher volatility of employment growth.

The main interest of this paper has been the link between trade openness and the volatility of employment. In contrast to findings for the US, we do not find evidence for a positive link between employment volatility and trade openness. There is evidence for a positive link in selected specifications but these results are driven by states hosting international harbors and thus having an above-average exposure to foreign trade. For the average German state, greater trade openness has not been associated with a greater volatility of employment.

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7 Data Appendix

Employment: We use data provided by a working committee of employment statistics (*Erwerbstätigenrechnung des Bundes und der Länder*). This dataset contains annual average values of the employees at the state level for the years 1970-2005. Freelancers are included.

Government revenues and expenditures: We use data from the German Federal Statistic Office (*Statistisches Bundesamt*) which contain information about the aggregated government revenues and expenditures at the state level. Data for the West German states are available since 1985, for the East German states since 1992.

Industry diversification: Herfindahl index computed for the number of workers in 15 industrial sectors. We calculate this index as:

$DIV_{i,t} = \sum_{j=1}^{n} \left(\frac{ERW_{i,j,t}}{ERW_{i,t}} \right)^2$, where $DIV_{i,t}$ is the industry diversification of state *i* in year *t*, $ERW_{i,j,t}$ is the number of employees in state *i*, in sector *j* in year *t*, $ERW_{i,t}$ is the number of employees in state *i* in year *t*, n is the total number of employees in state *i* in year *t*. Sectoral employment data are obtained from a working committee of employment statistics (*Arbeitskreis Erwerbstätigenrechnung des Bundes und der Länder*) for the years 1991-2004.

Long-term unemployment rate: The data are taken from the German Working Agency (*Bundesagentur für Arbeit*). Long-term unemployed are persons who are unemployed more than one year. We use the data from 1977-2003.

Openness: State-level exports and imports relative to state GDP. The data are taken from the German Federal Statistic Office (*Statistisches Bundesamt*)

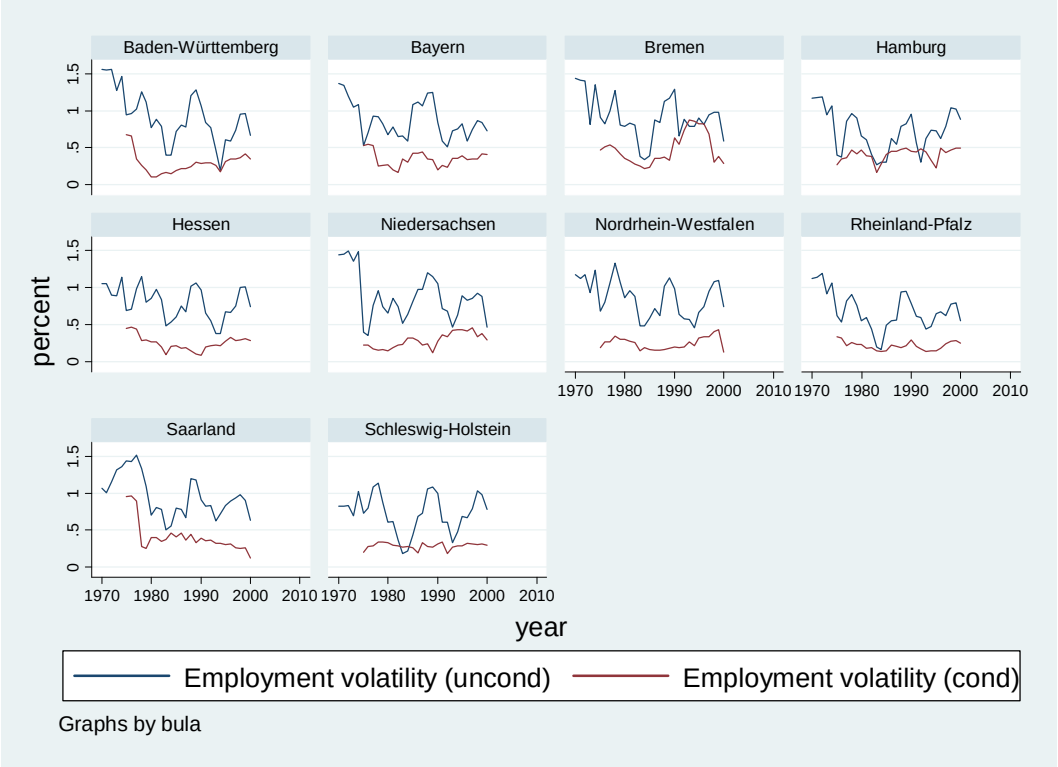
Output: Data we use are taken from the German Federal Statistic Office (*Statistisches Bundesamt*). We use the price-adjusted GDP growth at state level, for the West German States since 1971, for the East German states since 1991.

Service sector: We use sectoral data from from a working committee of employment statistics (*Arbeitskreis Erwerbstätigenrechnung des Bundes und der Länder*) for the years 1970-2004 to compute the share of employees in the service sector

Unionization: Data on the share of employees organized in German unions are taken from the German employees association (*Deutscher Gewerkschaftsbund*).

Graph 1: Employment Volatility by German State

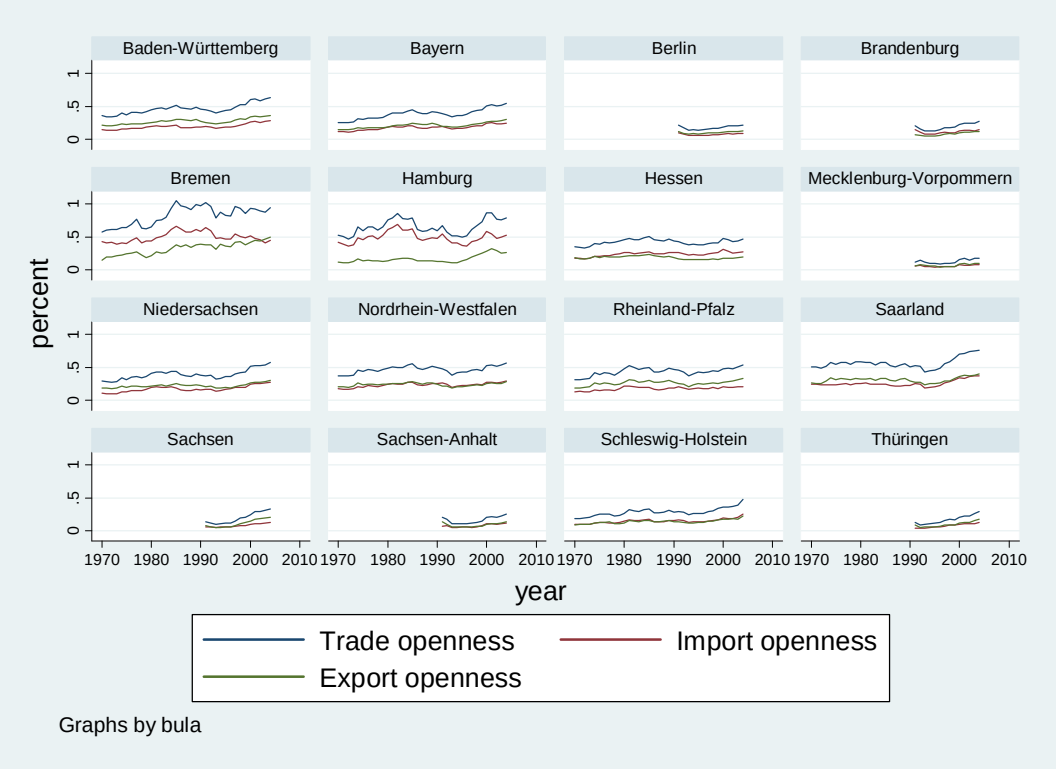
This Graph plots the volatility of regional employment growth for the West German states. Employment growth is the year-to-year cyclical change in the level of employment. The cyclical component is obtained using the Hodrick-Prescott-Filter. Volatility is the standard deviation of employment growth over a 5-year moving window. We show the unconditional volatility of employment growth and the conditional volatility of employment growth based on the residual of a regression of employment growth on time fixed effects and five lags of the dependent variable.



Source: German Statistical Office, authors' calculations.

Graph 2: Trade Openness by German State

Trade openness is the sum of state-level imports and exports over state-level GDP.



Source: German Statistical Office, authors' calculations.

Table 1: Descriptive Statistics

See the Data Appendix for a detailed description of these variables. 'Volatility' is the standard deviation of the growth rate of the respective variables over a five-year rolling window.

Variable	Observations	Mean	Std. Dev.	Min	Max
Degree of industrial diversification	240	0.113	0.013	0.094	0.170
Export openness (%)	455	0.200	0.088	0.040	0.500
Import openness (%)	454	0.216	0.138	0.040	0.690
Long-term unemployment rate (%)	330	0.289	0.073	0.129	0.377
Service sector (%)	450	0.631	0.096	0.378	0.855
Trade openness (%)	434	0.427	0.199	0.083	1.049
Unionization (%)	450	0.282	0.044	0.198	0.336
Volatility of employment growth (%, conditional)	290	0.345	0.169	0.081	0.969
Volatility of employment growth (%, unconditional)	370	0.925	0.497	0.160	4.176
Volatility of nominal government expenditures (%)	214	2.914	1.440	0.302	6.389
Volatility of nominal government revenues (%)	214	3.883	2.358	0.517	12.611
Volatility of real output growth (%)	370	1.568	0.646	0.120	3.420

Table 2: Determinants of Regional Employment Volatility

This Table presents results of fixed effects panel estimators. *t*-values based on robust standard errors clustered at the state-level are reported in brackets. The full sample includes information for 16 German states, the West German sample includes information for 10 West German states (excluding *Berlin*). Data are for the years 1971-2005. The dependent variable is the volatility of employment, calculated as the squared growth rate of employment. 'Unconditional' is the unadjusted employment growth, 'conditional' are the squared residuals of a regression of the growth rate of employment on up to five own lags, year fixed effects, and a unification dummy. The conditional and unconditional volatility of output growth and government spending and revenue are computed analogously. See the Data Appendix for details on the specifications of the variables. ***, **, * = significant at the 1%, 5%, 10% level.

a) Full sample

	Unconditional employment volatility							Conditional employment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Volatility of output growth	0.205**	0.206**	0.209**	0.240**	0.370***	0.199**	0.168**	0.056***	0.057***	0.058***
	(2.70)	(2.75)	(2.78)	(2.80)	(2.95)	(2.92)	(2.94)	(3.43)	(3.33)	(3.88)
Trade openness	0.486			3.150	3.477	-2.173	-0.159	0.276		
	(0.13)			(0.74)	(0.33)	(0.68)	(0.10)	(1.13)		
Import openness		-1.726							-0.167	
		(0.47)							(1.38)	
Export openness			4.525							1.047*
			(0.71)							(1.83)
Volatility of government revenue				-0.006						
				(1.12)						
Volatility of government spending				0.005						
				(0.62)						
Industry diversification					-171.245					
					(1.44)					
Unemployment						-23.789				
						(1.55)				
Service sector						-32.501***				
						(3.12)				
Long-term unemployment rate							0.331			
							(0.20)			

Table 2a continues …

Table 2a continued …

	Unconditional employment volatility							Conditional employment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Degree of unionization							6.661			
							(1.40)			
Reunification dummy 0/1	0.187	0.205	0.189	0.315	3.437	0.026	1.023**	-0.052	-0.064	-0.043
	(0.38)	(0.41)	(0.36)	(0.67)	(1.37)	(0.04)	(2.61)	(1.27)	(1.44)	(1.02)
Constant	0.469	1.051	-0.271	-0.804	17.312	24.263***	-1.518	0.006	0.174**	-0.085
	(0.31)	(1.33)	(0.21)	(0.46)	(1.22)	(3.36)	(0.81)	(0.05)	(2.76)	(0.61)
Observations	418	417	418	262	218	418	330	338	337	338
Number of states	16	16	16	16	16	16	16	16	16	16
R^2 (within)	0.32	0.32	0.32	0.37	0.35	0.35	0.19	0.28	0.28	0.29

b) West Germany

	Unconditional employment volatility							Conditional employment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Volatility of output growth	0.029***	0.030***	0.029***	0.023	0.056***	0.030***	0.075***	0.024	0.024	0.027*
	(4.22)	(4.06)	(3.91)	(1.33)	(4.39)	(4.00)	(5.49)	(1.69)	(1.53)	(2.08)
Trade openness	-0.293			0.261	1.270	-0.390	0.786**	0.332*		
	(0.65)			(0.29)	(0.96)	(0.61)	(2.42)	(1.84)		
Import openness		-0.708							-0.029	
		(1.01)							(0.46)	
Export openness			0.235							0.983*
			(0.24)							(1.97)
Volatility of government revenue				-0.000						
				(0.09)						
Volatility of government spending				0.008*						
				(1.87)						
Industry diversification					-10.950					
					(1.05)					
Unemployment						-1.757				
						(0.68)				
Service sector						-1.987				
						(0.71)				
Long-term unemployment rate							-2.831***			
							(3.95)			
Degree of unionization							-3.273***			
							(4.24)			
Reunification dummy 0/1	-1.566**	-1.560**	-1.561*	1.405***	-0.900**	-1.255	0.289***	-0.050	-0.028	-0.043
	(2.29)	(2.29)	(2.26)	(5.03)	(2.78)	(1.57)	(5.46)	(1.22)	(0.95)	(1.00)
Constant	3.327***	3.347***	3.152***	0.172	1.904*	4.498**	1.745***	-0.061	0.084**	-0.119
	(4.33)	(5.02)	(3.95)	(0.43)	(2.06)	(2.54)	(5.24)	(0.51)	(2.40)	(0.87)
Observations	340	339	340	190	140	340	270	290	289	290
Number of states	10	10	10	10	10	10	10	10	10	10
R^2 (within)	0.62	0.62	0.62	0.68	0.74	0.62	0.20	0.19	0.19	0.20

Table 3: Determinants of Regional Employment Volatility (Quasi Panel)

This Table presents results of fixed effects panel estimators. *t*-values based on robust standard errors clustered at the state-level are reported in brackets. All regressions are for all German states. Data are for the years 1975-2005. The dependent variable is the volatility of employment, calculated as the standard deviation of a non-overlapping 5-year window. 'Unconditional' is the unadjusted volatility of employment growth, 'conditional' is the volatility of the residuals of a regression of the growth rate of employment on up to five own lags, year fixed effects, and a unification dummy. See the Data Appendix for details on the specifications of the variables. ***, **, * = significant at the 1%, 5%, 10% level.

	Unconditional employment volatility							Conditional employment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Volatility of output growth	0.062	0.067*	0.066*	-0.026	0.132	0.056	0.076	0.034	0.019	0.044
	(1.73)	(1.96)	(1.79)	(0.38)	(1.43)	(1.38)	(1.64)	(0.65)	(0.30)	(1.09)
Trade openness	-0.065			-0.567	0.912	-0.179	0.151	0.551**		
	(0.27)			(0.95)	(1.27)	(0.89)	(0.88)	(2.47)		
Import openness		-0.586**							0.551	
		(2.34)							(1.52)	
Export openness			0.448							0.978*
			(0.67)							(2.00)
Volatility of government revenue				0.051***						
				(3.04)						
Volatility of government spending				0.071*						
				(2.00)						
Industry diversification					-18.378					
					(0.99)					
Unemployment						-0.979				
						(0.62)				
Service sector						-1.854				
						(1.07)				
Long-term unemployment rate							-0.591			
							(1.00)			
Degree of unionization							-0.885			
							(0.58)			

Table 3 continues …

Table 3 continued

	Dependent variable: unconditional employment volatility							Dependent variable: conditional employment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Reunification dummy 0/1	0.054	0.066	0.046	-0.174*	0.276	0.338	0.205***	0.145**	0.107*	0.126
	(0.47)	(0.58)	(0.42)	(1.77)	(1.55)	(1.33)	(3.08)	(2.21)	(2.02)	(1.43)
Constant	0.700***	0.778***	0.590***	0.718**	2.196	1.798*	0.939*	-0.03	0.127	0.015
	(7.41)	(10.46)	(4.40)	(2.40)	(1.20)	(1.88)	(1.80)	(0.19)	(0.99)	(0.09)
Observations	82	82	82	52	32	82	62	66	66	66
Number of states	16	16	16	16	16	16	16	16	16	16
R^2	0.57	0.57	0.57	0.6	0.41	0.58	0.37	0.19	0.17	0.18

Table 4: Determinants of Regional Employment Volatility (Robustness Check without City States)

This Table presents results of fixed effects panel estimators. *t*-values based on robust standard errors clustered at the state-level are reported in brackets. Data are for the years 1975-2005. The dependent variable is the volatility of employment computed as the squared residual of a regression of the growth rate of employment on up to five own lags, year fixed effects, and a unification dummy. See the Data Appendix for details on the specifications of the variables. ***, **, * = significant at the 1%, 5%, 10% level.

	Full Sample		Excluding Hamburg		Excluding Bremen		Full Sample		Full Sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Volatility of output growth	0.056***	0.058***	0.050**	0.054**	0.061***	0.061***	0.057***	0.059***	0.057***	0.060***
	(3.43)	(3.88)	(2.55)	(2.86)	(3.79)	(3.84)	(3.42)	(3.85)	(3.50)	(3.92)
Trade openness	0.276		0.459**		-0.013		0.345		0.092	
	(1.13)		(2.44)		(0.04)		(1.51)		(0.38)	
Openness * Hamburg							-0.228			
							(1.40)			
Openness * Bremen									0.412*	
									(1.89)	
Export Openness		1.047*		1.326**		0.357		1.192**		0.695
		(1.83)		(2.38)		(0.59)		(2.15)		(1.05)
Export Openness * Hamburg								-0.576		
								(1.51)		
Export Openness * Bremen										0.661
										(1.45)
Reunification dummy 0/1	-0.052	-0.043	-0.004	0.024	-0.059	-0.046	-0.055	-0.045	-0.065	-0.057
	(1.27)	(1.02)	(0.11)	(0.59)	(1.00)	(0.87)	(1.27)	(1.00)	(1.39)	(1.20)
Constant	0.006	-0.085	-0.109	-0.212	0.141	0.063	-0.010	-0.107	0.063	-0.025
	(0.05)	(0.61)	(1.08)	(1.48)	(0.89)	(0.44)	(0.09)	(0.85)	(0.49)	(0.17)
Observations	338	338	309	309	309	309	338	338	338	338
Number of states	16	16	15	15	15	15	16	16	16	16
R^2	0.28	0.29	0.30	0.31	0.31	0.31	0.28	0.29	0.28	0.29

Table 5: Determinants of Regional Employment Volatility (Heteroscedastic Regression Model)

This Table presents results of a heteroscedastic regression model as proposed by Harvey (1967). Observations are clustered at the state level. Robust *t*-values are reported in brackets. Regressions for the full sample include a full set of time and state-fixed effects. Regressions for the West German sample include time fixed effects only since the model did not converge for all specifications using state fixed effects. Data are for the years 1970-2003. See the Data Appendix for details on the specifications of the variables. ***, **, * = significant at the 1%, 5%, 10% level.

	Full sample				West Germany			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean equation								
Output growth	0.177**	0.185***	0.190***	0.187***	0.182***	0.182***	0.208***	0.154***
	(2.30)	(0.53)	(0.59)	(0.40)	(6.04)	(5.62)	(0.20)	(0.69)
Wage growth	-0.272*	-0.265**	-0.268**	-0.272***	-0.186***	-0.185**	-0.197***	-0.298***
	(1.65)	(1.96)	(2.68)	(2.57)	(2.61)	(0.46)	(0.03)	(3.41)
Trade openness	-1.063			0.537	-0.639***			-0.250
	(0.68)			(0.34)	(1.94)			(0.80)
Import openness		0.511				-0.760***		
		(1.03)				(5.05)		
Export openness			-1.629				-0.988**	
			(0.58)				(2.38)	
Unemployment				-10.568**				-6.779***
				(0.36)				(4.07)
Service sector				5.365				0.174
				(0.39)				(0.57)

Table 5 continues …

Table 5 continued

	Full sample				West Germany			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variance equation								
Output growth	0.052	0.063	0.067	0.037	0.048	0.023	-0.022	0.065
	(4.08)	(0.55)	(4.06)	(4.10)	(0.35)	(0.15)	(7.80)	(3.76)
Wage growth	0.153**	0.136*	0.136**	0.156***	-0.142	-0.113	-0.008	-0.274
	(2.00)	(2.00)	(1.83)	(2.61)	(0.48)	(2.54)	(2.89)	(0.83)
Trade openness	29.428			-0.617	1.684**			
	(0.11)			(0.25)	(6.32)			
Import openness		-3.149				1.965*		
		(0.44)				(1.69)		
Export openness			-1.947				2.098	
			(0.59)				(0.97)	
Unemployment				5.447				6.279
				(2.50)				(0.48)
Service sector				4.187				1.681
				(0.86)				(0.40)
Observations	418	417	418	418	340	339	340	340

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