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by Christopher Phillip Reicher

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JEL classification: E24, E32, J24, J62.

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* I wish to thank seminar participants at IfW-Kiel, Boston College, and the Deutsche Bundesbank for their helpful comments on a companion paper; all errors, omissions, and opinions are mine.

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This paper compares the aggregate effects of sectoral reallocation in the United States and Western Germany using a stochastic volatility model of sectoral employment growth. Reallocative shocks have no effect on the natural rate of unemployment in either country, and there is mild evidence that reallocative shocks are contractionary over the cycle. The overall statistical contribution of such shocks to the cycle, however, is limited. Reallocative shocks do not appear to be to blame for the rise in trend unemployment in Germany in the 1980s or for a possible rise in trend unemployment in the United States following the Great Recession.

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A tale of two countries: A comparison of the aggregate effects of sectoral reallocation in the United States and Germany

1. Introduction

There has been a major debate in the United States as to whether human capital mismatch, caused by a major reallocative shock, has much to do with the persistently high unemployment in that country.[1] That debate echoes a previous debate about the role of reallocation in generating stubbornly high European unemployment. This paper seeks to contribute something to both debates, by comparing the effects of long run reallocative shocks in the United States and Western Germany over a long sample, using an estimated stochastic volatility model of sectoral employment growth. The aggregate effects of reallocative shocks in both countries appear to have been limited, even though both countries have different labor market institutions and a different history of unemployment dynamics. There is mild evidence that reallocative shocks are somewhat recessionary in both countries, but these shocks have little to no effect on the natural rate of unemployment, and the quantitative contribution of reallocative shocks to the cycle is not large. While sectoral reallocation is an interesting phenomenon at the microeconomic level, its aggregate effects appear to be rather limited.

The findings presented in this paper have important implications for the conduct of theory. There is a large literature which discusses theoretical relationship between sectoral reallocation and trend unemployment, originating with the "islands" model of Lucas and Prescott (1974). Marimon and Zilibotti (1999), Phelan and Trejos (2000), Ljundqvist and Sargent (2004) and den Haan, Haefke, and Ramey (2005) have argued as to whether theory and data predict a rise in trend unemployment in response to long run reallocative pressure, and these estimates provide some hard evidence on the issue. Turbulence does not seem to be the culprit behind the rise in European (or at least German) unemployment at the beginning of the 1980s, nor does it appear to be the culprit behind a possible rise in trend unemployment in the United States after the Great Recession. Reicher (2011) finds that there is in fact little evidence of an empirical effect of reallocative shocks on the natural rate of unemployment in

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[1] Kocherlakota (2010), for instance, has claimed that mismatch in the supply and demand for different types of workers can account for a 2.5 percent rise in unemployment during and following the Great Recession. Others have offered differing estimates, with Schmitt and Warner (2011) arguing that reallocation and mismatch have played no role in the labor market situation.

the United States; this finding is robust to different levels of sectoral aggregation. That paper also finds that pure ("clean") reallocative shocks should have no effect on aggregate outcomes in a theoretical setting, though it is possible for a shock to have both aggregate and reallocative effects (a "dirty" shock). In comparison with the previous paper, this paper does not make any direct theoretical contributions; rather, it explores possible cross-country variation in the effects of reallocative shocks between two economies with different labor market institutions.

This paper takes the statistical model of Reicher (2011) and applies it to Western German data. Unlike the United States, Western Germany has seen large movements in the trend rate of unemployment over the past several generations, and like the United States, it has seen a gradual movement out of manufacturing and into services over time. This paper sees to what extent reallocation and the natural rate are related in Germany and compares the results with results from the United States. It turns out that the German economy and the U.S. economy behave similarly in response to reallocative shocks. Reallocative shocks seem to be mildly contractionary in both countries, but they have no permanent effect on unemployment. Even though they may be contractionary, reallocative shocks do not account for much of the variance of the cycle. Much of the discussion blaming reallocation for large movements in the unemployment rate does not appear to fit the data, if reallocation is measured using a high-level sectoral breakdown. There is one difference between the United States and Germany with respect to the pattern of sectoral reallocation. In the United States, reallocation consists primarily of construction busts plus the 2001 technology bust. In Germany, production industries (mining and manufacturing) play a more important role; Germany seems to be less prone to construction busts than the United States.

There are few cross-country comparisons of the nature and effects of reallocation. Pelloni and Polasek (2003) directly model sectoral shifts as relating to time-varying volatility, also in a cross-country setting. They extend the work of Campbell and Kuttner (1996) using a vector autoregression on data for the United Kingdom, Germany, and the United States with GARCH errors; they claim that sectoral shifts have large aggregate effects. Pelloni and Polasek (2003) do not allow for different industries to have different responses to aggregate shocks; they assume that the vector of reduced-form aggregate and sectoral disturbances is mutually uncorrelated. Abraham and Katz (1986) base their original critique of the Lilien (1982) approach on the fact that different sectors respond differently to the cycle, so Pelloni and Polasek appear to estimate a large effect of reallocative shocks since recessions are times when employment shares vary systematically.[2]

The Reicher (2011) approach introduces the concept of time-varying volatility into a state space model. The main driver of that model is an unobserved reallocative process which must be estimated. Output, sectoral employment, and unemployment have permanent and transitory components, and reallocative shocks show up in the second moments of sectoral trend employment growth. Reallocative shocks could also have direct effects on the natural rate of unemployment, productivity, or the cycle. The model is estimated using Bayesian techniques. This paper adopts that model and applies it to German and U.S. data in a symmetric manner. The rest of this paper proceeds as follows. Section 2 discusses the model; Section 3 discusses the data and priors used in the Bayesian estimation; Section 4 discusses the results; and Section 5 concludes.

2. The state space model

2.1 Overview of the main components of the model

The main object of interest is a time-varying reallocation process S_t. When S_t is high, the economy experiences a wave of long run sectoral reallocation. When S_t is low, the economy experiences less reallocation. S_t feeds into the economy in several ways. Most importantly, when S_t is high, the cross-sectional variance of long run employment growth at the sectoral level is high; this means that workers subsequently find themselves moving across sectors at a faster rate. In addition, S_t can directly affect the aggregate economy—it can have an effect on trend productivity, the business cycle, and the natural rate of unemployment. S_t is unobserved by the econometrician and must be estimated along with its effects. To the degree that S_t is related to aggregate output and unemployment, it can be said that reallocative shocks are "dirty" in the sense of Reicher (2011), and that reallocative shocks and aggregate shocks are statistically related.[3] If reallocative shocks are dirty, then some shocks which have aggregate effects also have reallocative effects; for instance, a construction bust might not be offset by a rise in the demand for nurses, so the construction bust is both a reallocative shock and an aggregate shock.

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[2] Rissman (2009), Aaronson, Rissman, and Sullivan (2004), and Rissman (1997) get around this problem by using a state space approach with U.S. data. They do not look at stochastic volatility, and they do not concentrate on unemployment dynamics.

[3] This is in contrast to a "clean" reallocative shock which has no aggregate effects; an example of a clean reallocative shock would be a pure shift in the relative demand for construction workers and nurses.

An exploratory analysis of the model does not reveal any posterior autocorrelation in sectoral dispersion, so it is reasonable to assume that the volatility process underlying sectoral growth is independent and identically distributed over time. S_t is therefore modeled as independently and identically distributed according to a lognormal distribution centered on a mean log of zero, with a constant variance:

$$E\left[\log(S_t)^2\right] = \sigma_S^2. \tag{1}$$

The mean of $\log(S_t)$ is not identified since it is possible to scale the variance of the errors of sectoral employment trends up or down inversely with S_t while leaving the likelihood unchanged. To normalize S_t, it is convenient to assume that $\log(S_t)$ has a mean of zero; this makes it easy to work with the equations where $\log(S_t)$ appears on the right hand side.

The statistical model has three component blocks which govern output, employment, and unemployment. Throughout the analysis, output and employment are expressed in natural logarithms relative to the working-age population, while unemployment is expressed as a percent of the civilian labor force. The first block of the model governs the evolution of output, which has three components. Output has a nonstationary long run trend z_t^y which is governed by the long run levels of productivity and employment. Output also has a persistent but stationary component w_t^y which indexes the state of the business cycle. The final component of output is the idiosyncratic noise term c_t. The observation equation for log output has these three components:

$$y_t = z_t^y + w_t^y + c_t. \tag{2}$$

The second block of the model governs unemployment dynamics; unemployment has two components. It has a nonstationary permanent component z_t^u and a stationary temporary component w_t^u which may be related to the state of the business cycle. The component z_t^u equals the natural rate of unemployment, or the rate of unemployment that the economy would tend toward on average if all shocks were temporary in nature. Unemployment has the following observation equation consisting of its two components:

$$u_t = z_t^u + w_t^u . \tag{3}$$

Employment at the sectoral level has three components. The first two components are the common long run component of employment x_t^n, and a full array of nonstationary idiosyncratic trends $z_{i,t}^n$. Shocks to these idiosyncratic trends have a common stochastic volatility component indexed by S_t. When S_t is large, the economy undergoes a burst of long run reallocative activity, and this shows up as higher levels of cross-sectional dispersion in long run sectoral growth. The third component of sectoral employment is its stationary component $w_{i,t}^n$, which is related to the state of the business cycle. Written as an observation equation, the aggregate trend, idiosyncratic trend, and cyclical component of employment respectively sum up to observed log employment for sector *i*:

$$n_{i,t} = x_t^n + z_{i,t}^n + w_{i,t}^n . \tag{4}$$

2.2 The state space model in detail: Laws of motion for output

Output consists of its long run, cyclical, and noise factors. Shocks are independent and identically distributed across time. The change in aggregate long run output is governed by a drift coefficient, the change in the aggregate employment factor, and reallocation, with the residual representing a pure productivity shock:

$$\Delta z_t^y = \mu^y + \Delta x_t^n + \delta_{S,zy} \log(S_t) + \varepsilon_t^{zy} , \qquad \text{where } E\left[\left(\varepsilon_t^{zy}\right)^2\right] = \sigma_{zy}^2 . \tag{5}$$

Including reallocation on the right hand side of (5) makes it possible to measure the long run effect of reallocative shocks on productivity. To the extent that reallocation is dirty in the long run, the coefficient $\delta_{S,zy}$ will differ from zero, and reallocative shocks will be related to aggregate long run productivity.

The cyclical output factor depends on its own lags. It can also respond to the process governing sectoral reallocation and to the process governing shocks to productivity. The parameter $\delta_{S,wy}$ captures the degree to which sectoral reallocation is recessionary in its direct effects. The parameter $\delta_{zy,wy}$ captures the effect of a shock to productivity on the cycle. Cyclical output evolves according to the following equation:

$$w_t^y = \sum_{p=1}^{P} \rho_p^{wy} w_{t-p}^y + \delta_{S,wy} \log(S_t) + \delta_{zy,wy} (\delta_{S,zy} \log(S_t) + \varepsilon_t^{zy}) + \varepsilon_t^{wy} ,$$

$$\text{where } E\left[\left(\varepsilon_t^{wy}\right)^2\right] = \sigma_{wy}^2 . \qquad (6)$$

Including reallocation on the right hand side of (6) gives another test of the effects of reallocative shocks. To the extent that reallocative shocks are contractionary in its direct short-run effects, the coefficient $\delta_{S,wy}$ will differ from zero. Reallocation can also have an indirect effect if productivity is systematically related to the cycle. The total effect of reallocation on the cycle is given by the composite coefficient $\delta_{S,wy} + \delta_{zy,wy}\delta_{S,zy}$. A negative value of that composite coefficient would indicate that reallocation tends to be recessionary on average, or in other words, that reallocative shocks tend to be dirty in the short run.

The idiosyncratic output factor (which mainly contains measurement error but also temporary shocks such as weather shocks or small strikes) is given by a white noise term:

$$c_t = \varepsilon_t^c , \qquad \text{where } E\left[\left(\varepsilon_t^c\right)^2\right] = \sigma_c^2 . \qquad (7)$$

Observed log output equals the sum of these three components given in (2)—trend, cycle, and error:

$$y_t = z_t^y + w_t^y + c_t .$$

2.3 The state space model in detail: Laws of motion for unemployment

Unemployment consists once again of its long run and short-run factors. The aggregate long run unemployment factor (the natural rate) is given by:

$$z_t^u = z_{t-1}^u + \delta_{S,zu} \log(S_t) + \varepsilon_t^{zu} , \qquad \text{where } E\left[\left(\varepsilon_t^{zu}\right)^2\right] = \sigma_{zu}^2 . \qquad (8)$$

The theoretical model of Reicher (2011) predicts that the coefficient $\delta_{S,zu}$ should equal zero. If reallocation is dirty, it should affect long run productivity and possibly have a short-run effect as well, but it should not affect the natural rate of unemployment, which in the long run is governed by preferences over leisure. By contrast, the turbulence literature blames a possible rise in the natural rate of unemployment on sectoral reallocation; such a situation would coincide with a positive value for $\delta_{S,zu}$. The estimated distribution for that coefficient will show the degree to which sectoral reallocation coincides with changes in the natural rate throughout the entire sample.

The short-run unemployment factor may vary according to the cycle and is given by:

$$w_t^u = \sum_{p=0}^{P} \alpha_p^u w_{t-p}^y + \varepsilon_t^{wu}, \qquad \text{where } E\left[\left(\varepsilon_t^{wu}\right)^2\right] = \sigma_{wu}^2 . \tag{9}$$

The factor loadings α_p^u capture the contemporaneous and lagged effects of the state of the business cycle on unemployment. Once again, observed unemployment equals the sum of its long run and short-run factors given in (3):

$$u_t = z_t^u + w_t^u .$$

Specifying unemployment dynamics this way makes it easy to talk about trend versus cyclical unemployment. Much of the discussion about a possible rise in trend unemployment due to reallocation is a discussion about the dynamics of the long run factor z_t^u. However, a dirty reallocative event can also affect cyclical unemployment w_t^u through its effect on cyclical output w_t^y, even if it leaves z_t^u unchanged. In that case, a reallocative shock does not cause the "new normal" unemployment rate to rise; instead, it simply contributes to a recession.[4]

2.4 The state space model in detail: Laws of motion for sectoral employment

Sectoral employment consists of an aggregate trend factor, an idiosyncratic trend factor, and a cyclical factor with variable factor loadings. All structural shocks are iid across sectors and

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[4] Trend unemployment and structural unemployment are not necessarily the same thing; one refers to the time-series properties of unemployment and the other refers to the economic causes of unemployment.

across time unless otherwise noted. The aggregate long run employment factor reflects changes in the long run level of employment which have a common effect across sectors; this factor will primarily consist of changes in labor force participation and in the coverage of the establishment survey.

The aggregate trend employment factor follows a random walk and is given by:

$$x_t^n = x_{t-1}^n + \delta_{u,n}(z_t^u - z_{t-1}^u) + \varepsilon_t^{xn}, \qquad \text{where } E\left[\left(\varepsilon_t^{xn}\right)^2\right] = \sigma_{xn}^2 . \tag{10}$$

Trend employment rates follow a random walk but one might naturally expect trend employment to be related to trend unemployment. The degree to which an innovation in trend unemployment affects trend employment is given by the coefficient $\delta_{u,n}$, and that coefficient should be relatively close to negative one.

Each idiosyncratic long run employment factor reflects changes to trend employment across industries which are not related to either the common trend or cycle. Sectors may have their own long run growth intercepts given by μ_i^n; these differing coefficients capture the fact that manufacturing in general has shrunken over time in a systematic way, while services have expanded. The idiosyncratic employment trends follow the law of motion:

$$\Delta z_{i,t}^n = \mu_i^n + \rho_i^{zn} \Delta z_{i,t-1}^n + \varepsilon_{i,t}^{zn}, \qquad \text{where } E\left[\varepsilon_t^{zn} \varepsilon_t^{zn'} \mid S_t\right] = \Sigma_{zn} S_t . \tag{11}$$

Theory has strong predictions about trend employment at the sectoral level. It predicts that shocks to trend employment should covary negatively by sector, which would show up as negative off-diagonal elements of Σ_{zn}.[5] It also predicts that employment growth should be positively autocorrelated since it takes time for sectoral employment to adjust to its new long run level after a shock.

Each idiosyncratic short-run employment factor may respond to the business cycle with different factor loadings and a different lag structure. These short-run employment factors are given by:

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[5] Actually, the model requires that Σ_{zn} be singular when the employment data cover the entire economy. Since the employment data do not have complete coverage, a matrix of full rank is consistent with the accounting identities which link sectoral and aggregate employment.

$$w_{i,t}^{n} = \sum_{p=0}^{P} \alpha_{p,i}^{n} w_{t-p}^{y} + \varepsilon_{i,t}^{wn}, \qquad \text{where } E\left[\left(\varepsilon_{i,t}^{wn}\right)^{2}\right] = \sigma_{wn,i}^{2}. \tag{12}$$

The coefficients $\alpha_{p,i}^{n}$ capture the fact that the business cycle affects different sectors of the economy with differing degrees of intensity and possibly different lags; for instance, durable goods manufacturing is known to be very responsive to the cycle while government employment is much less responsive. The heterogeneity in the systematic response of the different sectors to the cycle is what motivates Abraham and Katz (1986) in their critique of the sectoral reallocation literature at the time. Abraham and Katz, and those who follow them, have typically used other variables such as monetary policy indicators to “purge” sectoral employment of cyclical influences. Using equation (12) in a full Bayesian estimation makes it possible to directly purge cyclical influences from the employment series, so there is no need to rely on other indicators of the cycle. The Bayesian approach to purging also eliminates any problem with errors in variables and attenuation bias.

Once again, the three employment factors add up to the observed log of employment in each sector as shown in equation (4):

$$n_{i,t} = x_{t}^{n} + z_{i,t}^{n} + w_{i,t}^{n}.$$

It is necessary to make a normalizing assumption. I normalize the initial value of the common long run level factor x_{1}^{n} to zero since there are six unit roots in the employment block but only five nonstationary observables. Doing this gives the series x_{t}^{n} an interpretation as the cumulative level of excess employment growth from the beginning of the sample.

3. Data and priors

3.1 Data for the United States

Data for U.S. unemployment and nonfarm establishment employment come from the CPS and data for GDP come from the NIPA; these are both economywide measures. All employment and output series are divided by the civilian noninstitutional population 16 and over, smoothed for breaks. Sectoral establishment employment data come from the BLS’s Current

Employment Statistics program, broken out by the NAICS. The original data cover fourteen sectors: Mining and logging, construction, durable goods manufacturing, nondurable goods manufacturing, wholesale trade, retail trade, transportation and utilities, leisure and hospitality, information, financial activities, professional and business services, education and health services, other services, and government. I manually smooth out the effects of large strikes, weather events, and census workers from the individual employment series, and I begin in 1960 in order to avoid having to manually correct for the extremely large strikes of the 1950s.

I then collapse the data into five large sectors. I collapse mining and logging, durable manufacturing, and nondurable manufacturing into the production sector; construction stands on its own; I collapse wholesale trade, retail trade, leisure and hospitality, and transportation and utilities into the trade, leisure, and transportation sector; I collapse information, financial activities, and professional and business services into the financial and business services sector; and I collapse education and health services, other services, and government into the public and private services sector. I choose these sectoral classifications to approximate the industrial classification system used by Germany, and this classification also closely approximates the SIC. I place information into the financial and business services sector because the more volatile components of the information sector belong to that supersector.

3.2 Data for Western Germany

For western Germany the data for GDP and the number of employees across five major sectors come from the quarterly VGR des Bundes and the annual VGR der Länder. I concentrate solely on western Germany in order to make a consistent comparison across decades, so I construct a dataset for this purpose using quarterly all-German data after 1991 as an interpolator. I manually correct the construction employment data for the obvious large weather-related blips which sometimes occur in the first quarter. In Germany the data cover production industries (mining and manufacturing), construction, trade (which includes transportation, utilities, hospitality, and telecommunications but not information technology), financial and business services, and private and government services. The VGR also contains data on the unemployment rate according to a labor force concept, to which I add 0.4 times the number of Kurzarbeiter (short time workers) for the pre-1990 period.[6] I take the national accounts data as is from before 1991. Thereafter I extrapolate the western unemployment rate given quarterly nationwide national accounts data and annual state-level results from the household microcensus.

From the employment series I subtract 0.4 times the number of short-time workers from the sectoral employment totals using the sectoral shares of full-time equivalent short-time workers published by the BfA (2010), backcast using the change in aggregate sectoral employment shares. Properly excluding a portion of short-time workers particularly affects estimated employment in production industries, making it much more sensitive to the cycle. All employment and output series are expressed in per capita terms, using the total population of the western German states 15 and over from the GENESIS databank. For the post-1990 period, the population of Western Germany excluding Berlin is spliced to the population of Western Germany including the western sectors of Berlin.

3.3 Priors and lag selection

Table 1 shows the prior distributions used in the estimation. Where possible, I use natural conjugate priors which are as uninformative as possible. The variance terms all have an inverse gamma or inverse Wishart prior distribution. The prior distributions on the variance terms are rather loose and they are very rough guesses as to the order of magnitude of these objects, with the prior variance on the variance of log(S_t) set large enough (to 4) so that observed sectoral dispersion lines up reasonably well with estimated dispersion. I use a tighter prior on the variances of the short-run idiosyncratic employment terms since weather events, seasonal adjustment errors, benchmark errors, and strikes result in some fluctuations in sectoral employment which I do not wish to attribute to changes in the trend. I use weakly informative priors on the other variances so that the estimated variances stay within the numerical precision of the machine and away from zero. The results are robust to different priors on the variances, though if the variances on short-run sectoral employment become too

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[6] I particularly thank Dominik Groll at the IfW for helping me understand the issue of short-time work and providing retrospective data. Boysen-Hogrefe and Groll (2010) give a good overview of the Kurzarbeit program and labor market dynamics during the Great Recession. I use preliminary data from the BfA in order to estimate the number of Kurzarbeiter and the seasonally adjusted unemployment rate for late 2010 and early 2011, since the Statistisches Bundesamt has suspended the publication of seasonally adjusted unemployment data pending data revisions.

small, the model slightly overfits the observed blips in sectoral employment and attributes them to changes in trend.

I use two lags for each of the equations governing the cyclical components of output, employment, and unemployment. The data clearly indicate that the one lag is insufficient at describing cyclical dynamics; the estimated coefficients using two lags consistently give a hump-shaped response of the cycle to a cyclical shock. Moving beyond two lags does not yield a substantially different picture of business cycle dynamics than staying with two lags. I therefore use two lags in all of the estimated laws of motion. The system is estimated using the Markov Chain Monte Carlo (MCMC) algorithm discussed in Appendix A. I take 200,001 draws and discard the first 10,000, using the remainder to calculate posterior statistics for the parameters and unobserved processes of interest.

4. Estimation results

Table 2 shows the posterior median values of the major coefficients of interest—the coefficients governing the contribution of long run reallocation to the natural rate of unemployment and the contribution of reallocation to the cycle, respectively. Reallocation has no obvious effect on the natural rate of unemployment in either the United States or Western Germany; the median estimates for the effect of reallocation $\delta_{S,zu}$ are very close to zero in both cases. The effect of reallocation on productivity given by $\delta_{S,zy}$ is also ambiguous; in the Germany it appears to be slightly negative while it appears to be very slightly positive in the United States. Neither estimate of $\delta_{S,zy}$ is different from zero with a great degree of statistical confidence.

There is weak evidence in both countries that reallocation is contractionary in the short run (given by the composite coefficient $\delta_{S,wy} + \delta_{S,zy}\delta_{zy,wy}$). That coefficient is negative with 89.6% confidence in the United States and with 81.4% confidence in Western Germany. Reicher (2011) shows that the degree of confidence in the effect of reallocative shocks increases with the number of sectors; with a richer sectoral breakdown, it might be possible to more precisely pin down the cyclical effects of reallocation. The theoretical model and the data agree that reallocation has little to no relationship with the natural rate of unemployment, and the effect of reallocative shocks on productivity is ambiguous. There does seem to be mild but not overwhelming evidence that reallocative shocks are dirty in the short run in both countries; shocks which are reallocative in their effects appear to be somewhat recessionary.

4.1 Parameter estimates: United States

Table 3 presents the parameter estimates for the United States for the statistical model. Business cycles are highly persistent; the sum of persistence coefficients for the cycle equals 0.956. Unemployment unsurprisingly responds negatively to the cycle. Production industries and construction are the most cyclical industries, with factor loadings near two. Public and private services are the least procyclical. Unemployment and employment comove negatively in the long run, as given by the coefficient $\delta_{u,n}$. Disturbances to long run productivity appear to be mildly procyclical, though it is impossible to statistically distinguish the effects of productivity shocks from zero.

The effects of reallocative shocks on economic aggregates appear to be extremely limited. The median estimate of $\delta_{S,zu}$, which captures the effect of reallocative shocks on the natural rate, is almost exactly zero. In the median scenario, reallocative shocks contribute 2% of the variance of movements in the natural rate. Reallocation and the natural rate simply have very little to do with each other. The median estimate of $\delta_{S,zu}$, which captures the effect of reallocative shocks on long run productivity, is mildly positive but difficult to distinguish from zero. In the median scenario, reallocative shocks contribute 10% of the variance of movements in trend productivity. Reallocative shocks do appear to be mildly countercyclical. The median coefficient governing the effect of such shocks on the cycle is negative, and it is negative with just under 90% confidence. Even so, reallocative shocks appear to contribute very little to the cycle. They contribute about 13% to the cycle in the median scenario, with an extremely wide degree of uncertainty. This is not an artifact of the sectoral breakdown either; Reicher (2011) finds that a richer sectoral breakdown gives the same results as for the 5-sector breakdown.

Not surprisingly, sectoral employment trends move persistently. All of the trends have a high median quarterly persistence, which is compatible with the idea that there are large costs to adjusting sectoral employment. Construction is the most volatile trend; the posterior median standard deviation of shocks to the construction sector is twice as large as for the other sectors. In general, the estimates from the United States are compatible with the idea that reallocative shocks are at most only mildly “dirty”. Table 4 shows the posterior correlation of the sectoral employment shocks, given by the elements of Σ_{zn}. The interesting negative off-diagonal element is given by the element describing the correlation between construction shocks and shocks to production industries. The long run share of workers in construction and production industries has a correlation of -0.53. Interestingly, there is a slight negative relationship between construction and public and private services as well. There is some mild evidence that in the long run, when the relative demand for construction workers falls, the relative demand for nurses and teachers rises.

4.2 The historical behavior of reallocation and the natural rate in the United States

Figure 1 shows the historical behavior of the posterior geometric mean reallocation series S_t, along with two other measures. The Lilien (1982) measure weights squared sectoral employment growth by sectoral employment shares. The weighted measure is a precision-weighted measure which would be the maximum likelihood measure of reallocation were reallocation to be completely neutral in its aggregate effects. Reallocation in the United States has gone through several spikes; the wave of reallocation which accompanied the Great Recession is not the only wave of reallocation in the sample. Large reallocative events occurred in 1966, 1974, 1990, 2001, and 2008. Smaller reallocative events occurred in the early 1970s and early 1980s.

Except for the 1966 event, reallocative shocks have tended to accompany recessions and rising unemployment, though a look at Figure 2 will show that reallocation has no obvious relationship with shifts in the natural rate of unemployment. The natural rate of unemployment appears to be much smoother than the actual unemployment rate. Since it is difficult to econometrically distinguish a nonstationary trend from a very persistent cycle, estimates of the natural rate come with wide error bands. There is some evidence that the natural rate rose into the 1980s and has fallen since then, and there is little evidence that it has strongly risen in recent years. Reallocative shocks seem to be related to recessions and not necessarily to movements in trend unemployment.

Figure 3 shows the posterior mean log employment trends for the United States. Most of the series are relatively smooth, except for construction. There were major construction busts in the mid 1960s, the mid 1970s, the early 1980s, the early 1990s, and the Great Recession. All but one of the reallocative events in Figure 1 has coincided with a construction bust. The other event happened in 2001; it coincided with a fall in the share of workers in financial and business services. In the long run, the trend share of workers in production industries tends to move in the opposite direction from the share of workers in construction. In general, though, long run sectoral reallocation in the United States consists mainly of construction busts and the technology bust of 2001, and these busts are mildly associated with recessions.

4.3 Parameter estimates: Western Germany

Tables 5 and 6 show the parameter estimates for Western Germany. In Germany, the business cycle is mildly more persistent than in the United States; median quarterly persistence for the cycle equals 0.965. Unemployment is also countercyclical, and production industries and construction are the most procyclical industries. Unemployment and employment move in opposite directions in the long run as one might expect, and there is weak evidence that productivity shocks are expansionary in the short run as well. In general, Germany behaves in a very similar manner to the United States at the macroeconomic level, though shocks to the cycle are smaller in Germany and shocks to trend unemployment are larger.

The middle portion of Table 5 shows the posterior statistics on the aggregate effects of reallocative shocks. The point estimate of $\delta_{z,u}$ of -0.0002 is very close to zero; there is no obvious effect of sectoral reallocation on the natural rate of unemployment. The median contribution of reallocation to the variance of the natural rate stands at a little bit more than 2%. The point estimate of $\delta_{z,y}$ of -0.0030 is difficult to distinguish from zero; there is also little obvious effect of sectoral reallocation on the long run level of productivity. The median contribution of reallocation to the variance of long run productivity is about 20% with a very wide credible interval. The median effect of a reallocative shock to the cycle is -0.0008, and the median share of the variance of the cycle contributed by reallocative shocks equals 6%. In general, the estimates of the model for Germany and the United States give broadly similar results. There is mild evidence that reallocative shocks are contractionary over the cycle, but the contribution of reallocative shocks to the cycle is most probably small. Reallocative shocks simply do not appear to have large aggregate effects in either country.

The bottom portions of Table 5 show that sectoral employment growth in Germany is very persistent, about as persistent in the United States. Table 6 shows the posterior correlation between shocks to the different employment trends. Production industries contribute most of the off-diagonal elements here. Growth in production industry employment shares is offset by a reduction in the growth of other employment shares. While the aggregate effects of sectoral reallocation appear to look similar in Germany to the United States, reallocation in Germany appears to consist of reallocation between manufacturing and the rest of the economy; Germany is subject to manufacturing booms and busts while the United States is subject to construction booms and busts.

4.4 The historical behavior of reallocation and the natural rate in Western Germany

Figure 4 shows the posterior geometric mean reallocation process for Germany. Germany experienced a fair amount of reallocation in 1974, 1984, 1992-93, 1998, and 2008-09. The Great Recession is by far the largest reallocative event in the sample. The 1974, 1992, and 2008 events coincided with rises in adjusted unemployment, as shown in Figure 5. None of these events coincided with the obvious rise in trend unemployment around 1980, but there is a slight tendency for reallocative events to coincide with recessions. The 2008 episode even seems to have accompanied a fall in trend unemployment. The coincidence between reallocation and recessions is somewhat weaker in Germany than in the United States; in neither country, however, is there any clear link between the trend in unemployment and sectoral reallocation. Comparing Germany with the United States, the posterior estimates of S_t in both countries have a correlation of +0.32 which increases to +0.51 when taken as a four-quarter moving average. The 1974 and 2008 events happened in both countries, though they did not show the same industrial pattern. Most other reallocative events appear not to coincide with each other across countries.

A look at Figure 6 shows which industries experienced large shifts in their trends during those events. The 1974 and 1984 events coincide with mild construction busts. The 1992 and 2008 events coincided with upticks in the long run share of employment devoted to construction; production industries contracted in relative terms during both events, particularly the 1992 one. Bachmann and Burda (2010) document a large increase in net worker flows across sectors during the 1990s, with particular upticks during these two events. The 1998 reallocative event coincided with volatility in production industries and also saw a sharp rise in employment in financial and business services. Reallocative events in Germany do not show as clear of a sectoral pattern as in the United States. The construction sector has contributed little to reallocation in Germany, while production industries play a much larger role in Germany than in the United States. While the macroeconomic effects of reallocation appear to be similar in both countries, its microeconomic pattern appears to be quite different.

5. Conclusion

Based on a stochastic volatility model of sectoral employment growth estimated using Bayesian methods, several clear facts emerge. In both the United States and in Western Germany, there is mild but not overwhelming evidence that shocks which induce reallocation across sectors are also recessionary in their effects. There is no strong evidence on the relationship between reallocation and long run productivity, and reallocation does not appear to be related to movements in the natural rate of unemployment in either country. Reallocative shocks across major sectors appear to be rather limited in their aggregate effects. Sectoral turbulence, at least at a high level, does not appear to be to blame for the rise in European trend unemployment during the 1980s or a possible rise in U.S. trend unemployment after the Great Recession.

At the industry level, reallocative shocks appear to differ in both countries. In the United States, reallocative shocks coincide with investment busts, particularly construction busts, with the addition of the 2001 technology bust. In Germany, the picture is more complicated. Germany is not as prone to construction busts as the United States; there, manufacturing and mining play a more important role in reallocative dynamics. While both economies are actually more similar than different in the aggregate, they have important differences at the sectoral level.

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Table 1: Prior distributions for all parameters, state space model

Parameter	Prior distribution	Remarks
σ^2_{xn}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
$\sigma^2_{wn,i}$	Inverse Gamma (Mean = (0.01^2), #Obs=T)	Filters out transitory noise.
Σ_{zn}	Inverse Wishart (Mean = (0.002^2)*I, #Obs=1)	Keeps cov. away from 0.
σ^2_{zu}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
σ^2_{wu}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
σ^2_{zy}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
σ^2_{wy}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
σ^2_{c}	Inverse Gamma (Mean = (0.01^2), #Obs=1)	Keeps var. away from 0.
σ^2_{S}	Inverse Gamma (Mean = 2^2, #Obs=1)	Gives good fit to dispersion.
$\mu_{zn,i}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
μ_{zy}	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
ρ^{zn}	Multivariate Normal (Mean = 0*I, Cov. = ∞*I)	Diffuse prior.
ρ^{wy}_{p}	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
α^{u}_{p}	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
$\alpha^{n}_{p,i}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
$\delta_{u,n}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
$\delta_{S,u}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
$\delta_{S,wy}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.
$\delta_{S,zy}$	Normal (Mean = 0, Std. = ∞)	Diffuse prior.

This table gives the prior distributions used for each of the model parameters.

Table 2: Posterior statistics on the effects of reallocation on the natural rate of unemployment, trend productivity, and the cycle

	$\delta_{S,u}$		$\delta_{S,zy}$		$\delta_{S,wy} + \delta_{S,zy}\delta_{zy,wy}$	
Country	**Median**	**pr > 0**	**Median**	**pr > 0**	**Median**	**pr > 0**
United States	0.0000	0.459	0.0012	0.722	-0.0017	0.104
Western Germany	-0.0002	0.342	-0.0003	0.153	-0.0030	0.196

Statistics are posterior percentiles and probabilities of being above zero for the model parameters which govern the long run and cyclical responses to reallocation, after 200,001 draws with a burnin of 10,000 draws.

Table 3: Posterior percentiles for the five-sector model, United States

Variable		2.5	5	10	50	90	95	97.5	Mean
	Cyclical AR parameter ρ_1^{wy}	1.578	1.601	1.627	1.711	1.787	1.807	1.825	1.709
	Cyclical AR parameter ρ_2^{wy}	-0.870	-0.852	-0.832	-0.755	-0.671	-0.644	-0.621	-0.753
	Sum of AR parameters ρ_p^{wy}	0.925	0.930	0.936	0.956	0.975	0.980	0.984	0.956
Sum of cyc. loadings α	Unemployment	-0.670	-0.644	-0.617	-0.539	-0.470	-0.453	-0.438	-0.542
	Mining/Manufact.	1.501	1.565	1.638	1.910	2.228	2.333	2.430	1.924
	Construction	1.680	1.763	1.856	2.226	2.631	2.768	2.894	2.239
	Trade/Leisure/Transp.	0.551	0.586	0.626	0.771	0.932	0.981	1.023	0.776
	Fin. and Bus. Svcs.	0.560	0.598	0.644	0.809	0.996	1.052	1.100	0.816
	Pub. and Private Svcs.	-0.010	0.021	0.056	0.180	0.308	0.346	0.380	0.181
	$\delta_{u,n}$	-1.580	-1.489	-1.385	-1.024	-0.664	-0.560	-0.471	-1.025
	$\delta_{zy,wy}$	-0.499	-0.383	-0.260	0.107	0.387	0.469	0.547	0.083
	$\delta_{S,zu}$	-0.0008	-0.0007	-0.0005	0.0000	0.0005	0.0006	0.0008	0.0000
	Variance contrib. of S to z^u	0.0000	0.0002	0.0007	0.0195	0.1096	0.1514	0.1929	0.0418
	$\delta_{S,zy}$	-0.0031	-0.0024	-0.0015	0.0012	0.0034	0.0040	0.0046	0.0010
	Variance contrib. of S to z^y	0.0002	0.0010	0.0041	0.1028	0.4075	0.5005	0.5722	0.1662
	$\delta_{S,wy}$	-0.0052	-0.0045	-0.0039	-0.0018	0.0001	0.0008	0.0015	-0.0019
	$\delta_{S,wy} + \delta_{S,zy}\delta_{zy,wy}$	-0.0046	-0.0041	-0.0035	-0.0017	0.0000	0.0006	0.0011	-0.0017
	Variance contrib. of S to w^y	0.0005	0.0020	0.0076	0.1320	0.3941	0.4716	0.5384	0.1828
	Std. of log reallocation S	0.5354	0.5697	0.6152	0.8123	1.0649	1.1484	1.2277	0.8493
Intercept μ of n trends z^n, z^u	Mining/Manufact.	-0.0067	-0.0062	-0.0058	-0.0044	-0.0029	-0.0024	-0.0018	-0.0043
	Construction	-0.0040	-0.0032	-0.0023	0.0001	0.0025	0.0033	0.0040	0.0001
	Trade/Leisure/Transp.	0.0005	0.0007	0.0009	0.0015	0.0022	0.0024	0.0025	0.0015
	Fin. and Bus. Svcs.	0.0013	0.0016	0.0019	0.0030	0.0040	0.0043	0.0046	0.0029
	Pub. and Private Svcs.	0.0014	0.0018	0.0021	0.0030	0.0039	0.0042	0.0045	0.0030
Persistence ρ of n trends z^n	Mining/Manufact.	0.7536	0.7793	0.8058	0.8784	0.9298	0.9420	0.9518	0.8718
	Construction	0.7422	0.7626	0.7849	0.8508	0.9035	0.9169	0.9281	0.8468
	Trade/Leisure/Transp.	0.6015	0.6420	0.6833	0.7919	0.8680	0.8858	0.9004	0.7814
	Fin. and Bus. Svcs.	0.7202	0.7438	0.7686	0.8413	0.8979	0.9120	0.9236	0.8363
	Pub. and Private Svcs.	0.6859	0.7212	0.7571	0.8541	0.9219	0.9378	0.9506	0.8448
Std. of shock to n trends x^n, z^n	Common trend	0.0018	0.0018	0.0019	0.0022	0.0025	0.0026	0.0027	0.0022
	Mining/Manufact.	0.0010	0.0011	0.0012	0.0016	0.0021	0.0022	0.0024	0.0016
	Construction	0.0024	0.0025	0.0027	0.0033	0.0040	0.0043	0.0045	0.0034
	Trade/Leisure/Transp.	0.0008	0.0008	0.0009	0.0012	0.0016	0.0018	0.0019	0.0013
	Fin. and Bus. Svcs.	0.0010	0.0011	0.0012	0.0015	0.0019	0.0020	0.0021	0.0015
	Pub. and Private Svcs.	0.0008	0.0008	0.0009	0.0011	0.0015	0.0017	0.0018	0.0012
Std. of shock to n levels w^n	Mining/Manufact.	0.0073	0.0074	0.0075	0.0079	0.0083	0.0084	0.0085	0.0079
	Construction	0.0077	0.0078	0.0079	0.0083	0.0087	0.0089	0.0090	0.0083
	Trade/Leisure/Transp.	0.0071	0.0071	0.0072	0.0076	0.0079	0.0080	0.0081	0.0076
	Fin. and Bus. Svcs.	0.0071	0.0072	0.0073	0.0076	0.0080	0.0081	0.0082	0.0076
	Pub. and Private Svcs.	0.0071	0.0072	0.0073	0.0076	0.0080	0.0081	0.0082	0.0076
	Std. of shocks to u trend z^u	0.0014	0.0014	0.0015	0.0016	0.0018	0.0019	0.0019	0.0017
	Std. of shocks to u cycle w^u	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015	0.0015	0.0013
	Std. of shocks to Y trend z^y	0.0028	0.0030	0.0032	0.0039	0.0045	0.0047	0.0049	0.0039
	Std. of shocks to Y cycle w^y	0.0025	0.0027	0.0028	0.0035	0.0043	0.0046	0.0048	0.0036
	Std. of shocks to Y level c	0.0022	0.0023	0.0024	0.0028	0.0033	0.0034	0.0036	0.0029

Statistics in Table 3 are posterior percentiles and means for the parameters for the state space model, after 200,001 draws with a burnin of 10,000 draws. Posterior means for standard deviations are calculated as the square root of the posterior variance.

Table 4: Posterior correlation matrix for z^n shocks based on Σ_{zn}, 5-sector model, United States

Sector	(1)	(2)	(3)	(4)	(5)
(1)	1.00	-0.53	0.09	0.10	0.21
(2)	-0.53	1.00	0.35	0.33	-0.08
(3)	0.09	0.35	1.00	0.49	0.22
(4)	0.10	0.33	0.49	1.00	0.02
(5)	0.21	-0.08	0.22	0.02	1.00

This table shows the posterior correlations of the five long run sectoral shocks. The sectors are numbered as follows: (1) Mining and Manufacturing (Production), (2) Construction, (3) Trade, Leisure, and Transportation, (4) Financial and Business Services, (5) Public and Private Services.

Table 5: Posterior percentiles for the five-sector model, Western Germany

	Variable	2.5	5	10	50	90	95	97.5	Mean
	Cyclical AR parameter ρ_1^{wy}	1.489	1.529	1.572	1.700	1.805	1.832	1.853	1.693
	Cyclical AR parameter ρ_2^{wy}	-0.885	-0.864	-0.838	-0.736	-0.610	-0.568	-0.528	-0.729
	Sum of AR parameters ρ_p^{wy}	0.931	0.938	0.944	0.965	0.983	0.987	0.991	0.964
Sum of cyc. loadings α	Unemployment	-0.760	-0.716	-0.675	-0.553	-0.456	-0.435	-0.417	-0.561
	Mining/Manufact.	1.205	1.274	1.359	1.654	2.021	2.146	2.260	1.676
	Construction	0.875	0.957	1.051	1.399	1.846	2.002	2.148	1.428
	Trade/Leisure/Transp.	0.495	0.545	0.601	0.799	1.014	1.083	1.144	0.804
	Fin. and Bus. Svcs.	0.477	0.530	0.589	0.816	1.080	1.163	1.240	0.827
	Pub. and Private Svcs.	-0.243	-0.194	-0.141	0.027	0.193	0.242	0.285	0.026
	$\delta_{u,n}$	-1.066	-0.989	-0.898	-0.591	-0.271	-0.177	-0.092	-0.588
	$\delta_{zy,wy}$	-0.145	-0.072	0.002	0.181	0.342	0.399	0.455	0.175
	$\delta_{S,zu}$	-0.0013	-0.0011	-0.0009	-0.0002	0.0005	0.0007	0.0009	-0.0002
	Variance contrib. of S to z^u	0.0001	0.0002	0.0009	0.0246	0.1369	0.1887	0.2389	0.0516
	$\delta_{S,zy}$	-0.0080	-0.0071	-0.0062	-0.0030	0.0010	0.0024	0.0036	-0.0028
	Variance contrib. of S to z^y	0.0007	0.0028	0.0111	0.2034	0.5758	0.6614	0.7281	0.2605
	$\delta_{S,wy}$	-0.0033	-0.0027	-0.0021	-0.0003	0.0012	0.0018	0.0023	-0.0004
	$\delta_{S,wy} + \delta_{S,zy}\delta_{zy,wy}$	-0.0032	-0.0027	-0.0022	-0.0008	0.0005	0.0009	0.0013	-0.0009
	Variance contrib. of S to w^y	0.0001	0.0006	0.0024	0.0620	0.2643	0.3372	0.4029	0.1056
	Std. of log reallocation S	0.5243	0.5631	0.6097	0.8069	1.0698	1.1569	1.2385	0.8470
Intercept μ of n trends z^n, z^u	Mining/Manufact.	-0.0046	-0.0043	-0.0040	-0.0031	-0.0021	-0.0017	-0.0013	-0.0031
	Construction	-0.0077	-0.0066	-0.0057	-0.0032	-0.0008	0.0001	0.0010	-0.0032
	Trade/Leisure/Transp.	0.0012	0.0014	0.0015	0.0020	0.0025	0.0026	0.0028	0.0020
	Fin. and Bus. Svcs.	0.0054	0.0057	0.0061	0.0073	0.0084	0.0088	0.0092	0.0073
	Pub. and Private Svcs.	0.0012	0.0018	0.0023	0.0035	0.0046	0.0049	0.0053	0.0034
Persistence ρ of n trends z^n	Mining/Manufact.	0.3973	0.4889	0.5724	0.7678	0.8810	0.9055	0.9239	0.7404
	Construction	0.7287	0.7541	0.7810	0.8617	0.9252	0.9409	0.9539	0.8564
	Trade/Leisure/Transp.	-0.4131	-0.2525	-0.0616	0.4660	0.7490	0.7981	0.8331	0.3965
	Fin. and Bus. Svcs.	0.6385	0.6708	0.7054	0.8047	0.8808	0.8997	0.9151	0.7974
	Pub. and Private Svcs.	0.6854	0.7258	0.7666	0.8725	0.9394	0.9537	0.9649	0.8604
Std. of shock to n trends x^n, z^n	Common trend	0.0020	0.0020	0.0021	0.0025	0.0029	0.0030	0.0031	0.0025
	Mining/Manufact.	0.0010	0.0011	0.0012	0.0016	0.0024	0.0026	0.0029	0.0018
	Construction	0.0019	0.0020	0.0021	0.0027	0.0034	0.0036	0.0038	0.0028
	Trade/Leisure/Transp.	0.0009	0.0010	0.0011	0.0016	0.0023	0.0025	0.0028	0.0017
	Fin. and Bus. Svcs.	0.0012	0.0013	0.0014	0.0018	0.0024	0.0026	0.0027	0.0019
	Pub. and Private Svcs.	0.0007	0.0007	0.0008	0.0011	0.0015	0.0017	0.0018	0.0012
Std. of shock to n levels w^n	Mining/Manufact.	0.0074	0.0075	0.0076	0.0080	0.0085	0.0086	0.0087	0.0080
	Construction	0.0075	0.0076	0.0077	0.0081	0.0086	0.0087	0.0088	0.0081
	Trade/Leisure/Transp.	0.0072	0.0072	0.0074	0.0077	0.0082	0.0083	0.0084	0.0078
	Fin. and Bus. Svcs.	0.0071	0.0072	0.0073	0.0077	0.0081	0.0083	0.0084	0.0077
	Pub. and Private Svcs.	0.0071	0.0072	0.0073	0.0076	0.0081	0.0082	0.0083	0.0077
	Std. of shocks to u trend z^u	0.0017	0.0018	0.0018	0.0021	0.0023	0.0024	0.0025	0.0021
	Std. of shocks to u cycle w^u	0.0013	0.0013	0.0013	0.0015	0.0017	0.0017	0.0018	0.0015
	Std. of shocks to Y trend z^y	0.0033	0.0036	0.0039	0.0051	0.0062	0.0065	0.0067	0.0051
	Std. of shocks to Y cycle w^y	0.0021	0.0022	0.0023	0.0029	0.0036	0.0039	0.0042	0.0030
	Std. of shocks to Y level c	0.0029	0.0030	0.0032	0.0039	0.0047	0.0049	0.0051	0.0040

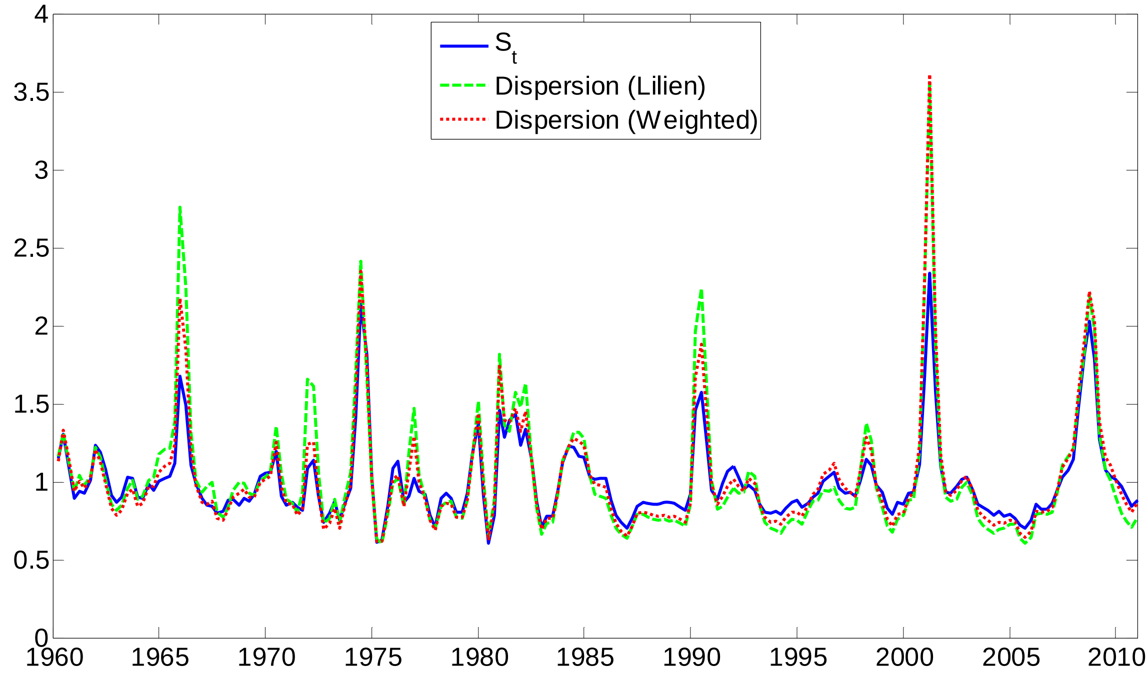
Sources and notes: See table 3.

Table 6: Posterior correlation matrix for z^n shocks based on Σ_{zn}, 5-sector model, Western Germany

Sector	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
(1)	1.00	-0.20	-0.41	-0.40	-0.24
(2)	-0.20	1.00	0.31	-0.08	0.06
(3)	-0.41	0.31	1.00	0.23	0.21
(4)	-0.40	-0.08	0.23	1.00	0.02
(5)	-0.24	0.06	0.21	0.02	1.00

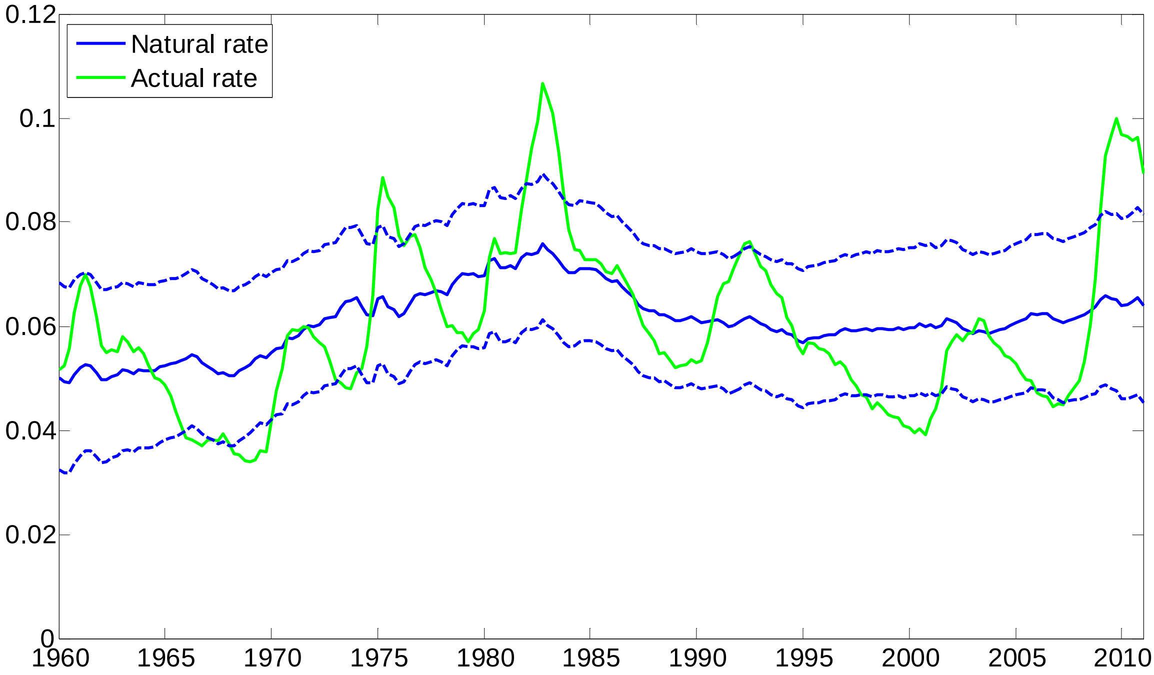
This table shows the posterior correlations of the five long run sectoral shocks. The sectors are numbered as follows: (1) Mining and Manufacturing (Production), (2) Construction, (3) Trade, Leisure, and Transportation, (4) Financial and Business Services, (5) Public and Private Services.

Figure 1: Posterior long run dispersion measures (United States, 5 sectors)



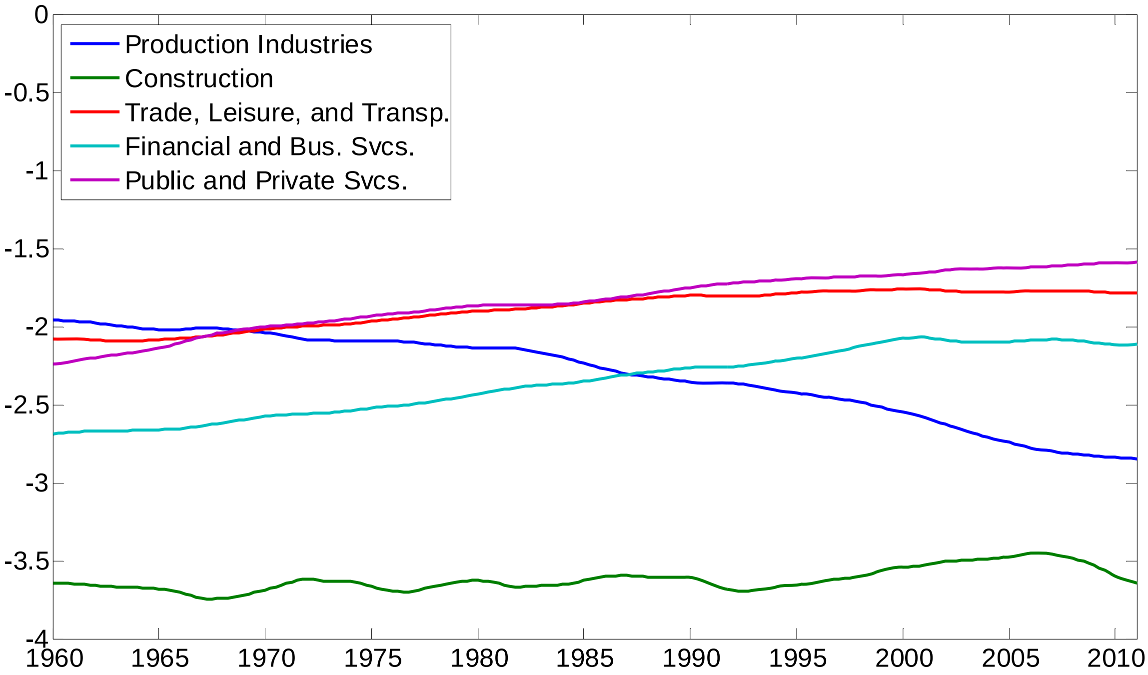
Numbers are scaled geometric means from the state space model.

Figure 2: Posterior mean natural rate of unemployment (United States, 5 sectors)



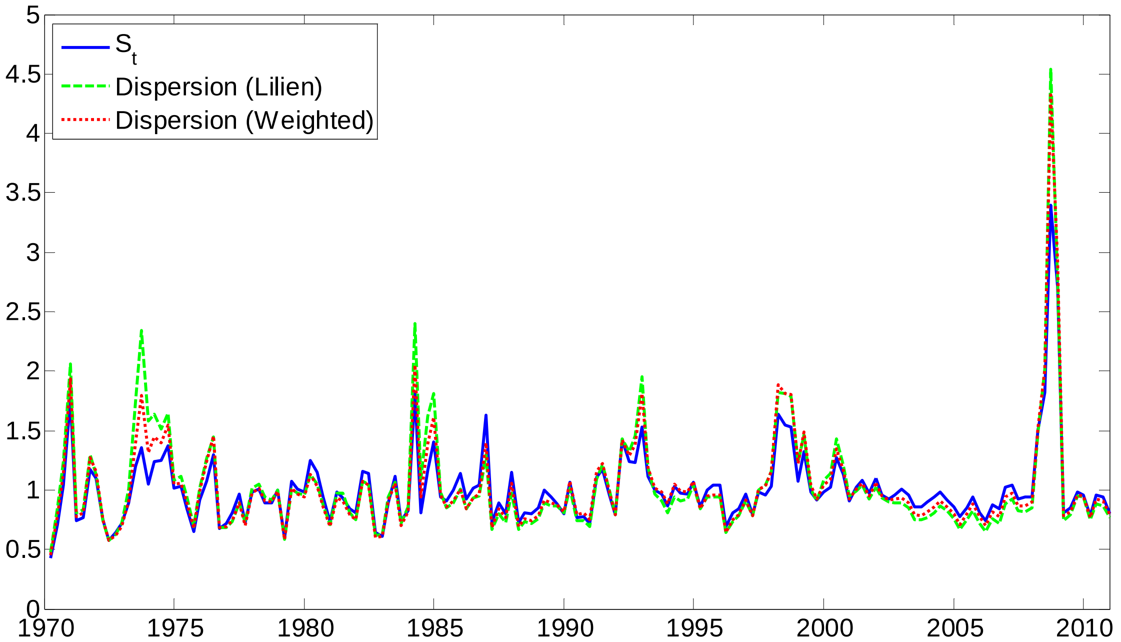
Error bands mark off the 2.5th percentile and the 97.5th percentile of the posterior distribution.

Figure 3: Posterior mean employment trends (United States, 5 sectors)



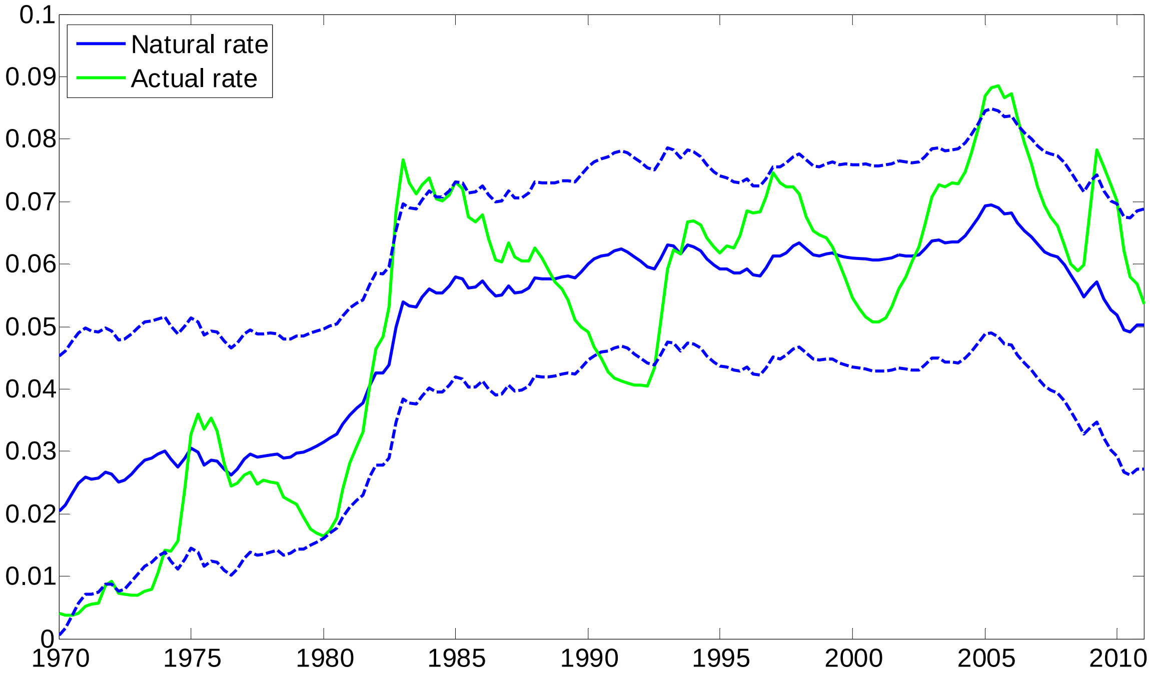
Numbers are posterior means from the state space model.

Figure 4: Posterior long run dispersion measures (Western Germany, 5 sectors)



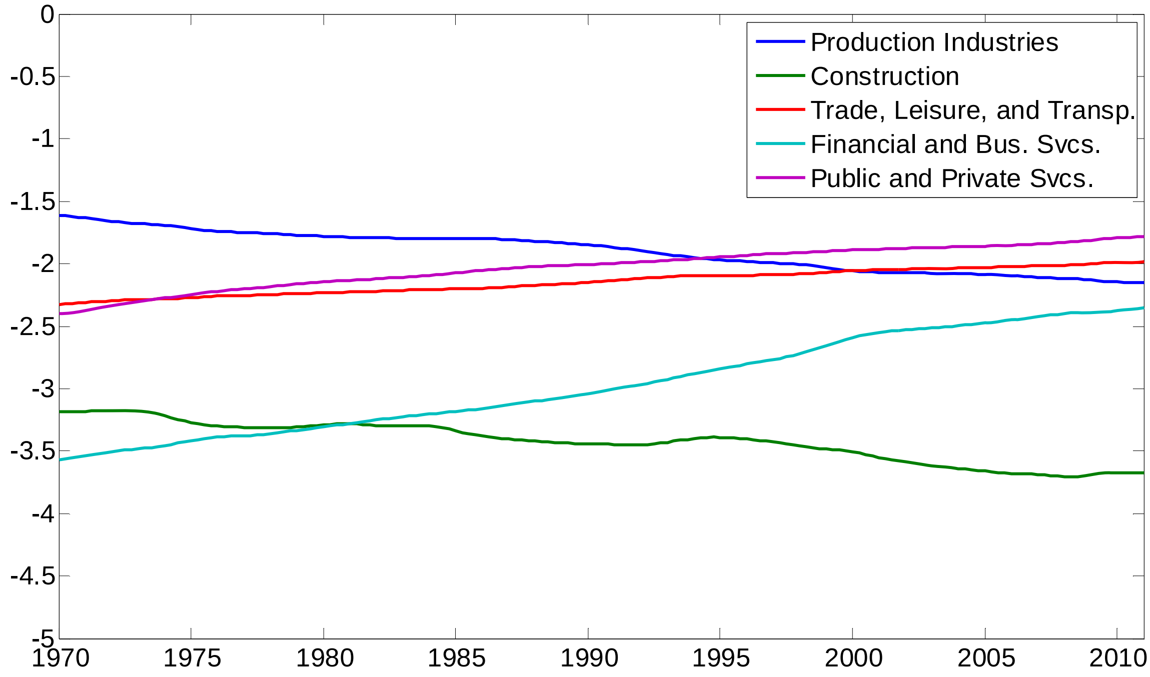
Numbers are scaled geometric means from the state space model.

Figure 5: Posterior mean natural rate of unemployment (Western Germany, 5 sectors)



Error bands mark off the 2.5th percentile and the 97.5th percentile of the posterior distribution.

Figure 6: Posterior mean employment trends (Western Germany, 5 sectors)



Numbers are posterior means from the state space model.