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GDP-Employment Decoupling and the Slow-down of Productivity Growth in Germany

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Content

List of graphics

List of tables

Abstract

This paper investigates the time-varying relationship between German output and employment growth, in particular their decoupling in recent years. We estimate a correlated unobserved components model that allows for persistent and cyclical time variation in the employment-GDP linkage as well as an additional employment component beyond the one linked to GDP. Controlling for the latter yields a more precise classification of what is a jobless recovery or a labour hoarding recession. We find that productivity growth has slowed down since the Great Recession because the co-movement of employment and GDP has loosened while the co-movement with other variables than GDP has become tighter. The decoupling is of permanent nature. The development of the time-varying parameter goes hand in hand with the change of the sectoral composition of the economy, especially with the rise of the service sector. Beyond that, recent employment growth would not have been that strong if labour market tightness had not been that high and – to some minor extent – if immigration, wage moderation and working time reductions had not taken place.

Zusammenfassung

Dieses Papier untersucht die zeitvariable Beziehung zwischen dem Wachstum des Bruttoinlandsprodukts (BIP) und dem Wachstum der Beschäftigung in Deutschland, insbesondere deren Entkopplung über die zurückliegenden Jahre. Wir schätzen ein korreliertes Unobserved-Components-Modell, das sowohl persistente als auch transitorische Zeitvariation der Beziehung zwischen BIP- und Beschäftigungswachstum erlaubt sowie eine über den BIP-Einfluss hinausreichende autonome Beschäftigungskomponente enthält. Letzteres erlaubt eine präzisere Klassifikation von Konjunkturphasen für den Arbeitsmarkt, etwa ob es sich um eine beschäftigungsarme Erholung handelt. Als Ergebnis finden wir, dass sich das Produktivitätswachstum seit der Großen Rezession abgeschwächt hat, weil die Beziehung zwischen Beschäftigung und BIP schwächer, die Beziehung mit anderen Variablen als dem BIP aber enger geworden ist. Diese partielle Entkopplung ist permanent. Die Entwicklung des zeitvariablen Parameters geht Hand in Hand mit dem sektoralen Wandel hin zum – relativ konjunkturunabhängigen – Dienstleistungsbereich. Zudem wäre das Beschäftigungswachstum nicht so kräftig gewesen, wenn der Arbeitsmarkt weniger angespannt gewesen wäre und wenn die hohe Einwanderung, Lohnmoderation und Verkürzungen der Arbeitszeit nicht gewesen wären.

JEL-Classification

E24, E32, J23, J24, C32

Keywords

Decoupling, Productivity Growth, Unobserved Components, Time-Varying Coefficient

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1 Introduction

A decade after the acute phase, the Great Recession is still being analysed regarding the driving mechanisms and spreading (e.g. Christiano et al. 2014) as well as its consequences: Some of the effects turned out to be sustainable and revitalize the awareness of parameter instability (Ng/Wright 2013). Such permanent effects of the crisis are discussed in two main directions, (un)employment hysteresis or Okun´s law (Yagan 2019, Canarella et al. 2017, Daly/Marks 2014, Pissarides 2013, Owyang/Sekhposyan 2012) and a general slow-down in productivity growth (Blundell et al. 2014, Barnett et al. 2014, Ball 2014). Our paper contributes to both and brings together the two strands.

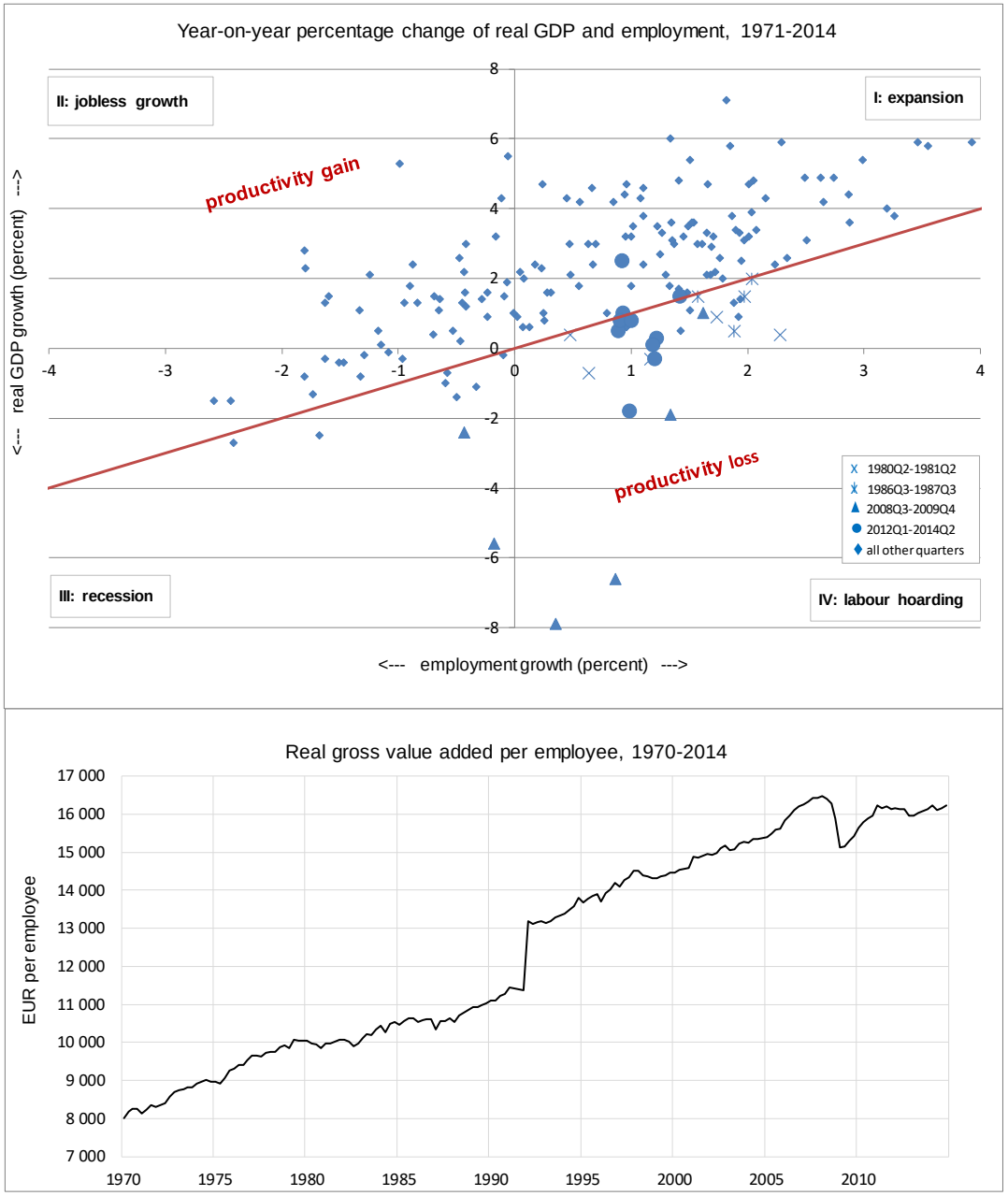
Output per worker unexpectedly rose during the Great Recession in the U.S. (Lucchetta/Paradiso 2014), whereas it fell and hardly recovered in Europe, e.g. in Great Britain or Germany. The data do not fit the idea of a clear positive correlation between the growth rates of real output and productivity per employee (Verdoorn 1949). Some analyses of this phenomenon focus on the production function and shocks to total factor productivity, capital intensity, and input utilization (Barnett et al. 2014, Pessoa/van Reenen 2013). We put it directly to analysing whether and why the link between GDP growth and employment growth has changed. We seek to answer two questions: 1) Did the Great Recession introduce a persistent or temporary decoupling of the labour market from GDP growth? 2) Which indicators go together with the time-variation in the GDP-employment relation – i.e., why did firms hoard labour or even increased their staff despite poor economic performance?

We focus on Germany as a useful subject to study the productivity slow-down. Germany is the largest European economy with the reputation of being a highly productive location due to a relatively large and high quality industrial sector. Moreover, after decades of sclerosis, its labour market is on an internationally recognized upswing and performed outstandingly well in the Great Recession.

Expanding labour productivity (GDP per employee) used to be the typical pattern in Germany; GDP used to grow more strongly than employment (Figure 1). Productivity loss helped to absorb economic slumps as in 1980/81 and 1986/87, but such phases were exceptions – until the Great Recession. The sharpest drop in GDP for decades caused hardly any reaction in employment but a sharp drop in productivity. Moreover, it marks the beginning of a general slow-down in productivity growth, aside from the V-shape recovery. Further on, the Euro zone recession 2011-2013 forced the German economy on fragile growth with utterly weak investment. Nevertheless, employers continued to hire on balance. This behaviour was especially pronounced in the industrial sector.

Productivity slows down if employment growth is unusually high at given GDP growth. We distinguish between two potential reasons for such a development: One hypothesis would be that the correlation between GDP growth and employment growth has become tighter. Then, given GDP growth corresponds to higher employment growth. The alternative hypothesis states that the correlation between the two has stayed the same or even loosened. Then, the rise or fall in other variables that employment correlates with overlaid the original GDP-employment relation.

Figure 1: The development of GDP, employment, and labour productivity in Germany



Source: Destatis, own computations. The self-employed are not included. Structural break due to German reunification.

In order to confirm either of the hypotheses, we conduct a regression analysis of employment on GDP growth with two specialties: First, we control for the fact that employment may develop above and beyond the direct correlation with GDP, partially autonomously. We call this part `autonomous´ employment growth and the factors corresponding with it `autonomous´ factors. Second, we estimate the coefficient that links employment growth to GDP growth as time-varying parameter (TVP). An increase of that linkage coefficient would confirm the hypothesis. A fall would confirm the alternative.

The time-varying linkage coefficient is exposed to both permanent and transitory influences. Permanent effects are produced by trend shocks. They refer to an underlying structure or long-run development. Examples are the change in the sectoral composition of the economy or institutional reforms. Inasmuch as the Great Recession involved permanent effects, it is a trend shock. By contrast, cycle shocks change the link between GDP and employment growth only temporarily. This

variation arises from the regular asymmetry of the business cycle (e. g. Friedman 1993, Kim/Nelson 1999a; Sinclair 2010) and from asymmetric movements of the labour market with the cycle. Such asymmetry is found in Okun´s law, as unemployment reacts more strongly to recessions than to expansions (e. g. Cevik et al. 2013, Holmes/Silverstone 2006, Silvapulle et al. 2004, Harris/Silverstone 2001). The studies differentiate regimes for Okun´s coefficient but do not distinguish between cyclical and long-run forces. Pereira (2013), Sinclair (2009), and Weber (1995) consider trend and cycle in the series of unemployment and GDP but do not consider asymmetric responses by the coefficient. Our paper bridges the gap: Applying an unobserved components approach (e.g., Morley et al. 2003, Sinclair 2009) to a TVP estimation, we analyse parameter instability with respect to its permanent or transitory causes and explicitly allow for further co-movements of employment growth beyond the one with GDP. This approach augments the traditional TVP specification as random walk (Kim/Nelson 1999b, Tucci 1995) and goes well beyond rolling window regressions (Owyang/Sekhposyan 2012).

In a second step, we conduct OLS regressions of the parameter´s trend and cycle as well as autonomous employment growth to uncover potential determinants of time-variation. Variable selection is based on search & matching theory. This approach seems to be promising as the German labour market has experienced an outstanding sustained upswing with labour market tightness, employment and labour force reaching the highest levels in decades. We thus check econometrically, inasmuch labour supply (high immigration and participation), tightness (long vacancy duration, low unemployment), and business expectations (incentives for labour hoarding) correspond to changes in the relation between employment and GDP growth. Beyond the explanatory power of GDP, autonomous employment growth could correspond with further variables like wages (wage moderation), working time (part-time, flexibility), and matching efficiency. Most of these variables were influenced by severe labour market reforms that had come into force in 2003-2005.[1] Last but not least, we consider changes in the industrial composition (connected to changes in skill type and intensity).

These are the main results: Since the Great Recession, employment has grown more strongly than GDP because the co-movement between the two has loosened while the co-movement with other variables than GDP has become tighter. Thereby, the linkage coefficient between GDP and employment growth has shrunk permanently, it still is only half of the long-run average (which we estimate at 0.4, somewhat smaller than previously Leon-Ledesma 2000, Oelgemöller 2013). We find strong cyclical effects in the time-variation of that coefficient, too, but their pattern has not changed substantially.

The decrease in the trend component of the linkage coefficient is closely tied to the rise of service sectors. Employment in services is less volatile over the business cycle than in industrial sectors. Since the Great Recession, this effect has been further strengthened by a sustained drop in the relevance of the sector trade/gastronomy/logistics. As expected, the change in the industry mix is of minor importance for the cyclical component of the employment-GDP linkage. The most important factor here is labour supply – firms are more willing to hire in expansions and fire in recessions if they can choose from a wide labour supply.

[1] The so called Hartz reforms reduced search frictions, lowered outside options, deregulated temporary agency work and marginal employment, eased employment protection. For an overview see Klinger/Rothe 2012.

Employment growth unrelated to GDP has gained substantial importance. A tight labour market where workers are hard to find prompts companies to increase hiring and restrain from separations; it is the most influential regressor variable for that autonomous component. Then, wages, working time and changes in the labour force are of similar importance, while the change in the sectoral composition of the economy only ranks third.

The details of our research are organized as follows: Section 2 describes the unobserved components model for the GDP-employment relation and treats identification and estimation. Section 3 presents the results. Section 4 explains factors to rationalize time-variation and tests their relevance econometrically. Section 5 provides robustness checks. Finally, we summarize and conclude.

2 Time-variation in the GDP-employment relation: a correlated unobserved components model

The statistical linkage between GDP and the labour market is frequently described as Okun´s law, the reverse short-run relation between unemployment and GDP. As we target on productivity in this study, we focus on a similar short-run relation – the one between employment and GDP growth[2], specifically, on its change over time.

Such a change over time may imply a change in the linkage coefficient of an employment-GDP regression (the pendant to Okun´s coefficient). However, this nearby implication is not mandatory: The labour market is subject to a multitude of shocks that affect employment apart from current GDP fluctuations. These shocks have to be controlled for because they may overlay and mask the real and potentially unchanged GDP-employment relation. For instance, improvements of labour market institutions in Germany led to faster transitions of unemployed workers into employment while the usual business cycle effect on these transitions had remained unchanged (Klinger/Rothe 2012). We therefore seek to disentangle the direct employment-GDP linkage from an autonomous employment component that accidentally affects the empirical employment-output-correlation.

This differentiation is essential to draw appropriate conclusions: A high linkage coefficient is beneficial during expansions but bears employment risks if the economy enters a recession. In contrast, autonomous labour market influences do not change their character over the business cycle.[3] Moreover, it is interesting for its own right in how far labour markets are GDP-related or swayed by other factors and whether the importance of these two categories changes over time.

[2] A linear long-run relation between employment and GDP growth was proposed by Kaldor (1966) as a re-interpretation of Verdoorn`s law on productivity and output growth.

[3] Still, the autonomous labour market influences themselves may vary over the business cycle. In the flexible unobserved components model, GDP-related and autonomous employment growth are not restricted to be independent. The empirical correlation of the autonomous component and GDP growth is negligible, though (-0.09). In the second stage regression of autonomous employment growth, the regressor variables themselves may also vary with the business cycle, but this would not be the source of their explanatory power.

We will better under-stand the reasons and implications of the observations in the GDP–employment scatter (Figure 1).

To meet the requirements of that purpose, we employ a two-fold strategy: On the one hand, we add a simultaneous autonomous component to a standard regression of employment on GDP. We let the data speak on the persistence of that component. On the other hand, in the same regression, we treat the linkage coefficient between employment and GDP as time-varying. Traditionally, a time-varying parameter (TVP) approach would model the linkage coefficient as random walk (Kim/Nelson 1999b, Tucci 1995). We introduce more flexible time variation: the linkage coefficient includes not only a random walk but a random walk (trend) plus a stationary autoregression (cycle). This layout is typical of standard unobserved components (UC) models (e.g., Morley et al. 2003, Sinclair 2009) that decompose observed time series like GDP into its unobserved trend and cyclical components. In fact, our model is an application of the standard UC decomposition to an (unobserved!) TVP estimation. With a persistent trend and a stationary cycle in the time-varying parameters, the link between GDP growth and employment growth may vary for permanent as well as transitory reasons. This is a crucial feature since time variation can be governed by various factors such as changes in the industry mix or labour market institutions on the one hand and regular asymmetry on the other.

2.1 Model set-up and identification

2.1.1 GDP-related and autonomous employment growth

Empirical macro models, specifying labour demand functions, regularly find the labour market lagging behind the development of GDP. Therefore, we specify a linear distributed lag model for employment growth e_t and GDP growth y_{t-i} ($t=1…T$; $i=0…q$; see equation 1). The number of GDP lags q is determined empirically. It involves $q+1$ linkage coefficients β_{it} for the different lags. Moreover, we include the autonomous component c_t^a to capture the time series dynamics of employment growth beyond GDP-dependent components in a very general way. *d92q1* represents a dummy variable for the German reunification. u_t is a white noise error term that avoids unsystematic effects being captured by the UCs.

Equation 1:

$$e_t = \sum_{i=0}^{q} \beta_{it} y_{t-i} + c_t^a + \delta_1 + \delta_2 d92q1 + u_t$$

Each of the $q+1$ linkage coefficients is allowed to be time-varying.

2.1.2 Time-varying linkage parameters

In order to explain how we specify time variation, we shortly present how our UC-TVP model builds up from its two ingredients: The traditional TVP approach is to specify a state-space model with the following observation and transition equations (see Kim/Nelson 1999b. For this brief demonstration: h_t is observed endogenous, g_t is observed exogenous, β_t is the linkage coefficient, u_{it} are white noise error terms):

$$h_t = g_t\beta_t + u_{1t}$$

$$\beta_t = \varrho\beta_{t-1} + \mu + u_{2t}$$

If $\varrho = 1$, the regression coefficient β_t follows a random walk. We will stick to this simple model in the robustness section. However, the restrictive specification does not allow for simultaneous occurrence and interaction of permanent and transitory impact on the coefficient.

The decomposition of observed series into a stochastic trend τ_t and a stationary cycle c_t is the purpose of unobserved components (UC) models. Their state space representation reads as (see Morley et al. 2003):

$$h_t = \tau_t + c_t$$

$$\tau_t = \tau_{t-1} + \mu + \eta_t$$

c_t is stationary and ergodic, usually described as autoregression $\Phi_p(L)c_t = \varepsilon_t$.

Our model is a UC application to a TVP problem. In a general representation, we would write

$$h_t = g_t\beta_t + u_t$$

$$\beta_t = \tau_t + c_t$$

$$\tau_t = \tau_{t-1} + \mu + \eta_t$$

$$\Phi_p(L)c_t = \varepsilon_t$$

This composite model does not come up with additional problems. As regards identification and estimation, we elaborate on them later with respect to the exact model we use.

After this demonstration, we come back to our specific application, see Equation 1. We disentangle each of the *q+1* linkage coefficients into a stochastic trend τ_{it} and a cyclical component c_{it}.

Equation 2:

$$\beta_{it} = \tau_{it} + c_{it}$$

The trends are modelled as random walks with drift μ_i and shocks η_{it} (Equation 3). This allows for persistent stochastic change in the linkage coefficients. The transitory components are specified as stationary autoregressions (Equation 4), which can capture various dynamic patterns. All roots of the lag polynomials in modulus lie outside the unit circle. We follow the standard UC approach (e.g. Morley et al. 2003) and specify an AR(2), which is sufficient to enable cyclical fluctuations. Therein, ϕ_{ij} (j=1, 2) are the autoregressive coefficients and ε_{it} are the cycle shocks.

Equation 3:

$$\tau_{it} = \mu_i + \tau_{i,t-1} + \eta_{it}$$

Equation 4:

$$c_{it} = \phi_{i1}c_{i,t-1} + \phi_{i2}c_{i,t-2} + \varepsilon_{it}$$

2.1.3 Autonomous cycle

A similar specification is used for the autonomous component (Equation 5). While its persistence is not restricted a priori, this component empirically turns out to be stationary and is thus referred to as a cycle.

Equation 5:

$$c_t^a = \sum_{k=1}^{p} \phi_k^a c_{t-k}^a + \varepsilon_t^a$$

2.1.4 Shock correlation

In general, there is no reason to assume that the different unobserved states are independent of each other. Therefore, all trend shocks and all cycle shocks – including that of the autonomous cycle – are allowed to correlate. Such a correlated UC model provides a flexible framework avoiding assumptions not appropriate for the data at hand.[4] Equation 6 gives the covariance matrix for the residual vector $\bar{u}_t = \left(\eta_{0t} \dots \eta_{qt} \;\; \varepsilon_{0t} \dots \varepsilon_{qt} \;\; \varepsilon_t^a \;\; u_t\right)'$.

Equation 6:

$$E(\bar{u}_t \bar{u}_t') = \begin{pmatrix} \sigma_{\eta_0}^2 & \sigma_{\eta_0\eta_1} & \cdots & \sigma_{\eta_0\varepsilon^a} & 0 \\ \sigma_{\eta_0\eta_1} & \sigma_{\eta_1}^2 & & \vdots & \vdots \\ \vdots & & \ddots & \sigma_{\varepsilon_q\varepsilon^a} & 0 \\ \sigma_{\eta_0\varepsilon^a} & \cdots & \sigma_{\varepsilon_q\varepsilon^a} & \sigma_{\varepsilon^a}^2 & 0 \\ 0 & \cdots & 0 & 0 & \sigma_u^2 \end{pmatrix}$$

Our model provides a highly flexible specification of the output-employment linkage. Furthermore, we allow not only the coefficient but the shocks themselves to be of different size during recessions than during expansions (breaks in $\sigma_{\eta_i}^2$, $\sigma_{\varepsilon_i}^2$). Particularly, this enables changes in the components of a size that is preferred by the data. We apply a deterministic regime split following Schirwitz (2009). In the absence of an official business cycle dating in Germany, Schirwitz (2009) provides a comprehensive business cycle chronology based on several methods. As a robustness check, we will limit ourselves to just one variance break during the Great Recession, i.e. in the four quarters of negative GDP growth from 2008Q2 until 2009Q1. In other words, we allow the Great Recession to be a unique shock.

2.1.5 Summary into one linkage coefficient

Although we estimate parameter trends and cycles for each GDP lag *i=0…q* to capture time series dynamics appropriately, we suggest a summary for interpretation to get an idea of the comprehensive relation. Concretely, we summarize all trends into one by $\tau_t = \sum_{i=0}^{q} \tau_{i,t+i}$, all cycles into one by $c_t = \sum_{i=0}^{q} c_{i,t+i}$ and all complete linkage coefficients into one by $\beta_t = \sum_{i=0}^{q} \beta_{i,t+i}$. Thereby,

[4] Moreover, correlation of the trend and cycle innovations reconciles the outcomes of UC and Beveridge-Nelson type decompositions (Morley et al. 2003).

the state value β at time t reflects the total multiplier of a GDP change at time t. It takes into account that the influence spreads out until $t+q$. With TVP, the total multiplier is also time-variant. The timing of the coefficient`s summarized trend and cycle is analogue. The summarized states, i.e. the total multiplier itself and its trend and cycle components, will be the endogenous variables in the second-step regressions that investigate economic explanations for the development of the linkage coefficient.

2.1.6 Identification

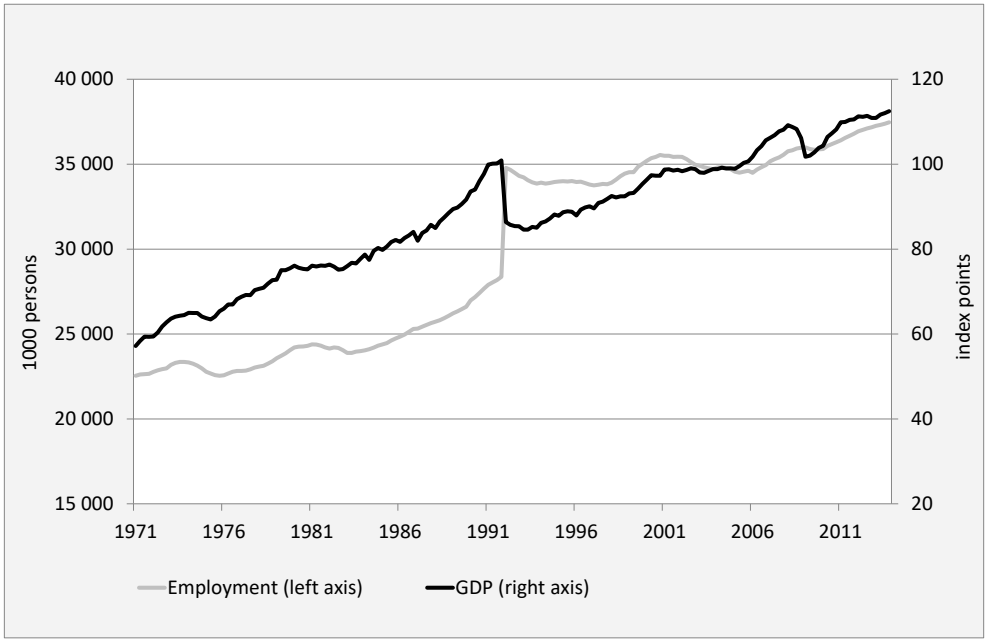
The challenge regarding identification is the need to recover multiple UCs from one model equation. As we explained above, our model results from a combination of TVP and UC approaches. In fact, identification in our case can be shown to follow from existing results for these two model classes. For that purpose, consider the different building blocks of our model (Equation 1), precisely GDP-related and autonomous employment growth. UCs appear in both terms, particularly in each of the regression coefficients (Equation 2) and directly in the level of e_t (i.e., the autonomous cycle serves as a time-varying intercept of the regression). Thus, the building blocks with the UCs are defined by applying to different regressors (the y_{t-i} or *1*, respectively). This clearly separates the building blocks. Indeed, this is exactly the same as in standard TVP models (e.g., TVP VARs), where the random walks in the coefficients are differentiated by applying to different right-hand-side variables.

That said, identifying the UCs within each of the different building blocks is crucial. In this regard, we can rely on results on identification from the UC literature; e.g., Harvey (1985), Morley et al. (2003) and Weber (2011) for correlated / simultaneous models and Trenkler/Weber (2016) for the multivariate case. It is shown that a trend (random walk) and a cycle (autoregression) component are uniquely identified from the autocovariance structure. This case applies to our regression coefficients according to equation (2). Regarding the time-varying intercept, the autonomous cycle and the white noise shock have to be differentiated. This corresponds to a standard error-in-variables UC model. I.e., identification is secured by the autoregressive structure of the cycle c_t^a in contrast to the purely unsystematic shocks u_t .

2.2 Data, model specification, and estimation

We use official seasonally adjusted quarterly growth rates of real GDP and employment delivered by the Federal Statistical Office from 1971Q1 to 2013Q4. Employment covers all persons in dependent contracts regardless of their working time and professional status. The structural break of German reunification occurs in 1992Q1 and is captured by a special impulse dummy variable. Figure 2 shows the development of GDP and employment levels, Table 1 provides descriptive statistics of the growth rates.

Figure 2: Level series of employment and GDP, 1971 to 2013



Source: Destatis. GDP is a price- and seasonally adjusted index with the base year changed at reunification (before: 1991=100, after: 2005=100).

Table 1: Descriptive statistics, 1971Q1 to 2013Q4

	employment growth	GDP growth
Mean	0.2	0.5
Median	0.2	0.5
Maximum	1.4	3.1
Minimum	-0.9	-4.1
Std. Dev.	0.4	0.9
Observations	172	172

Source: Destatis.

For the purpose of model specification, we first estimate the employment equation 1 as a constant parameter OLS regression, i. e. as a regression of employment growth on (lagged) GDP growth, own lags and deterministics. Here, lag lengths could be chosen by the criteria of autocorrelation-free residuals and parameter significance. This provides us with a lag structure of GDP (q=2) and the autonomous component (p=4, with lags 2 and 3 being insignificant and dropped from the further analysis). According to the residual diagnostics, this model specification is a reasonable choice. With p-values far above 0.05, we could neither reject the null hypothesis of no residual autocorrelation (Q-Test) nor the null hypotheses of no ARCH(1) effects (F-Test). The estimates as given in Table 2 also serve as sensible starting values for the TVP trend states and the autonomous cycle parameters, respectively. Starting values of the autoregressive coefficients in the TVP cycles as well as the trend and cycle shock variances are gained from an intensive grid search in order to avoid local maximum problems. As usual, the starting values of the covariances and cycles are set to zero.

Table 2: Constant parameter OLS regression of employment growth

explanatory variables		coefficient	p-value
constant		-0.0360	0.129
structural break dummy		-0.8358	0.000
GDP growth	contemporary	0.0940	0.000
	lag 1	0.0504	0.012
	lag 2	0.0485	0.016
AR part	lag 1	0.5301	0.000
	lag 4	0.1438	0.008
R^2		0.6400	

Source: Own estimation based on data by Federal Statistical Office.

To quantify the unobserved components, we cast the model into state space form and apply maximum likelihood via numerical optimisation to estimate the parameters. Thereby, the likelihood function is constructed using the prediction error decomposition from the Kalman filter.

3 Results: Time variation in the GDP-employment relation

3.1 Trend and cycle of the coefficient linking GDP and employment growth

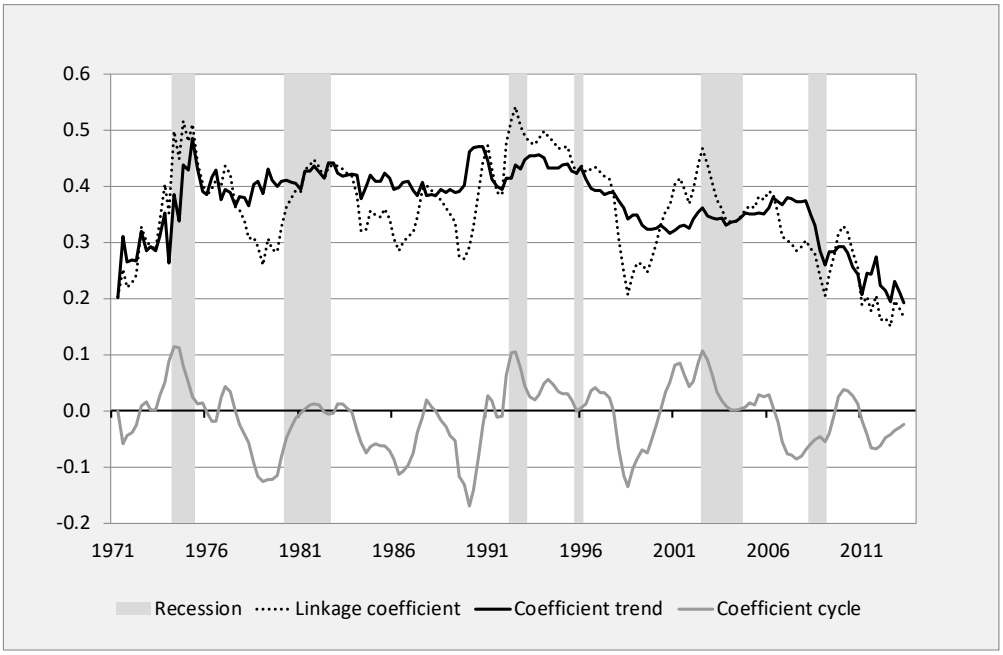
The estimated states of the TVP-UCs are given in Figure 3. The linkage coefficient is positive all over the horizon. It experiences, however, trend increases and especially decreases as well as a pronounced cycle. The recessions according to Schirwitz (2009) are given in grey shade.

After a sharp increase around the time of the oil crisis, the trend in the linkage coefficient kept a level of nearly 0.4 with slight fluctuations. The early 1990s saw a short increase[5]. Afterwards, the trend decreased slowly until millennium. With the emergence of the new economy bubble it flattened again but slightly increased in the upswing before the Great Recession. The German labour market was announced for its mild response to the Great Recession (e. g. Burda/Hunt 2011), and Figure 3 reveals one of the reasons: the coefficient´s trend dropped sharply such that employment growth did not adequately correspond when GDP plummeted. The linkage coefficient (trend + cycle) reached its first all-time low at this time. We emphasize that it is the trend that reacted to the crisis, not the cycle – even though the model would allow the latter to pick up a transitory recession effect. Nevertheless, a permanent decrease occurred, and the trend has not recovered ever

[5] This is not due to statistical effects from the German reunification – these effects occur in 1992 and are captured by a separate dummy variable in the measurement equation.

since. Consequently, the linkage coefficient has been at its lowest value for the whole period since 2011, when the Eurozone recession started to unfold.

Figure 3: The linkage coefficient and its unobserved components



Source: Own estimation based on data by Federal Statistical Office.

We conclude that the developments of GDP and employment growth decoupled to some extent. At least, the relationship is the loosest throughout the past 40 years.

Additional insight is gained from the specification of a transitory TVP component (the result from a model without cycle is shown in the robustness section): First, the model demonstrates that the data prefer a permanent decline of the linkage coefficient in 2009, indeed. Second, there is a regular pattern related to GDP recessions. Third, the cycle causes much higher variability in the connection of GDP and employment than would the trend alone. Finally, in specific phases, the cycle changes the assessment of whether a recovery is jobless or not (and similar for recessions). We shortly elaborate on these issues.

The cycle of the linkage coefficient varies between -0.17 and +0.11. It is the main source of its variation. The unconditional variance of shocks to c_t is more than twice as high as the unconditional variance of shocks to τ_t. The cycle exhibits six pronounced peaks, corresponding to an average cycle length of about seven years.[6] The cycle peaks often coincide with the beginning of a recession. In four of the six recessions, we find the cycle dropping towards zero – the relation between (negative!) GDP growth and employment growth loosens transitorily. In other words, during recessions, the linkage coefficient approaches its trend from above. This approach also appears in the beginning of the 1980s. However, as the cycle evolves from a negative value in that example, it rises during the first quarters of the recession and reaches its peak just then. The other outstanding case

[6] For each GDP lag, the sum of the cycles´ autoregressive coefficients reveals that persistence (compare equation 4: $\varphi_{01}=1.12$; $\varphi_{02}=-0.47$; $\varphi_{11}=1.14$; $\varphi_{12}=-0.32$; $\varphi_{1}=1.22$; $\varphi_{22}=-0.49$).

is the Great Recession. Although this was a phase of extraordinarily good labour market performance due to severe reforms as well as increased competitiveness of the German industry, the cycle does not show any extraordinary movement.

Over the whole horizon, the TVP cycle and GDP growth correlate at -0.21; until the Great Recession the correlation was -0.38.[7] The (moderate) negative empirical correlation reveals that employment corresponds to GDP modestly stronger in recessions than in expansions. This result is in line with the studies on asymmetry in Okun´s law.

On the basis of the linkage coefficient (trend + cycle), we can classify the business cycle phases (pairs of recession and recovery according to Schirwitz 2009) with regard to their bonding to the labour market. For each phase, we calculate an average linkage coefficient and its percent deviation from the long-run average. The sign of the deviation uncovers whether a recession came along with or without labour hoarding and whether the subsequent recovery was jobless or not. The absolute value of the deviation gives a hint on the strength of hoarding and job-intensity (Table 3).

The recession and recovery shortly after reunification show the closest link to employment. Since then, the damaging effect of recessions has declined but at the same time, recoveries started to become jobless. Employment growth did no longer correspond to GDP growth. The Great Recession and the recovery thereafter push this development into extremes: The recession is classified as the only hoarding recession since the 1970s while the recovery thereafter seems to be outstandingly poor with regard to its transmission onto the labour market. The classification for the latest data is strongly driven by the drop in the coefficient´s trend. By contrast, the high trend as well as a positive coefficient cycle in the first half of the 1990s account for the strong GDP-employment link at that time. Before reunification, the high trend was instead compensated by a comparatively large negative cycle. In other words, employment growth during the expansion of the 1980s would have been substantially larger if the permanent component alone had been responsible for the linkage. By contrast, the recession following the new economy bubble would have cost less jobs if the positive cycle had not turned it into a recession without labour hoarding.

At first glance, the classification seems to contradict the impression in Figure 1: there, productivity did not only decline during the Great Recession but in the recessions of the 1980s as well. Moreover, companies bore productivity loss at the end of our sample as well. The explanation is that the non-GDP component must be added to complete the picture. In fact, autonomous employment growth contributed to protecting employment in the recessions of the 1980s. By the same token, the autonomous component constitutes a large part of the recent employment growth.

[7] For this correlation measure, GDP growth was smoothed by a third-order moving average, as differences are typically much more volatile than levels.

Table 3: Business cycle classification by means of percent deviation of the linkage coefficient from its long-run average

business cycle phase	coefficient's deviation from average (%)	classification
1974Q2 – 1975Q2	39.5	regression without labour hoarding
1975Q3 – 1980Q1	0.7	job-intensive growth
1980Q2 -1982Q3	17.1	regression without labour hoarding
1982Q4 – 1992Q1	4.2	job-intensive growth
1992Q2 – 1993Q1	46.2	regression without labour hoarding
1993Q2 – 1995Q3	35.2	job-intensive growth
1995Q4 – 1996Q1	22.3	regression without labour hoarding
1996Q2 – 2002Q2	-0.6	jobless growth
2002Q3 – 2004Q3	7.5	regression without labour hoarding
2004Q4 – 2008Q1	-3.3	jobless growth
2008Q2 – 2009Q1	-28.1	regression with labour hoarding
2009Q2 – 2013Q4	-37.3	jobless growth

Source: Own calculation.

3.2 GDP-related versus autonomous employment growth

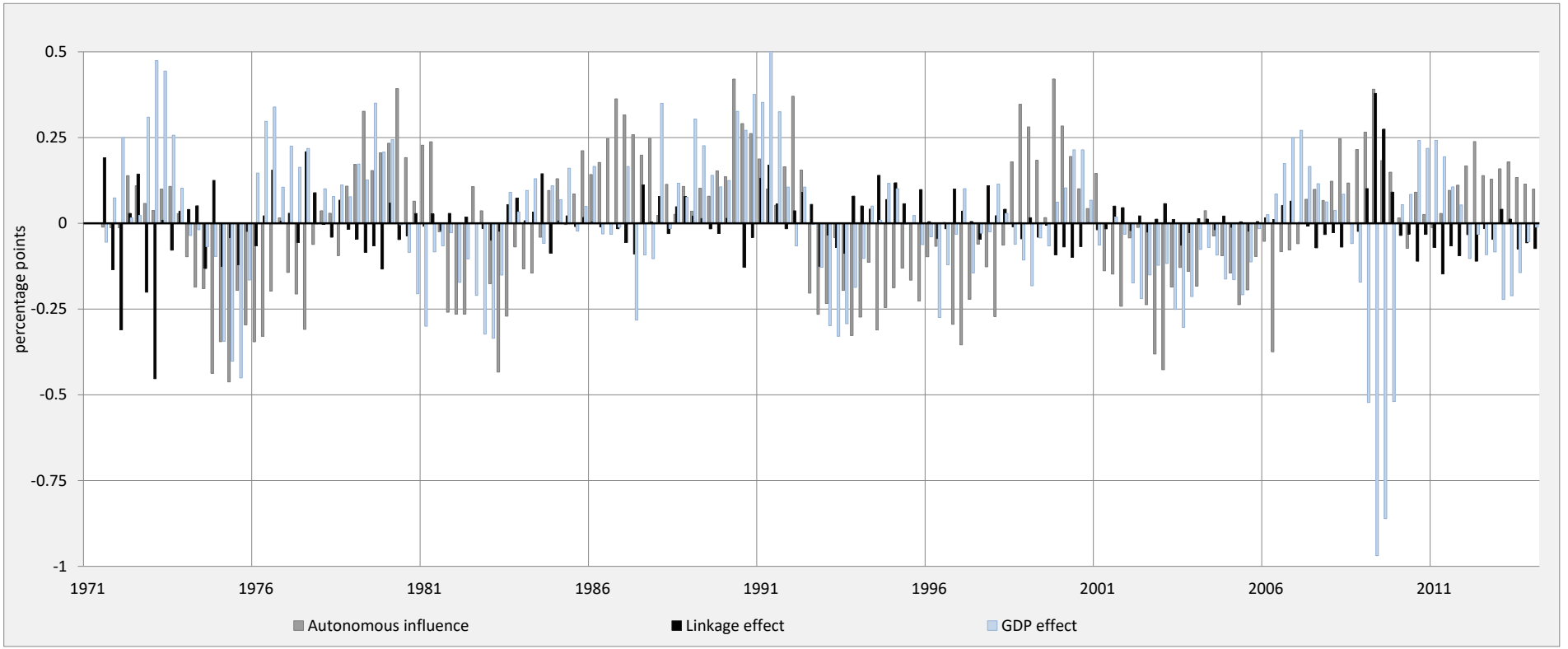
The estimated linkage coefficient allows us to decompose predicted employment growth ($\hat{e}_t$) into four components (Equation 7): Three of them are related to GDP growth – first, the normal or sample average state; second, the linkage effect that arises from mean-deviations of β_{it}; and third, the GDP effect evaluated at an average linkage coefficient. Finally, the autonomous effect presents the component of employment growth which is beyond the explanatory power of GDP.

Equation 7:

$$\hat{e}_t = \sum_{i=0}^{q} \overline{\beta}_i \overline{y}_{t-i} + \sum_{i=0}^{q} (\beta_{it} - \overline{\beta}_i) y_{t-i} + \sum_{i=0}^{q} \overline{\beta}_i (y_{t-i} - \overline{y}_{t-i}) + (c_t^a + cons)$$

The average effect is estimated at 0.17 – if the linkage coefficient as well as GDP growth equal their sample means, employment will grow by 0.17 percent in each quarter, other influences being zero. Empirically, however, these other influences were not zero; they are depicted in Figure 4. The decomposition shows a clear autonomous component with pronounced cycles (grey bars). It further reveals a high cyclicality of the GDP effect (light bars). Thus, much of employment growth volatility can be traced back to these fluctuations. Moreover, the two effects exhibit a slight positive correlation and thus seem to go hand in hand on average – but not uniformly.

Figure 4: Decomposition of estimated employment growth into GDP related and autonomous components



Source: Own calculations.

Above all, the picture is markedly different during the Great Recession and thereafter. The extreme drop in the GDP effect was compensated commonly by the linkage effect and the autonomous component. Thus, the resilience of the German labour market during the Great Recession resulted from two factors. On the one hand, companies´ employment decisions did no longer refer to GDP, i.e. they practiced typical labour hoarding adjusting at the intensive margin. On the other hand, changes in the industry mix and labour market institutions, particularly following the Hartz reforms, improved the functioning of the labour market and exerted positive effects on employment even through the crisis. For example, in the service sector, which was not severely hit by the crisis, employment steadily rose. As a consequence, productivity growth declined.

During the recovery from the crisis, the positive GDP effect is larger than the negative linkage effect. However, if the linkage coefficient had not fallen permanently, employment would have grown at higher rates. In 2011 to 2013, during the Euro zone recession, employment kept on rising mostly because of autonomous effects. Thereby, the autonomous component is not larger than before, but the positive correlation with the GDP effect is interrupted. Thus, during those years, factors beyond GDP did not add to but substituted the correlation between employment and GDP growth, at least in large parts.

4 Time variation and economic indicators

4.1 Variable selection

So far, we explain the slow-down of productivity growth as a partial decoupling of employment and GDP, replaced by correlations with factors beyond GDP that boost employment. In the following we discuss potential sources of this time variation in the linkage coefficient and the autonomous cycle. Variable selection is motivated by two fundamentals: first, a partial theoretical model of search & matching with endogenous separations (Pissarides 2000, Fujita/Ramey 2012) and second, an empirical sketch that detects remarkable developments of some of these key labour market variables.

The law of motion for employment is determined by matches M that raise employment, and separations S deteriorating employment (Equation 8). Thus, any influence on these flow variables will affect employment change, the dependent variable in the first stage of the analysis.

Equation 8:

$$\Delta E_t = M_t - S_t$$

Matches are inflows into employment from any source. They are formed by the job finding rate multiplied by the number of job seekers. Thereby, the job finding rate is represented by a matching function, often of Cobb-Douglas type and with constant returns to scale (Petrongolo/Pissarides 2001, Equation 9). The latter assumption ensures that vacancies V and job seekers J can be summarized into labour market tightness $\theta_t = V_t/J_t$. With match efficiency *m* and elasticity of the job finding rate with respect to job seekers α, matches are given by

Equation 9:

$$M_t = m_t \theta_t^{1-\alpha} J_t$$

Separations consist of a group of exogenous dismissals or quits (as in the DSGE model by Christiano et al. 2014, for example) and a group of endogenously dismissed workers (e. g. Fujita/Ramey 2012, see our equation 10). Exogenous separations occur with separation rate *s*. Endogenous separations occur because *i*) a worker´s productivity is hit by an idiosyncratic shock with arrival rate λ that leads to a new productivity below reservation productivity with probability *G(R)* or ii) reservation productivity changes such that a fraction of workers ($E_{t-1}(R_t) / E_{t-1}$) falls below even if they do not face a productivity shock (expressed by the complementary probability $(1-\lambda)E_{t-1}$).

Equation 10:

$$S_t = sE_{t-1} + (1-s)\big(\lambda G(R_t)E_{t-1} + (1-\lambda)E_{t-1}(R_t)\big)$$

Reservation productivity is derived from the endogenous job destruction condition (Pissarides 2000). A job is destroyed if its value is zero, i.e. if its return (productivity minus wages) is too low:

Equation 11:

$$0 = pR - w(R) + \frac{\lambda}{r+\lambda}\int_R^1 \big[p(n-R) - \big(w(n) - w(R)\big)\big] dG(n)$$

In sum, employment change would depend on the following factors, which we will investigate empirically: aggregate productivity (or output change) and job productivity, tightness, number of job seekers, matching efficiency, wages, and – in our model just for the deterministics – exogenous separation rate, productivity shock arrival rate and discount rate.

Aggregate output was dealt with on the first stage of the analysis. The theoretical considerations confirm that higher output boosts employment as it raises the return of a job and decreases reservation productivity. The other variables directly influence autonomous (not GDP-related) employment growth. Though, some of them could also influence the time-varying linkage coefficient because they may raise incentives to produce a given GDP growth more or less labour-intensively. This is subject to empirical investigation.

The aspect of labour hoarding – productivity, not employment changes with GDP – is captured in the integral of equation 11 (Pissarides 2000, 44 f.; potential rehiring is not considered): Firms keep unproductive jobs because further productivity shocks will arrive with probability λ and might raise the job productivity to a new level n above reservation. In that case, the firm could start to exploit productivity immediately without searching for a new worker. The probability that a shock leads to job productivity below reservation (*G(R)*) would be conditioned on agents´ expectations if they possess relevant information about the future shock. If companies expect an economic recovery arriving soon they are likely to be more prone to labour hoarding. We check this kind of information by including an indicator of business expectations into our model.

Another rationale for labour hoarding (Bentolila/Bertola 1990; Horning 1994) is hardly mirrored in the search & matching model due to the free entry condition[8]: a tight labour market makes it time-consuming and costly to fill vacancies. The value of rehiring in comparison to the value of hoarding would increase incentives to reduce separations. And it may also pay to enact precautionary hiring when tightness and hiring costs are high. We check these arguments empirically, including tightness as a measure of labour scarcity into the regression. The robustness section will provide further evidence on this kind of reasoning; it also mitigates worries about potential endogeneity.

While tightness is often referred to as vacancies over unemployed, and unemployment does not mirror the total number of job seekers, we further consider the labour force potential. This allows employment to grow from other sources than unemployment, especially from outside the labour force. The influential role of an increased labour force in explaining the UK productivity puzzle has been shown by Blundell et al. (2014). A high labour supply could reduce the incentive to hoard labour but increase the opportunity to recruit workers.

Matching efficiency summarizes factors that influence the functionality of the labour market, precisely how fast vacancies can be filled and unemployed find a job. The labour market reforms that came into force between 2003 and 2005 addressed search intensity, market flexibility and transparency. Previous research found that they contributed to a substantial (permanent) increase of matching efficiency (e.g. Klinger/Weber 2016, Krebs/Scheffel 2013).

Wages determine the return of a job and therefore negatively influence job creation. Moreover, they influence reservation productivity which has a direct positive impact on separations as well as an indirect effect via the probability that a new shock will degrade job productivity below reservation. E.g., wage development reflects employees´ shrinking bargaining power as trade union coverage has decreased and outside options worsened due to the Hartz Reforms (compare Dustmann et al. 2014, Krebs/Scheffel 2013 for Germany; Blundell et al. 2014, Gregg et al. 2014 for UK).

Any parameter in the model may differ by economic sector. As an illustrative example, the reservation productivity shall be smaller in services and higher in industries because of the technological infrastructure. As a consequence of such heterogeneity, the linkage coefficient between employment and GDP growth would depend on the sectoral composition of the economy. This refers to persistent sectoral growth paths (Palley 1993) but also to transitory shifts stemming from the evolution of the production chain or factor substitution over the business cycle (Silvapulle et al. 2004).

We augment the variable list for the autonomous cycle by working time. This bridges the gap between productivity per employee, which is in our focus, and productivity per hour. Working time per employee is a substitute for employment to meet the demand for a certain volume of work.

4.2 The empirical model and data

To capture economic heterogeneity, we control for shares of sectoral gross value added. Perfect collinearity is avoided by skipping one sector (manufacturing). The service sector beyond trade/gastronomy/logistics and financial services/insurance contains business, public, information & communication as well as other services. Data is provided by the German Federal Statistical Office.

[8] With free entry and exit, the value of an additional vacancy is zero. But if there are frictions to market exit and if the market is still adjusting towards equilibrium, hiring costs matter for the value of the vacancy.

Labour market tightness is calculated as vacancies over unemployed, both published by the Federal Employment Agency. Starting after the labour market reforms until 2012, tightness had risen up to 17 vacancies per 100 unemployed while the average is 11 vacancies per 100 unemployed. The 2012 value was only exceeded in the late seventies and early nineties.

Job seekers are captured by labour force potential, a business-cycle independent measure of labour supply. It rose strongly in recent years as high immigration – a balance of more than 400,000 people as in 2013 has not been observed since the early 1990s[9] – as well as rising participation rates of women and older people outperformed the demographic decline. Labour force potential is calculated by the Institute for Employment Research (IAB) with yearly frequency; we interpolated the data.

Business expectations are an indicator based on regular survey responses of 7,000 enterprises on whether they anticipate their situation during the next six months to be more favourable, unchanged, or more unfavourable; it is calculated by the ifo Institute.

Wages have developed remarkably moderately since the end of the 1990s which was further sharpened after the labour market reforms. Meanwhile, they have started to rise again. We use total labour costs per hour including social contributions, published by the Federal Statistical Office.

Working time according to IAB data has been decreasing by trend, mainly due to an increase in the part-time ratio but also due to reductions in weekly working time negotiated in collective bargaining. Our measure also contains short-time work, a scheme widely used during the Great Recession to adjust labour without mass layoffs.

To summarize, the vector x_t contains the explanatory variables: shares of agriculture, construction, trade/gastronomy/logistics, finance and services in total gross value added, business expectations, tightness and labour force. A second vector z_t equals x_t with (GDP-related) business expectations excluded and wages as well as working time included. The role of institutional change is checked in the robustness section. We do so because matching efficiency is not observed but we make use of a generated series from an external econometric approach (Klinger/Weber 2016).

Nonstationary series in the trend equation establish a cointegration relation. In the cycle equations, nonstationary series were differenced or captured by an explicit trend.

As described above, a large linkage coefficient means high employment growth or high employment losses, depending on the sign of GDP growth. Thus, we allow the explanatory variables to have different coefficients on the trend and cycle of the linkage coefficient (Equation 12 and 13, depending on the sign of GDP growth. Beyond deterministics, we write the regression models as

Equation 12:

$$\tau_t = \gamma' x_t D_t^n + \gamma^{*\prime} x_t (1 - D_t^n) + \omega_t^\tau$$

Equation 13:

$$c_t = \kappa' \Delta x_t D_t^n + \kappa^{*\prime} \Delta x_t (1 - D_t^n) + \omega_t^c \quad \text{(no differences for expectations and tightness)}$$

[9] Our sample ends before the high refugee immigration took place.

Equation 14:

$c_t^a = \pi' \Delta z_t + \omega_t^{c^a}$ (no differences for tightness and trend-stationary labour force potential)

γ, κ and π denote the respective parameter vectors. ω_t^i are white noise error terms. The dummy variable *D* is 1 for negative GDP growth rates.

$$D_t^n = \begin{cases} 1 \; if \; y_t < 0 \\ 0 \; if \; y_t \geq 0 \end{cases}$$

The parameters can be estimated by OLS using Newey-West standard errors for inference. Data availability restricts us to run those regressions from 1992 onwards. They reveal correlations, not causal effects. Nonetheless, the results allow a cautious interpretation of the relations of employment growth with or without reference to GDP. As a measure of effect size, we use Cohen´s f^2 (with x_{it} being the variable of interest). According to Cohen (1988), f^2=0.02 denotes a small, f^2=0.15 a medium, and f^2=0.35 a large effect size.

$$f^2 = \frac{R^2 - R^2_{excluding \; x_{it}}}{1 - R^2}$$

4.3 Results

The results for the TVP regressions are given in Table 4. The remarkably lower R^2 for the TVP cycle regression is typical of regressions in differences. The asymmetry due to positive / negative GDP growth is visible in the short-run cycle. Most of the parameters change their sign, too, when GDP growth changes its sign. Regarding the long-run component of the coefficient, however, hardly any parameter changes its sign with respect to increasing / decreasing GDP. This finding is consistent with the idea of a permanent component: it does not routinely adjust to GDP changes. Once the effect is established, it continues to be effective in a similar manner over a long period. The details are interpreted in the following.

To start with, we elaborate on changes of the sectoral composition of the economy. We find the change in the industry mix to be the most important factor of time variation in the linkage coefficient between GDP and employment growth. Thereby, effect sizes for the permanent component (trend) are far larger than for the cyclical component. The rise in service sectors is of outstanding importance – its effect size for the coefficient´s trend is 0.79 (and 0.10 for the coefficient´s cycle). A persistent increase in the importance of the service sector (compared to manufacturing) by 1 percentage point in gross value added comes along with a permanently lower linkage coefficient by 0.04. This effect is temporarily strengthened (by 0.08) if an upswing comes through relatively higher service gross value added. By contrast, an importance gain in trade/gastronomy/logistics implies a permanently closer link between GDP and employment growth by 0.04.

Figure 5 underlines the role of the sectoral composition for the development of the TVP trend. Employment volatility has always been stronger in industrial sectors. With the rise of the service economy, consequently, the GDP-employment relationship has become looser. This development was especially pronounced in the 1990s (compare Bachmann/Burda 2010 on the decisive role of sectoral change for the German labour market at that time) and during the Great Recession. To emphasize the strong negative correlation, we depict the TVP trend with negative sign in Figure 5.

Table 4: OLS regressions for trend and cycle of the time-varying linkage coefficient

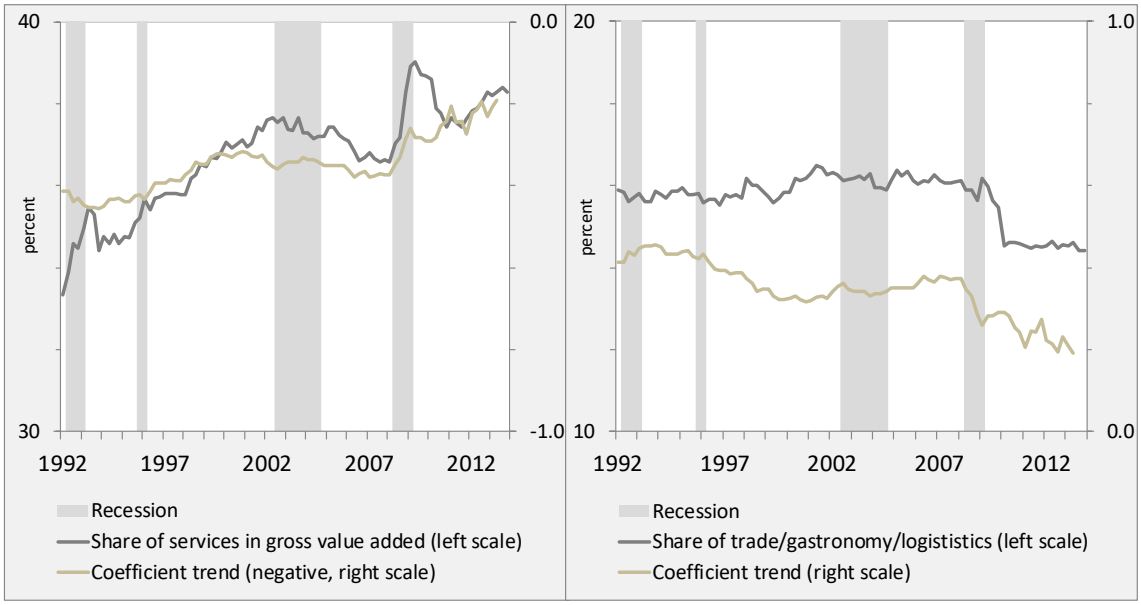
				trend			cycle		
explanatory variables [1]		**GDP**	**growth**	**coefficient**	**p-value**	**Cohen's f^2**	**coefficient**	**p-value**	**Cohen's f^2**
constant				1.0897	0.244		0.0705	0.528	
deterministic trend				-0.0008	0.334		-0.0006	0.018	
share in gross value added	agriculture/ forestry	> 0		-0.1177	0.000	0.211	-0.0228	0.836	0.027
			< 0	0.0540	0.197		0.3374	0.147	
	construction	> 0		-0.0005	0.949	0.022	-0.0539	0.202	0.087
			< 0	-0.0124	0.317		0.2047	0.036	
	trade/gastron-omy/ logistics	> 0		0.0378	0.006	0.164	-0.0441	0.132	0.023
			< 0	0.0198	0.155		0.0224	0.751	
	financial services/ insurance	> 0		0.0099	0.341	0.032	0.0185	0.397	0.027
			< 0	0.0127	0.288		-0.0692	0.211	
	service sectors	> 0		-0.0372	0.000	0.788	-0.0844	0.003	0.099
			< 0	-0.0470	0.000		0.0226	0.524	
ifo business expectations		> 0		-0.0007	0.284	0.074	-0.0004	0.744	0.042
			< 0	-0.0019	0.001		0.0005	0.680	
tightness		> 0		-0.3154	0.078	0.050	-0.2141	0.226	0.043
			< 0	-0.2511	0.444		-0.7362	0.024	
labour force potential		> 0		4.34E-06	0.827	0.016	0.0003	0.001	0.129
			< 0	1.79E-05	0.473		0.0003	0.028	
R^2				0.9308			0.4009		

[1] nonstationary variables differenced for cycle regression.
f^2 print in grey where coefficients are insignificant.

Source: Own estimation based on data as described in the text.

Besides, the share of the sector trade/gastronomy/logistics did not recover from the crisis – which is reflected in the drop of the TVP trend in the right part of the figure. Obviously, while in Germany the Great Recession was quickly overcome, it left an imprint in the structure of the economy and thereby induced a sustainable adjustment of the macroeconomic relations.

Figure 5: Trend of linkage coefficient and the shares of gross value added of services as well as trade/gastronomy/logistics



Source: Federal Statistical Office, own calculation and estimation.

Regarding the cyclical component of the linkage coefficient, we find a positive coefficient of construction when GDP is in recession. Then, if the share of construction in total gross value added

shrinks – that is if the recession comes through a decline in construction –, the linkage coefficient will also shrink and employment decreases in these recessions less than normal.

For autonomous employment growth, the change in the sectoral composition is of minor concern (Table 5). Construction and services (only at the 10 percent significance level) prove relevant, at least more relevant than manufacturing, the left-away category. But the effect sizes at 0.09 and 0.03 are rather small. The coefficients at 0.28 and 0.10 imply a moderate positive link given that the autonomous component ranges between -0.45 and +0.43.

Table 5: OLS regression of autonomous employment cycle

explanatory variables [1]		coefficient	p-value	Cohen's f^2
constant		-10.6929	0.001	
deterministic trend		-0.0034	0.081	
share in gross value added	agriculture/forestry	0.1274	0.625	0.003
	construction	0.2803	0.006	0.085
	trade/gastronomy/ logistics	-0.0253	0.765	0.001
	financial services/ insurance	-0.0146	0.826	0.001
	service sectors	0.0981	0.071	0.031
average working time		-0.0415	0.001	0.136
wage costs per hour		0.3660	0.002	0.145
tightness		3.2124	0.000	0.321
labour force potential		0.0002	0.002	0.119
R^2		0.5519		

[1] nonstationary variables differenced for cycle regression.
f^2 print in grey where coefficients are insignificant.

Source: Own estimation based on data as described in the text.

To summarize the influence of sectoral changes, we calculated a counterfactual scenario on the basis of the filtered states and estimated parameters. It delivers the size of employment growth had the sector structure remained constant. Between reunification and the onset of the Great Recession the average annualized employment growth rate was 0.2 percent. Without the change in the industry mix, this rate would have amounted to 1. The difference stems almost exclusively from the sector-driven decline of the linkage between employment and GDP. From the beginning of the Great Recession up to the end of our sample in 2013, average annualized employment growth was 0.7 percent. Without the change in the industry mix, it would have been 0.3. Again, the sector-driven development of the linkage coefficient is the major contribution here, it accounts for a positive employment growth by about 0.3 percent per year. However, one should bear in mind a peculiarity of the Great Recession: As services were hardly affected and kept on hiring, they provided a favourable starting point for the macroeconomic recovery, too.

With respect to the regressors beyond sectoral gross value added, we find: First, better business expectations go along with a smaller trend component of the GDP-employment linkage when GDP growth turns out to be negative: A unit increase in the expectations index implies a reduction by 0.002 – a relatively small number with an adequately small effect size at 0.07. Still, there is a labour hoarding aspect visible in this result: the better (respectively, less pessimistic) expectations are,

the less employment will decline. For positive GDP growth rates, the coefficient is not significant, just as within the cycle regression.

Second, labour market tightness shows a negative and significant coefficient in the cycle regression when the economy is in recession (Table 4). The parameter and the effect size are small, however. In the trend regression, the respective parameter is not even significant. Thus, a tight labour market and potential labour shortage seem to be at best an incentive for a temporary decoupling of employment from poor economic growth. But it is not the factor to explain the pronounced labour hoarding during the Great Recession (compare Klinger et al. 2011). However, tightness strongly correlates with the autonomous employment component. If there was 1 vacancy more per 10 unemployed – which is about the average tightness – the employment growth rate would jump by 0.32 percentage points. The effect size at also 0.32 is the largest in that regression. A tight labour market seems to prompt companies to increase hiring activities further than the direct GDP link would suggest. In periods of weak economic performance this may result into poor productivity at the beginning. With an upswing arriving, however, the capacity of these workers can be immediately utilised.

Third, a rich labour supply contributes the most to explaining increases in the cyclical part of the linkage coefficient between GDP and employment. This holds for economic upswings as well as downturns. Presumably, companies raise employment more strongly in expansions and reduce employment more strongly during recessions if they can choose from a wide labour supply. A unit increase in differenced labour force potential (concerning 1000 persons) goes along with an increase in the linkage coefficient´s cycle by 0.0003 – a moderate influence given an average quarterly change in labour force potential by about 30,000 persons. Furthermore, labour force potential – with a lag of 4 quarters – positively correlates with autonomous employment growth. The effect size is at a moderate value of 0.12. Still, recent employment growth would not have been possible if extraordinary high immigration and rising labour participation had not increased labour supply. The fact that both labour supply and tightness were high and positively correlate with employment underlines the substantial increase in labour demand that has taken place during the past few years.

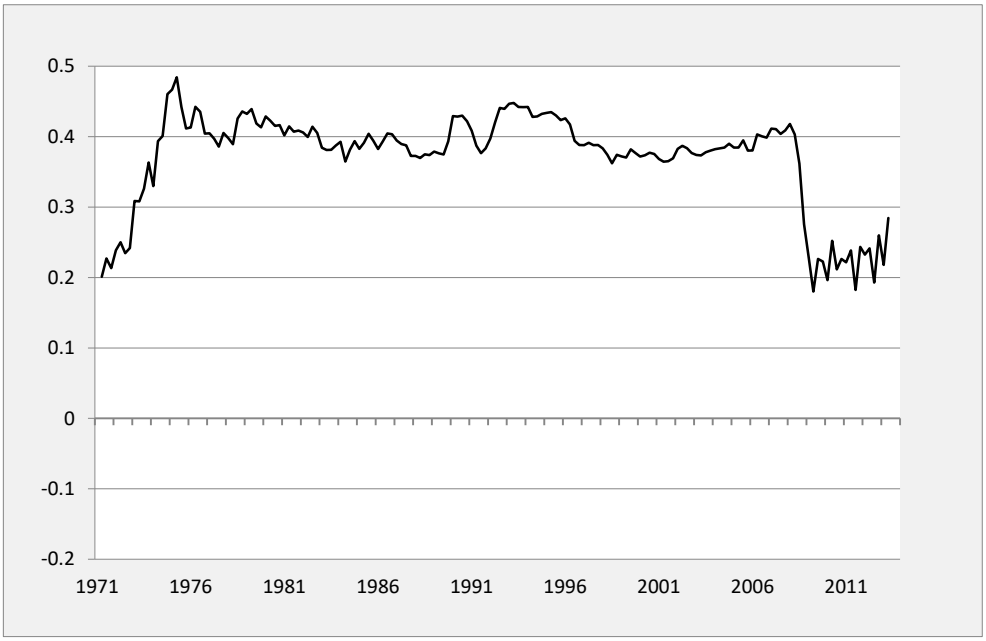
Fourth, there is a negative correlation between working time and employment confirming that the two are substitutes in satisfying labour demand. A decrease in differenced quarterly working hours per employee by 1 hour – about 30 percent more than the average change – comes along with an increase in autonomous employment growth by 0.04 percentage points. According to f^2 at 0.14, the correspondence is medium-sized and of similar importance as the one with wages.

Finally, labour costs negatively correlate with autonomous employment growth. Quantitatively, an increase in differenced gross wages including social contributions per hour by 1 Euro (empirically, the average is one tenth of this) implies a significant reduction in employment growth by 0.37 percentage points. Thus, the wage moderation in the last decade and the strong employment growth beyond the GDP-related part go hand in hand.

5 Robustness

As there is a lack of comparable studies on time-variation of the GDP-employment relation, we pursued the following robustness checks: The development of the unobserved states did not change remarkably when we introduced a higher lag length to the TVP cycles nor when we allowed for lag 2 and 3 in the autonomous cycle although they were insignificant. Neither had artificial starting values for the trend components – instead of the ones from the OLS regression – any influence. Restricting the TVP specification to a random walk without cycle yields a similar development of the permanent component as in the preferred model. However, we miss the additional information from the cycle estimation. For example, the drop during the Great Recession is less pronounced in the flexible full model because part of this break on the labour market is found to be cyclical (see Figures 3 and 6).

Figure 6: TVP as random walk only



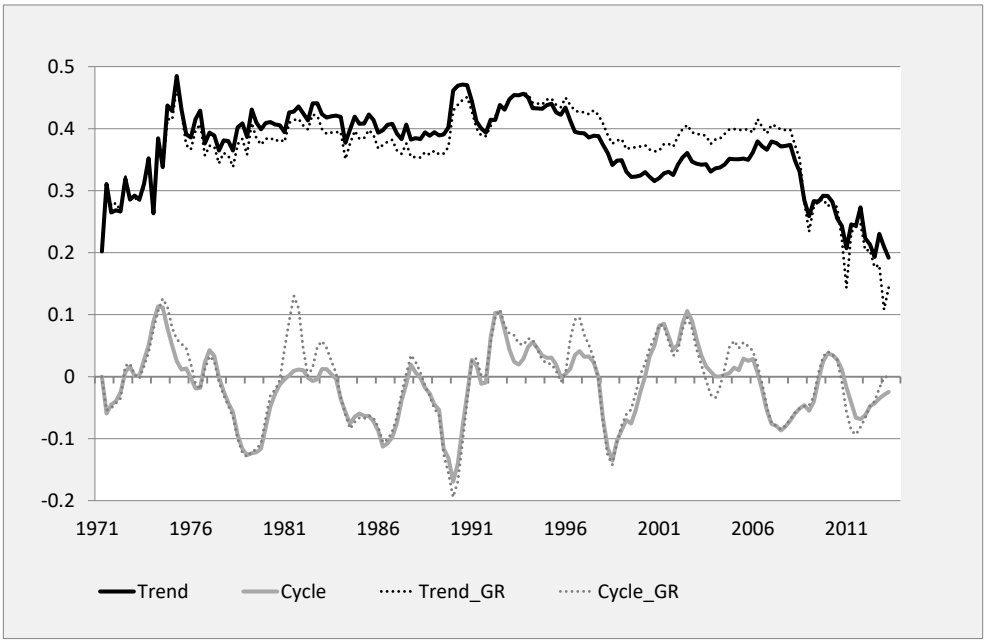
Source: Own estimation based on data by Federal Statistical Office.

Regarding the Great Recession we introduced several bounce-back specifications according to Morley/Piger (2012). The idea was to allow for an explicit drop as well as an explicit recovery in the trend or cycle. None of the specifications proved to be significant in our context. Thus, the persistent drop in the trend proved to be robust. Furthermore, we checked the relevance of the Great Recession by a model specification that allows the trend shock´s and the cycle shock´s variances to break only during that time but not in the recessions before. Figure 7 shows that there are only minor differences with regard to the course of the trend and the cycle alike.

Both approaches lead to a trend reaction to the Great Recession – the trends jump down to a very similar value. The drop in the robustness model is even sharper as it starts from a higher value. In contrast, our preferred specification already brings the trend line down at the beginning of the 1990s. The Great Recession marks an outstanding event, but still, the other recessions should be

accommodated explicitly as the likelihood ratio test proves our main model to be significantly better. The most remarkable difference regarding the cycle occurs in the recession in the early 1980s when the more restrictive model reaches a higher and clearly positive peak. Nonetheless, the basic development of the cycle does not change.

Figure 7: Comparison of TVP states with one or several shock variance breaks



Source: Own estimation based on data by Federal Statistical Office.

In the OLS regressions above we used labour market tightness as an indicator of tough recruitment processes. Since one may be worried about potential endogeneity of that variable containing unemployment, we check its empirical quality using other indicators that directly refer to labour shortage. Based on a yearly written questionnaire to firms, the German Job Vacancy Survey provides information on vacancies and recruitment processes (Kettner/Vogler-Ludwig 2010). For example, firms indicate whether they faced difficulties in finding new workers, whether they had to negotiate higher wages than planned, whether labour shortage constrained their business activity and for how long they had searched until the new worker started the job. Replacing tightness by these variables in the OLS regression for the autonomous cycle confirms our previous results (Table 6), especially that employment rises due to preventive hiring or hoarding, irrespective of GDP.

Furthermore, Table 6 shows the results of an augmented regression of autonomous employment growth on matching efficiency. This unobservable is the time-varying trend component of the efficiency parameter of an empirical matching function. It is gained from a multivariate UC estimation (Klinger/Weber 2016). We choose the trend as the appropriate measure to capture institutional change as by the Hartz reforms. Autonomous employment growth indeed profited from increased matching efficiency. From 2005 to 2011, the measure rose by 27 units which implies a total increase of employment growth by 0.20 percentage points. The respective effect size f^2 would be 0.06, clearly ranging behind labour supply, wages and working time. Though the coefficient of tightness becomes slightly smaller, it still has the major influence on autonomous employment

growth. Beyond this, matching efficiency is not significant in the regressions of the GDP-employment linkage coefficient. This is in line with previous findings that the reforms did not significantly change the relation between GDP and the labour market (Klinger/Rothe 2012). However, there is one exception: An expansion permanently comes along with more hirings when the matching process is relatively easy.

6 Summary and conclusions

Labour productivity per capita used to rise almost steadily in Germany. Astonishingly, during the Great Recession, productivity dropped sharply and has hardly recovered in the subsequent years. Employment kept on rising despite low to mediocre GDP growth. Over time, the linear relationship between the two variables appears not to be stable. Our study emphasizes the relevance of time-variation in macroeconomic relationships and investigates its patterns and reasons with regard to productivity.

The paper contributes to a more flexible modelling of time variation in macroeconomic relationships. It takes into account that parameter instability can occur in two ways: as long-lasting changes and as transitory switches. We employ an unobserved components model to disentangle the linkage coefficient between employment and GDP growth into a stochastic trend – the permanent component – and a transitory cycle. Beyond the explanatory power of GDP, we consider a further autonomous component of employment growth.

We find that, first, labour productivity has fallen or stagnated because the co-movement of employment and GDP has loosened while the co-movement with other variables than GDP has become tighter. In contrast to previous experience, autonomous employment growth is able to compensate for weak economic performance. Second, the decoupling is inherent to the trend component of the linkage coefficient between employment and GDP. It is a permanent decline down to historical lows. Third, controlling for autonomous employment growth yields a more precise classification of when a recession / recovery is a hoarding recession / a jobless recovery. Fourth, the development of the time-varying parameters goes hand in hand with the change of the sectoral composition of the economy, especially with the rise of the service sector. Labour availability and business expectations rank behind sectoral change. Fifth and contrarily, labour market tightness comes along with strong autonomous employment growth. Here, wages, working time, and labour supply rank second and the industry mix ranks third. In summary, recent employment growth would not have been possible if tightness and immigration had not been that high and if wage moderation and working time reductions had not taken place.

The underlying study can provide valuable guidance for explaining patterns of labour market development. Our model could be a useful reference point when evaluating the current labour market performance. This holds true especially for periods with strongly changing patterns such as decoupling of GDP and employment. Methodologically, the new approach shows potential for future research due to its flexible specification of trend and cycle in instable parameters.

Table 6: OLS regression of autonomous employment growth on variables substituting tightness and on matching efficiency as additional regressor

				variable instead of tightness								data include an own estimate of matching efficiency	
				share of hirings with recruitment difficulties [2]		share of hirings with wage compromise by employer [2]		share of companies with activity constraints due to labour shortage [2]		search duration until worker starts job [2]			
explanatory variables [1]		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
constant		**-10.6929**	0.001	-5.0133	0.060	**-7.5571**	0.018	**-9.5919**	0.007	**-9.9513**	0.013	**-11.5431**	0.001
deterministic trend		-0.0034	0.081	-0.0007	0.627	0.0005	0.776	-0.0011	0.540	-0.0018	0.444	**-0.0059**	0.013
gross value added	agriculture/forestry	0.1274	0.625	0.3519	0.100	0.3181	0.112	0.3256	0.129	0.4041	0.059	0.0029	0.992
	construction	**0.2803**	0.006	**0.2513**	0.013	**0.2833**	0.008	**0.2676**	0.016	**0.2900**	0.013	**0.2294**	0.025
	trade/gastronomy/ logistics	-0.0253	0.765	0.0406	0.604	0.0717	0.292	0.0121	0.899	0.0395	0.620	0.0003	0.997
	financial services/ insurances	-0.0146	0.826	0.0191	0.791	0.0112	0.877	0.0036	0.959	-0.0220	0.775	-0.0087	0.895
	service sectors	0.0981	0.071	**0.1104**	0.030	**0.1742**	0.001	**0.1358**	0.013	**0.1649**	0.004	**0.0841**	0.130
average working time		**-0.0415**	0.001	**-0.0395**	0.000	**-0.0346**	0.004	**-0.0423**	0.002	**-0.0298**	0.014	**-0.0442**	0.001
wage costs per hour		**-0.3660**	0.002	**-0.3228**	0.002	**-0.2868**	0.007	**-0.3512**	0.008	**-0.2245**	0.049	**-0.3999**	0.001
tightness		***3.2124***	*0.000*	***3.3439***	*0.000*	***1.4468***	*0.000*	***2.3931***	*0.000*	***1.6034***	*0.011*	***2.5938***	*0.000*
labour force potential		**0.0002**	0.002	0.0001	0.105	**0.0002**	0.034	**0.0002**	0.012	**0.0002**	0.021	**0.0002**	0.002
matching efficiency												**0.0074**	0.008
R^2		0.5519		0.5895		0.4957		0.5262		0.4374		0.5788	

[1] nonstationary variables differenced for cycle regression.
[2] parameters after normalization to same standard deviation as of tightness.
print in bold: significant at the 5% level

Source: Own estimation based on data as described in the text.

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