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On GDP-Employment Decoupling in Germany

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Contents

Abstract 4

Zusammenfassung 4

1 Introduction 5

2 The rationale of time variation in Verdoorn´s law 7

3 A correlated UC model for time-varying Verdoorn coefficients 10

4 Technical issues 12
4.1 Identification 12
4.2 Estimation 13
4.3 Data 13

5 Results 14
5.1 Verdoorn's law and time variation 14
5.2 Robustness 18

6 Explaining time variation by economic indicators 19

7 Summary and conclusions 24

References 25

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 both persistent and cyclical time variation in the employment impact of GDP as well as an autonomous employment component capturing other factors than real output. As one result, we measure a permanent decline in Verdoorn's coefficient as well as pronounced effects of the autonomous employment component in the recent years. The development of the estimated impact parameters is shown to crucially depend on structural change, but also on labour availability and business expectations.

Zusammenfassung

In dieser Studie wird für Deutschland untersucht, in welchem zeitvariablen Zusammenhang das Wachstum von Beschäftigung und Bruttoinlandsprodukt (BIP) stehen, insbesondere, ob und warum sich dieser Zusammenhang in der jüngeren Vergangenheit abgeschwächt hat. Wir schätzen ein korreliertes Unobserved-Components-Modell, in dem sich der Einfluss des BIP auf die Beschäftigung sowohl aus permanenten als auch aus transitorischen Gründen verändern kann. Zusätzlich wird eine autonome – von der Konjunktur unabhängige – Beschäftigungskomponente modelliert. Als wichtiges Ergebnis finden wir einen permanenten Rückgang des Verdoorn-Koeffizienten sowie substanzielle Effekte der autonomen Komponente seit der Großen Rezession 2008/2009. Die Entwicklung der geschätzten Einflussparameter des BIP auf die Beschäftigung hängt wesentlich vom Strukturwandel ab, ferner von der Verfügbarkeit des Produktionsfaktors Arbeit und von den Konjunkturerwartungen.

JEL classification: E24, E32, J23, J24, C32

Keywords: decoupling, unobserved components, time-varying coefficient, Verdoorn´s law

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1 Introduction

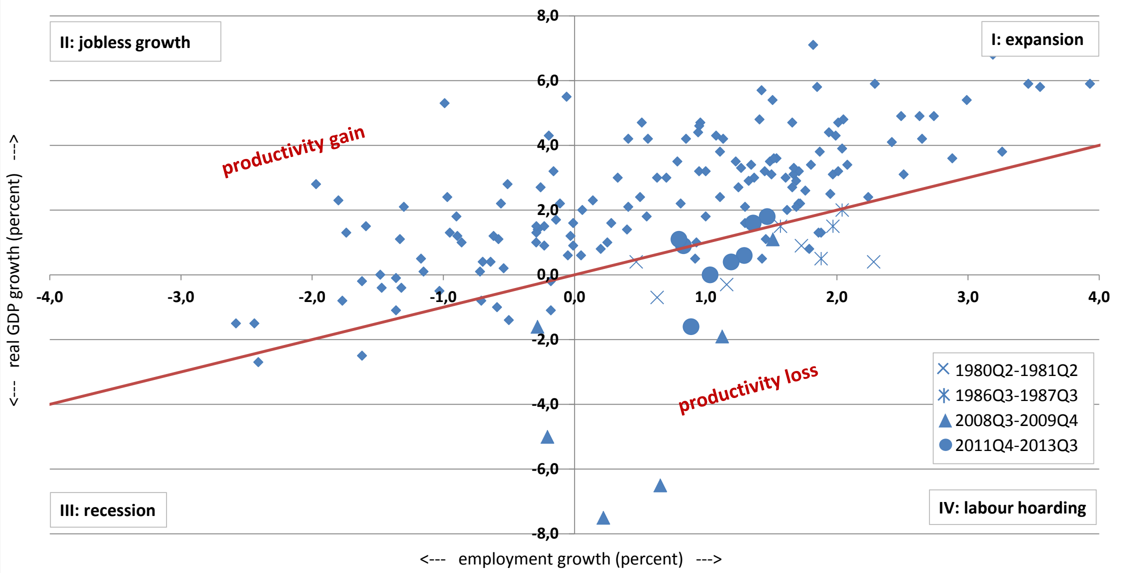
We investigate time variation and the reasons behind with regard to the relationship between employment and output growth (Verdoorn´s law) in Germany. The crucial role of parameter instability in macroeconomics has again been brought to the fore by the recent financial crisis (e.g. Ng/Wright 2013). Regarding Germany, especially its strong labour market performance and its rise from the sick man of Europe call for an analysis of structural change.

According to Verdoorn (1949), output growth induces productivity growth because it allows for higher labour division and specialisation. This relation used to be fairly stable in constant parameter regressions and valid in several countries (see e. g. Erber 1994, León-Ledesma 2000, Oelgemöller 2013). Kaldor (1966) developed the framework under which Verdoorn´s law has been mostly discussed: the linear relation between employment and output growth that results from the one between productivity and output growth.

Concerning the empirics of labour markets worldwide, the stability of Verdoorn´s law is to be doubted, indeed: Labour markets experience jobless recoveries as well as extreme labour hoarding – implying opposite developments of productivity. Germany proved illustrative for this statement, especially during the recent years (compare Figure 1; Lucchetta/Paradiso 2014 provide a description of the (opposite) US-American case). Whereas expanding labour productivity per worker has been the typical pattern, the economic slumps in 1980/81, 1986/87 and – as an outstanding case – 2008/09 were fully absorbed by productivity loss (including a reduction of hours per worker). Employment was hardly reduced or even kept on rising. But not only did the Great Recession mark a sharp drop in productivity. Beyond the V-shape recovery, it also marks the beginning of a general slow-down in productivity growth. Further on, in 2011 to 2013, the Euro zone recession forced the German economy on fragile growth with utterly weak investment. Nevertheless, employers continued to hire more workers than they dismissed. This behaviour was especially pronounced in the industrial sector. Obviously, Verdoorn´s law must have changed.

Our research emphasizes the relevance of time-variation in macroeconomic relationships and investigates its sources. Specifically, we address the following questions: a) How did Verdoorn´s coefficient develop and is the development driven by structural or cyclical forces? b) How much do GDP growth and change in GDP impact contribute to employment growth? Concretely, does the German labour market decouple from GDP growth or is the typical Verdoorn relationship just overlaid by other factors? c) Which are the determinants of time-variation in the GDP-employment relation? Or more pronouncedly, why do firms sometimes increase their staff despite poor economic performance and sometimes not?

Figure 1
Year-on-year percentage change of real GDP and employment, 1971 to 2013



Source: Destatis.

This study contributes to several strands of literature, both with regard to economics and methodology. The first set of articles deals with asymmetric responses of the labour market to the business cycle. Within that literature, research on asymmetries of Okun´s law – the relation of GDP growth and unemployment – is most relevant in our context (e. g. Silvapulle et al. 2004, Holmes/Silverstone 2006, Pereira 2013, Cevik et al. 2013). Regime shifts due to GDP growth are distinguished either exogenously (by NBER business cycle dating) or endogenously by Markov switching. Typically, the impact of GDP on unemployment is found to be larger in recessions. Given that U. S. unemployment does not appear to be non-stationary (does not imply a linear form of hysteresis), the larger impact of recessions is offset by longer durations of expansions (compare Ng/Wright 2013) or a larger output gap (trend deviation). Time variation in Verdoorn´s law, however, has not been investigated yet. The two laws would be perfect complements if employment and unemployment were the only labour market states. But employees could also leave the labour force or enter the labour market via immigration or higher labour participation. Regarding Germany, these two sources of potential employment have gained importance during the phase of the Euro zone recession. The unemployed, by contrast, while having gained from the labour market (“Hartz”) reforms for some years from 2005 onwards, did not relevantly participate in continued employment growth. Thus, with respect to the very edge of the data, Verdoorn´s law seems to bear more discontinuity than Okun´s. Moreover, it delivers the starting point of implications for structural policies, e.g. with respect to enhancing productivity that stagnated for years.

Another augmentation of the existing literature lies in our implementation of time variation. We implement a time-varying parameter specification (TVP, for a survey see Tucci 1995, for example) that allows for high flexibility. Thereby, we extend the usual specification of TVP as a random walk (e. g. Kim/Nelson 1999) to a full unobserved components model that contains trends as well as transitory components.

Thus, the impact of GDP on employment may vary for permanent but also for cyclical reasons. This amendment bases upon the unobserved components (UC) literature, e. g. Morley et al. (2003) or Morley/Piger (2012) with respect to asymmetric cycles. So far, persistence in Okun´s law has been related to the long-run components of unemployment and GDP, isolated by either Hodrick-Prescott filtering (Pereira 2013), Beveridge-Nelson type or unobserved components decompositions (Sinclair 2009); it has not yet been related to the impact coefficient which we do for Verdoorn´s law. Moreover, we apply a new identification strategy for the unobserved states as well as correlation of shocks in our UC-TVP model.

As a last contribution, we investigate the driving forces of parameter instability. A second-step regression of the TVP on indicators relevant for the employment decision as well as indicators of economic heterogeneity, business environment and labour shortage adds economic content to the structural information obtained from the unobserved components model.

As the main results we find that the average Verdoorn coefficient in the aggregate German economy is about 0.4, somewhat smaller than previous estimates. The coefficient reveals a pronounced cycle with an average length of seven years. The trend component rose markedly in the mid-1970s as well as at the beginning of the 1990s. Beyond this, it evolved flat or slightly decreasing. However, during the Great Recession the trend component dropped markedly and did not recover ever since. The cycle cannot compensate for that drop. Accordingly, we conclude that the relationship between German employment and GDP has become remarkably looser throughout the recent years. Further determinants (beyond GDP) have gained importance in the labour market. A main factor driving the development of Verdoorn´s coefficient is found to be structural change, i.e. the rise of the service economy. In addition, we can show that further variables such as labour market tightness, business expectations and labour force potential play relevant roles in the interaction of the economy and the labour market.

The remainder of the paper is organized as follows: The next section provides an overview of theoretical explanations of why Verdoorn´s coefficient should vary. Thereafter, we describe our model and sketch our identification and estimation strategy as well as robustness checks. The subsequent sections present the results. Finally, we summarize and conclude.

2 The rationale of time variation in Verdoorn´s law

In the following we discuss potential sources of time variation in Verdoorn's coefficient. As employment change usually induces a reaction in unemployment, explanations of asymmetry in Okun´s law apply in part (compare Silvapulle et al. 2004). The list of arguments will uncover that there are structural as well as transitory reasons for time variation which calls for a strategy to disentangle the two.

The explanations can be summarized into two categories, between-effects and within-effects. The between-perspective takes into consideration that different firms react differently to GDP growth. Heterogeneity across regions, sectors, and employers makes Verdoorn´s law depend on the economic structure and its time variation. This refers not only to persistent structures but also to transitory shifts stemming from, for example, the production chain as well as factor substitution evolving over the business cycle (Silvapulle et al. 2004). Rather long-lasting heterogeneity may arise from sectoral growth paths (Palley 1993), task diversity, and qualification levels needed for production. As a consequence, the aggregate Verdoorn coefficient rises if sectors, tasks, or qualifications with high GDP impact on employment gain importance. Such a development will probably come along with a decline in productivity due to an increase in the share of low-productive subfields in the economy. Putting it on an even more disaggregated level, Harris/Silverstone (2001) and Campbell/Fisher (2000) state that heterogeneous firms adjust their job creation and destruction decisions differently to external shocks.

As another permanent influence, technological progress – often operationalised as total factor productivity, the Solow residual of a production function – may affect Verdoorn´s law as it may lead to more efficient production processes with lower labour input. If growth is highly productive because it is driven by innovation and investment, Verdoorn´s coefficient might fall. Contrariwise, the coefficient might rise if technological progress induces higher job creation in addition to higher output.

Not only causes technological progress different sector movements, it also changes the production decisions within a single firm – which leads us to the within-perspective. This perspective takes into consideration that over time, one and the same firm may translate a certain GDP growth rate differently into labour demand. This firm behaviour should then be recognizable on the macroeconomic level.

Labour hoarding is a pronounced example that reconciles structural as well as cyclical determinants of time-variation in Verdoorn´s law. In some recessions, companies are more ready than in others to bear labour costs that are – at least for that while – higher than productivity. Economic literature put much emphasis on specifically explaining the acceptance of productivity loss – low Verdoorn coefficients – during the Great Recession. Among the hypotheses were higher labour demand due to improved institutions (Gartner/Klinger 2010), well-functioning industrial relations (Möller 2010), and normalization of overshot productivity during the upswing of the years 2006 to 2008 (Burda/Hunt 2011).

The more general view on labour hoarding (e. g. Bentolila/Bertola 1990, Horning 1994) suggests that companies avoid transaction costs that are expected to be higher than wage costs while hoarding personnel. Potential transaction costs include firing and training but also search and recruitment costs, a category that has become more important during the recent years as employers have been mourning labour shortages, with the highly productive sectors of metal, machinery and chemistry being among the most concerned. Thus, companies may want to recruit and hoard labour despite poor economic performance instead of postponing search until the next recovery when competition for qualified workers will have increased, search takes more effort and recruitment may only come at higher wages. Moreover, the more important firm-specific capital is for production or evolution of the firm, the higher is the incentive to keep well-trained workers with tenure over a phase of bad economic performance. This concerns full-time workers more often than part-time workers. Thus, while a higher part-time share ceteris paribus increases employment, it may weaken the employment-protecting effect of labour hoarding.

However, hoarding might not pay if it persists too long. Companies shall expect an economic recovery arriving soon. Hiring or hoarding decisions depend on the expected duration of an upswing or downturn as well as on the speed and depth of a recession. Not only are expectations but also is the psychic nature of signal extraction another explanation for time variation in Verdoorn´s law (see also Silvapulle et al. 2004): bad news is often believed more quickly than good news.

Finally, permanent changes in the impact of GDP on employment could be driven by fundamental trends: institutional change, demographic change, labour force participation or immigration, to name but a few. For example, the severe labour market reforms of the years 2003 to 2005 could have enhanced more labour-intensive GDP growth via the channel of higher market transparency and lower vacancy posting costs and wage costs. A permanent wage moderation and dispersion could also stem from a lower degree of unionization, higher labour participation of women and older people or immigration. All these trends have been observed in Germany throughout the past years and might have caused employment to react differently to GDP.

In general, we stress the fact that a change in the relation of employment and GDP growth does not necessarily imply a change in the effect of GDP on employment. Certainly, the labour market is subject to a multitude of shocks that affect employment independently of current GDP fluctuations. These shocks may overlay and mask the real GDP impact. For instance, improvements of labour market institutions might reduce unemployment by faster matching independently of the state of the business cycle. In this context, Klinger/Rothe (2012) confirm the effectiveness of the Hartz reforms, but do not find a more than usual business cycle effect on matches. As another example, immigration might affect the labour market by increasing labour supply both in economic upswings and downturns.

The differentiation is essential: A high Verdoorn coefficient is beneficial during expansions but bears employment risks in case the economy enters a recession. In contrast, autonomous labour market influences are principally not subject to such switches driven by the business cycle. Moreover, it is also interesting for its own right to measure in how far labour markets are GDP-determined and in how far they follow influences from different sources.

As a consequence of the aforementioned arguments, we employ an empirical strategy that estimates time-varying Verdoorn coefficients, simultaneously disentangles their permanent and transitory components and allows for an autonomous component of employment changes not linked to GDP growth. The next section describes our model.

3 A correlated UC model for time-varying Verdoorn coefficients

Verdoorn´s law in the representation of Kaldor is given by a linear relationship between employment growth e_t and GDP growth y_t (equation 1). Empirical macro models regularly find the labour market lagging behind the development of GDP. Thus, we include *q* lags of GDP growth into the Verdoorn equation. This general procedure implies *q+1* Verdoorn coefficients υ_{it}, *i=0,…,q, t=1,…,T*. Moreover, we include the autonomous component c_t^a that captures the time series dynamics of employment growth beyond GDP-dependent components. $d92q1$ represents a dummy variable for the German reunification. v_t is a white noise error term that avoids unsystematic effects being captured by the UCs.

(1) $$e_t = \sum_{i=0}^{q} \upsilon_{it}\, y_{t-i} + c_t^a + \delta_1 + \delta_2\, d92q1 + v_t$$

Time variation is introduced by letting each Verdoorn coefficient consist of a stochastic trend τ_{it} and a cyclical component c_{it} (equation 2). Thus, we allow the impact of GDP on employment to have a permanent as well as a transitory component. This enrichment of the literature is founded by the economic arguments in favour of both structural and cyclical variation in Verdoorn´s law given in the previous section.

(2) $$\upsilon_{it} = \tau_{it} + c_{it}$$

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 Verdoorn coefficients. Equation 4 specifies the transitory components as stationary autoregressions, 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, Sinclair 2009) 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.

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

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

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.

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

In general there is no reason to assume that the different UCs are independent of each other. Therefore, all trend shocks and all cycle shocks – including that of the autonomous cycle – are allowed to correlate. The covariance matrix for the residual vector $u_t = \begin{pmatrix} \eta_{ot} & \cdots & \eta_{qt} & \varepsilon_{ot} & \cdots & \varepsilon_{qt} & \varepsilon_t^a & v_t \end{pmatrix}'$ is given in equation (6).

(6) $$E(u_t u_t') = \begin{pmatrix} \sigma_{\eta_0}^2 & \sigma_{\eta_0\eta_1} & \cdots & \sigma_{\eta_0\varepsilon^a} & 0 \\ \sigma_{\eta_0\eta_1} & \sigma_{\eta_1}^2 & & \vdots & \vdots \\ \vdots & & \ddots & \sigma_{\varepsilon_q\varepsilon^a} & 0 \\ \sigma_{\eta_0\varepsilon^a} & \cdots & \sigma_{\varepsilon_q\varepsilon^a} & \sigma_{\varepsilon^a}^2 & 0 \\ 0 & \cdots & 0 & 0 & \sigma_v^2 \end{pmatrix}$$

Correlated unobserved components models provide a flexible framework that avoids overly restrictive assumptions for the shocks. Thus, they allow for a wide range of results that could not be achieved by more restrictive procedures. As one example, in the UC literature a high negative correlation between trend and cycle shocks is frequently confirmed by the data (e. g. Morley et al. 2003). It can account for a sluggish adjustment process of the time series to permanent shocks. Further correlations could capture a complex interference of shocks on the Verdoorn coefficients at different GDP lags or between GDP-related and -unrelated shocks.

As Figure 1 suggested, the Great Recession seems extraordinary with regard to the drop in GDP as well as the modest reaction of the German labour market. In order to specify the model flexibly enough to account for this extraordinary development, we allow the variances of all trend and cycle shocks of the TVP to break during that period, i.e. in the four quarters of negative GDP growth from 2008Q2 until 2009Q1. Particularly, this enables changes in the components of a size that is preferred by the data. Even more flexibility is achieved if we allow for similar behaviour through all recessions. Thus, we include additional variance breaks in all economic downturns according to 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. This will be our preferred model; as a robustness check, we will limit ourselves to the one variance break during the Great Recession.

Although different trends and cycles of the TVP occur for each GDP lag, we suggest a summary in order to get an idea of the total impact of a GDP shock in a certain period. Concretely, we summarize all trends τ_{it}, cycles c_{it}, and complete coefficients

υ_{it} into one single trend $\tau_t = \sum_{i=0}^{q} \tau_{i,t+i}$, cycle $c_t = \sum_{i=0}^{q} c_{i,t+i}$, and Verdoorn coefficient $\upsilon_t = \sum_{i=0}^{q} \upsilon_{i,t+i}$. Thereby, the state value at time *t* reflects the total impact of a GDP growth shock at time *t*. It takes into account that the impact of this shock spreads out until *t+q*. The summarized states will be the endogenous variables in the second-step regressions that investigate economic explanations for the development of Verdoorn's law.

4 Technical issues

4.1 Identification

The challenge regarding identification is the need to recover multiple UCs from just one model equation. We begin with some intuition for why the specified model can be identified. In fact, all UCs can be uniquely determined: We distinguish the shocks to the Verdoorn coefficients by their persistence (permanent vs. transitory), the Verdoorn cycles from the autonomous cycle by the dependence on GDP of the former, and the autonomous cycle from the white noise shock by their autoregressive structure. Thus, all latent components have distinct characteristics.

Formally, we treat identification of our UC model by comparing the structural to the reduced form. Skipping the deterministic part for simplicity, the structural form of the model reads as follows:

$$(7)\quad e_t = \sum_{i=0}^{I} \frac{\mu_i}{1-L} y_{t-i} \quad + \quad \sum_{i=0}^{I} \frac{\eta_{it}}{1-L} y_{t-i} \quad + \quad \sum_{i=0}^{I} \frac{\varepsilon_{it}}{\Phi_i(L)} y_{t-i} \quad + \quad \frac{\varepsilon_t^a}{\Phi_a(L)} \quad + \quad v_t$$

Therein, $\Phi_i(L)$ (*i*=0,…,*q*) and $\Phi_a(L)$ give the lag polynomials of the stationary TVP components as well as the autonomous cycle.

Next we derive the reduced form. First, equation (7) is multiplied by all lag polynomials. Then, multiplying by *(*1-*L)* yields the first difference of employment growth on the left hand-side of the equation:

$$(8)\quad \begin{aligned} \prod_{i=0}^{q} \Phi_i(L) \cdot \Phi_a(L) \cdot \Delta e_t = & \sum_{i=0}^{q} \prod_{i=0}^{q} \Phi_i(L) \cdot \Phi_a(L) \mu_i y_{t-i} \\ & + \sum_{i=0}^{q} \prod_{i=0}^{q} \Phi_i(L) \cdot \Phi_a(L) \cdot \eta_{it} y_{t-i} \\ & + \sum_{i=0}^{q} \prod_{i^*=0, i^* \neq i}^{q} \Phi_{i^*}(L) \cdot \Phi_a(L) \cdot (1-L) \cdot \varepsilon_{it} y_{t-i} \\ & + \prod_{i=0}^{q} \Phi_i(L) \cdot (1-L) \cdot \varepsilon_t^a \quad + \quad \prod_{i=0}^{q} \Phi_i(L) \cdot \Phi_a(L) \cdot (1-L) \cdot v_t \end{aligned}$$

The right hand-side of equation 8 consists of several MA terms. Some of their stochastic shocks are multiplied by time-varying GDP growth. This leads to heteroscedastic shocks on employment defined as $\eta_{it,s} = \eta_{it} y_s$ and $\varepsilon_{it,s} = \varepsilon_{it} y_s$, which still have mean zero but non-constant conditional variances. I. e., a shock to the Verdoorn coefficient translates the stronger into employment, the larger current GDP changes. For identification, we can make use of an enriched set of information delivered by the heteroscedastic structure (see Weber 2011 for the use of heteroscedasticity as means of identification in a simultaneous UC model). The reduced form is finally obtained by applying Granger´s Lemma (Granger/Morris 1976): The linear combination of the different MA terms results in a new composite MA term with the maximum lag length of the single MA components $P = (q+1) \cdot 2 + p + 1$.

The autoregressive components as well as the drifts from the UC model can be gained directly from the reduced form, as can be seen from equation 8. The variances and covariances of the UC shocks must be recovered from the MA part, compare Morley et al. (2003). The heteroscedastic innovations on the RHS of equation 8 lead to time-varying autocovariances in the reduced form as well. Some information about the structure of this time variation is provided by the structural-form representation: The $(q+1) \cdot 2 + p + 2$ non-zero autocovariances consist of components that depend on either y_{t-j} or $y_{t-j-i} y_{t-j}$ (i=0,…,q and j=0,…,P+1) or do not depend on y_t at all. Thus, we gain many pieces of information out of one autocovariance instead of just one. Consequently, we obtain more identifying equations than unknowns have to be estimated (29 variances and covariances of the UC shocks). Furthermore, it can be shown numerically that the coefficient matrix from the equation system has full rank 29. Thus, the structural model is identified.

4.2 Estimation

For the purpose of model specification, we first estimate the employment equation 1 as a constant parameter OLS regression, e. g. as a regression of employment growth on 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). Moreover, we gain starting values for the TVP trends (the estimated constant Verdoorn coefficients) and the autoregressive coefficients of the autonomous cycle. 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. As usual, the starting values of the covariances and cycles are set to zero.

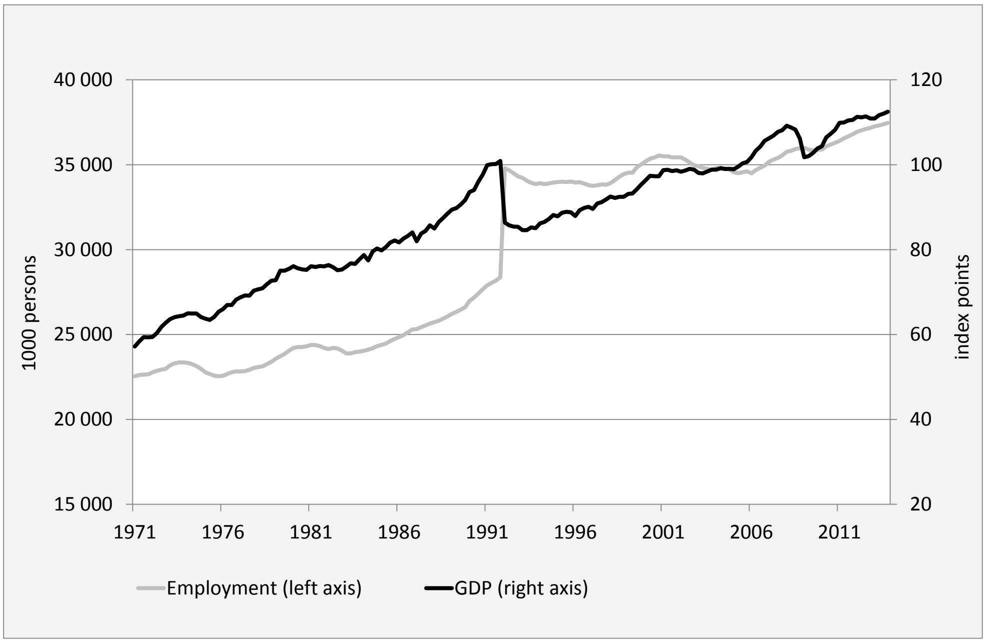
We cast the model into state space form and apply maximum likelihood via numerical optimisation to estimate the parameters. Thereby, the likelihood function is constructed using the prediction error decomposition from the Kalman filter.

4.3 Data

As far as the unobserved components model is concerned, we have very low data limitations. We use official seasonally adjusted growth rates of 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 unification occurs in 1992Q1 and is captured by a special 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.

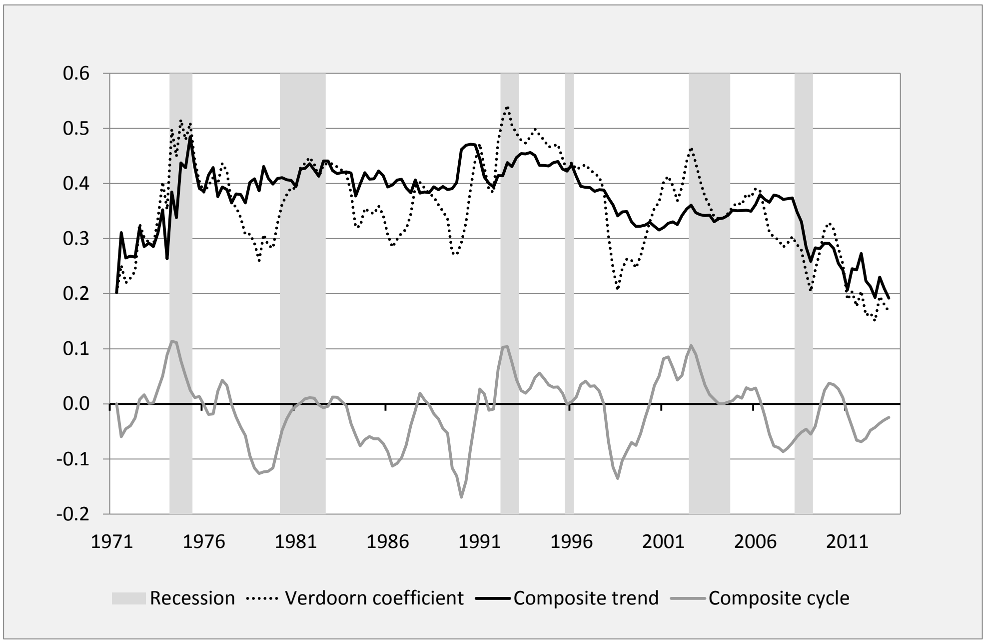
5 Results

5.1 Verdoorn's law and time variation

The estimated states of the TVP-UCs are given in Figure 3. The employment impact of GDP 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.

The cycle varies between -0.17 and +0.11; it is the main source of variation in the Verdoorn coefficient. It exhibits six pronounced peaks, corresponding to an average cycle length of about seven years. The sum of the autoregressive coefficients of each single cycle (compare equation 4: $\phi_{01} = 1.12;\ \phi_{02} = -0.47;\ \phi_{11} = 1.14;\ \phi_{12} = -0.32;\ \phi_{21} = 1.22;\ \phi_{22} = -0.49$) reveals that persistence. The composite cycle peaks often coincide with the beginning of a recession. In four of the six recessions, we find the cycle dropping towards zero which implies that the transitory impact of a contraction on employment decreases. In other words, during recessions, the GDP impact on employment approaches its trend from above. This summary also holds for the beginning of the 1980s. However, as the cycle evolves from a negative value, it rises during the first quarters of the recession and reaches its peak just then. The other outstanding case 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.

Figure 3
Composite Verdoorn coefficient and its unobserved components



Over the whole horizon, the cycle and GDP growth (smoothed by a third-order moving average) correlate at -0.21; until the Great Recession the correlation was -0.38. The (moderate) negative empirical correlation reveals that German firms adjust employment modestly stronger to recessions than to expansions. This result is in line with the studies on asymmetry in Okun´s law.

After a sharp increase around the time of the oil crisis, the trend in the Verdoorn coefficient kept a level of nearly 0.4 with slight fluctuations. The early 1990s saw a short increase[1]. Afterwards, the trend impact 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: trend impact of GDP dropped sharply such that the fall in GDP growth (-4.1 % in the first quarter of 2009) was hardly passed through to employment. The total Verdoorn coefficient reached its first all-time low at this moment. Interestingly, 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 reaction occurred, and the trend has not recovered ever since. Consequently, GDP impact has been at its lowest value for the whole period since the beginning of 2011, when the Eurozone recession started to unfold. Section 6 will uncover economic reasons for this development.

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. In fact, determinants beyond GDP must have gained importance in explaining the employment growth that occurred during the recent years. The estimated Verdoorn coefficients allow us to decompose predicted employment growth ($\hat{e}_t$) into four components (equation 9): Three of them are related to GDP growth – first, the normal or sample average state; second, the Verdoorn effect that arises from mean-deviations of υ_{it}; and third, the GDP effect evaluated at an average Verdoorn coefficient. Finally, the autonomous effect presents the employment growth component beyond GDP.

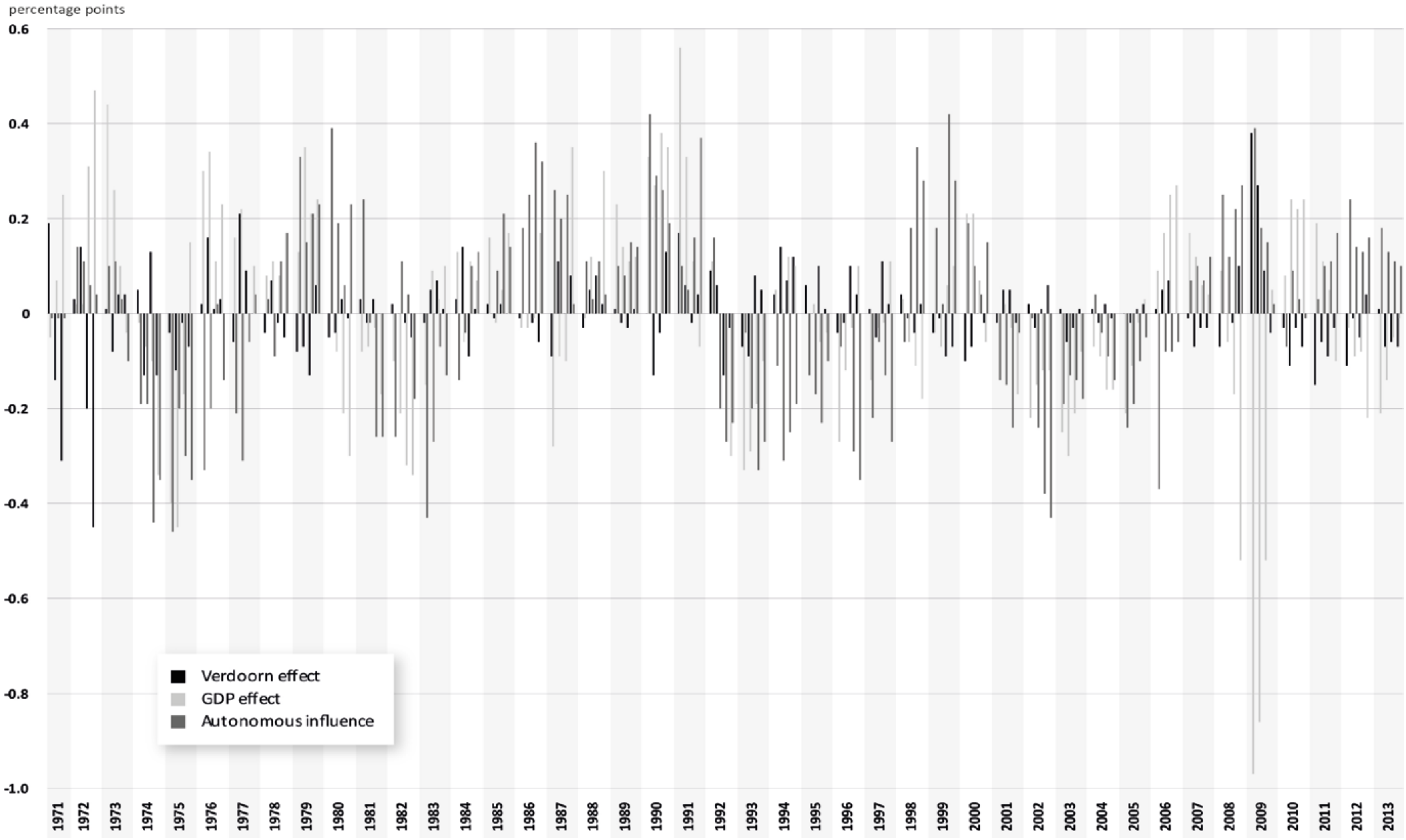
(9) $$\hat{e}_t = \sum_{i=0}^{I} \bar{\upsilon}_i \, \bar{y}_{t-i} \quad + \quad \sum_{i=0}^{I} (\upsilon_{it} - \bar{\upsilon}_i) y_{t-i} \quad + \quad \sum_{i=0}^{I} \bar{\upsilon}_i (y_{t-i} - \bar{y}_{t-i}) \quad + \quad (c_t^a + cons)$$

The average effect is estimated at 0.17 – if Verdoorn´s coefficient as well as GDP growth equal their sample means, employment will grow by 0.17 percent, other influences being zero. Empirically, however, these other influences were not zero; they are depicted in Figure 4.

The decomposition reveals pronounced cycles of the autonomous component as well as of the GDP effect. 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.

[1] 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.

Figure 4
Decomposition of GDP and non-GDP impact on employment growth



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 Verdoorn and the autonomous effects. Thus, the resilience of the German labour market during the Great Recession resulted from two factors. On the one hand, companies stopped translating GDP into employment decisions, i.e. they practiced typical labour hoarding. On the other hand, institutional and structural change, 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 increased.

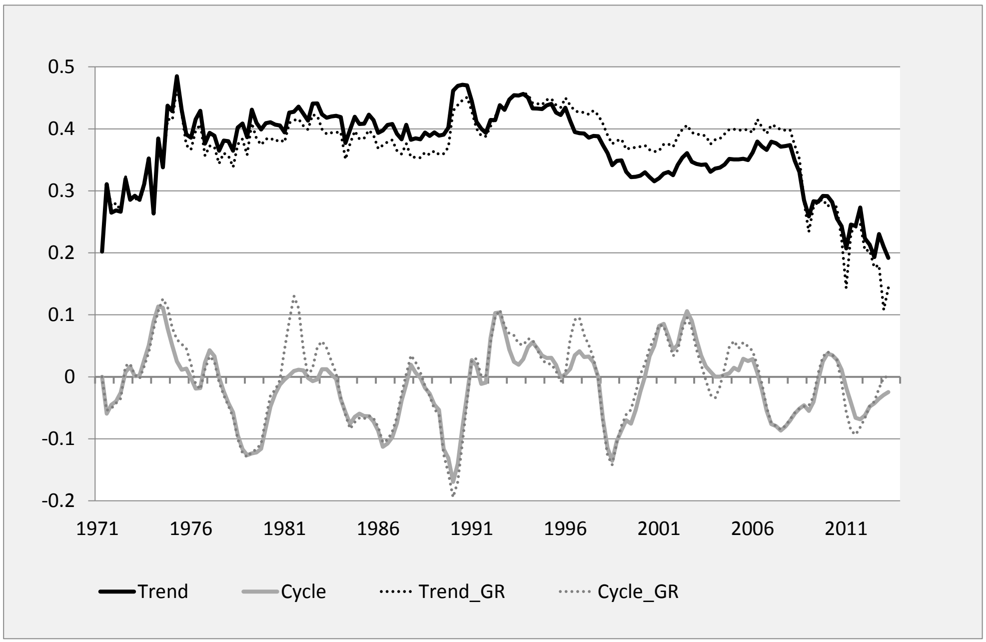
Even though the Verdoorn coefficient did not notably rise again, the recovery from the crisis should be classified not as jobless but as job-poor – the positive GDP effect is larger than the negative Verdoorn effect in 2010. In 2011 and 2012, during the Euro zone recession, employment kept on rising mostly because of autonomous effects. Thereby, the autonomous component is not larger than previously, but the positive correlation with the GDP effect is obviously interrupted. Thus, during the latest years, factors beyond GDP did not support but substituted GDP as a determinant of employment growth, at least in large parts. This is in line with Ng/Wright (2013) who state that the less procyclical productivity is, the more important must have been supply-side shocks for labour market variation. In our context, such shocks might have occurred from the highest immigration for the past two decades, from increasing labour participation of women and older workers as well as from increased matching efficiency after the Hartz reforms (e. g. Klinger/Weber 2014) and better competitiveness due to wage moderation and dispersion (Dustmann et al. 2014).

5.2 Robustness

As there are no comparable studies on time-varying Verdoorn´s law, robustness checks are especially important. First, 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 – the actual starting values were chosen from an OLS regression, see section 4.2 – any influence on its development.

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. Neither 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 only for variance breaks in the TVP trends and cycles during that time but not in the recessions before. Figure 5 shows that there are only minor differences with regard to the course of the trend and the cycle alike.

Figure 5
Comparison of TVP states with one or several shock variance breaks



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; it seems to be overdrawn. In contrast, our preferred specification already brings the trend line down at the beginning of the 1990s. After all, the Great Recession marks an outstanding event also in the context of Verdoorn´s law. 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.

6 Explaining time variation by economic indicators

In the second-step regressions, we seek to explain the development of the Verdoorn coefficient trend and cycle as well as the autonomous cycle. We start from the theoretical arguments given in section 2.

To capture economic heterogeneity, we control for shares of sectoral gross value added. This accounts for the fact that the link between aggregate employment and GDP might be altered if the structure of the economy changes. Perfect collinearity is avoided by skipping one sector (manufacturing).

Moreover, business expectations are included as prospective determinant of employment decisions. For instance, employers' reactions to a recession might be different depending on their expectations of the further course of the economy.

Labour market tightness as well as labour force potential can be viewed as measures of labour availability or shortage. The role of labour supply is not exactly straightforward. An increase in labour supply by migration, for example, shifts the supply curve outwards and creates additional employment. In this respect, it is likely to be found in the autonomous component of employment growth. Beyond this, however, the same increase in labour supply could affect the GDP impact on employment if it leads to a change in the wage-elasticity of labour supply; in other words, if the shock on labour supply does not only shift but also rotate the supply curve. Then, wage increases could lead to a relatively strong enlargement of the labour force. Such a scenario is plausible in Germany as during the past few years net migration balance was substantial. At the same time, wage moderation that had lasted for years came to a preliminary end. Thus, it seems promising to include labour supply not only into the autonomous cycle but into trend and cycle of GDP impact as well.

Other variables relevant for employment are wages as well as working time. An increase in these variables is expected to reduce the autonomous component as wages make labour more expensive and working time is a substitute for employment to satisfy the demand for a certain volume of work.

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. Moreover, a second vector z_t equals x_t with business expectations excluded (as the autonomous cycle does not include any GDP-related influence) and wages as well as working time included. Nonstationary series in the trend equation establish a cointegration relation. In the cycle equations, by contrast, nonstationary series were differenced.

As described above, a large Verdoorn coefficient may mean high employment growth or high employment losses depending on the sign of GDP growth. Therefore, we also allow the explanatory variables to have different impact on the trend and cycle of Verdoorn´s coefficient (equations 10 and 11) depending on the sign of GDP growth.

Beyond intercept and trend, we formulate the second-step regression models as

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

(11) $c_t = \lambda' \Delta x_t D_t^n + \lambda^{*\prime} \Delta x_t (1 - D_t^n) + \omega_t^c$ (no differences for expectations, tightness, and trend-stationary labour force potential)

(12) $c_t^a = \pi' \Delta z_t + \omega_t^{c^a}$ (no differences for tightness)

κ, λ and π denote the respective parameter vectors. ω_t^i are white noise error terms.

The dummy variable *D* is set to 1 for negative GDP growth rates.

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

The parameters can be estimated by OLS. Data availability, however, led us to the rather parsimonious model and is also limited regarding the length of the time series. We, thus, run these regressions from 1992 onwards which also circumvents a special treatment of German reunification. The data stem from different sources: Series on gross value added as well as wages (total labour costs including contributions to social security) are provided by the Federal Statistical Office. 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. Tightness is calculated as registered vacancies over registered unemployed, both published by the Federal Employment Agency. Labour force is a business-cycle independent measure of potential labour supply under the assumption of full employment. As it is calculated by IAB (Institute for Employment Research) just yearly, we linearly interpolate for quarters. IAB also publishes hours per worker.

The results for the TVP second-step regressions are given in Table 2. Regarding the long-run component of the coefficient, hardly any parameter changes sign with respect to GDP increasing or declining. 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. By contrast, the TVP cycle does adjust to GDP growth changing its sign.

First, with respect to changes of the sectoral composition of the economy we find that a persistent increase in the importance of the service sector (compared to manufacturing) by 1 percentage point in gross value added leads to a permanently lower GDP impact on employment 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 larger employment intensity of GDP growth (by 0.04) which is temporarily offset during economic expansions.

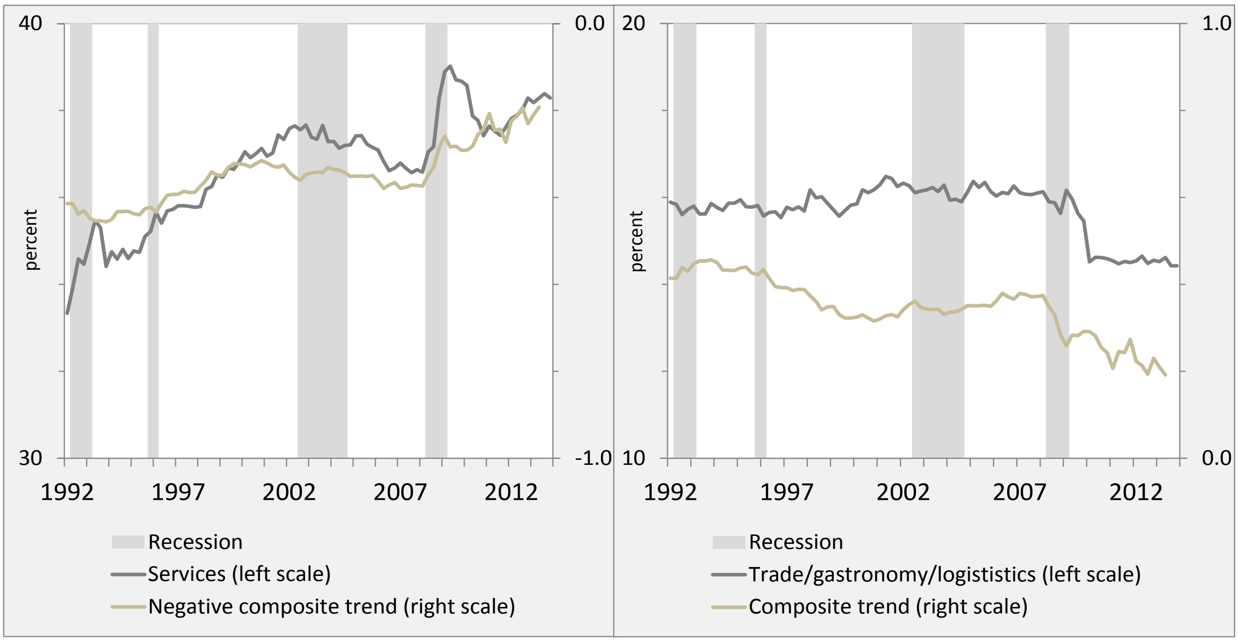
Figure 6 underlines the crucial role of structural change. Employment volatility has always been stronger in industrial sectors. With the rise of the service economy, consequently, the GDP-employment relationship has become looser. This development was especially pronounced in the 1990s (compare Bachmann/Burda 2010 on the decisive role of sectoral change for the German labour market at that time) and during the Great Recession. Furthermore, the share of the trade/gastronomy/logistics sector did not recover from the crisis – which seems to be one reason behind the drop in the TVP trend. Obviously, while in Germany the Great Recession was quickly overcome, it left an imprint in the structure of the economy.

Table 2
OLS regressions for the time-varying Verdoorn coefficient

		trend		cycle	
explanatory variables[1)]	GDP growth	coefficient	p-value	coefficient	p-value
constant		1.0897	0.340	0.0705	0.638
deterministic trend		-0.0008	0.484	-0.0006	0.093
share in gross value added: agriculture / forestry	> 0	**-0.1177**	0.001	-0.0228	0.799
	< 0	0.0540	0.229	0.3374	0.203
share in gross value added: construction	> 0	-0.0005	0.955	-0.0539	0.251
	< 0	-0.0124	0.342	**0.2047**	0.042
share in gross value added: trade / gastronomy / logistics	> 0	**0.0378**	0.030	**-0.0441**	0.029
	< 0	0.0198	0.223	0.0224	0.741
share in gross value added: financial services / insurances	> 0	0.0099	0.418	0.0185	0.343
	< 0	0.0127	0.173	-0.0692	0.124
share in gross value added: service sectors	> 0	**-0.0372**	0.000	**-0.0844**	0.003
	< 0	**-0.0470**	0.000	0.0226	0.525
ifo business expectations	> 0	-0.0007	0.293	-0.0004	0.812
	< 0	**-0.0019**	0.002	0.0005	0.755
tightness	> 0	-0.3154	0.191	-0.2141	0.353
	< 0	-0.2511	0.455	**-0.7362**	0.041
labour force potential	> 0	4.34E-06	0.862	**0.0003**	0.031
	< 0	1.79E-05	0.525	**0.0003**	0.042
R^2		0.9308		0.4009	

[1)] nonstationary variables differenced for cycle regression.
print in bold: significant at the 5 % level.

Figure 6
Trend of Verdoorn´s coefficient and the shares of gross value added of services as well as trade/gastronomy/logistics



Source: Federal Statistical Office, own calculation and estimation.

As a further finding with respect to sectors, if a recession comes through a decline in construction, Verdoorn´s coefficient will rise and induce more dismissals. Construction and services also prove relevant for employment growth independently of GDP: The shares of these two sectors positively affect the autonomous component by 0.28 and 0.10 (see Table 3) – a strong effect given the range of the autonomous component between -0.45 and +0.43. Evidently, construction and services are more relevant for autonomous employment growth than manufacturing, the left-away category.

Table 3
OLS regression of autonomous employment cycle

explanatory variables[1]		coefficient	p-value
constant		**-10.6929**	0.037
deterministic trend		-0.0034	0.328
gross value added	agriculture / forestry	0.1274	0.649
gross value added	construction	**0.2803**	0.002
gross value added	trade / gastronomy / logistics	-0.0253	0.739
gross value added	financial services / insurances	-0.0146	0.833
gross value added	service sectors	**0.0981**	0.038
average working time		**-0.0415**	0.000
wage costs per hour		**-0.3660**	0.002
tightness		**3.2124**	0.001
labour force potential		**0.0002**	0.049
R^2		0.5519	

[1] nonstationary variables differenced for cycle regression.
print in bold: significant at the 5 % level.

Second, higher business expectations reduce the permanent component of the impact of GDP on employment when GDP growth turns out to be negative: A unit increase in the expectations index leads to a reduction of the negative GDP impact by 0.002 – a relatively small number. In this sense, the better (respectively, less pessimistic) expectations are, the less employees will be dismissed. For positive growth rates, the effect is not significant, just as within the cycle regression.

Third, the coefficient of tightness suggests that labour hoarding due to a (comparatively) tight labour market and potential labour shortage appears as a temporary adjustment strategy to declining GDP (negative and significant in the cycle regression). Regarding the trend regression, tightness is not significant, especially not during downturns. Thus, it is not the factor to determine the pronounced decrease of GDP impact in the Great Recession (compare Klinger et al. 2011). However, tightness strongly affects 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. This means that a tight labour market prompts companies to increase hiring activities independently from GDP growth. 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 is immediately available to be utilised more intensively. Indeed, part of the recent employment upswing, which even survived periods of weak economic growth, could be explained by the effect of a relatively high tightness in the German labour market.

Fourth, a rich labour supply enlarges the cyclical part of GDP impact on employment during both upswings and downturns. Presumably, companies are more willing to exploit positive GDP growth in terms of employment but also to 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) raises the employment intensity of GDP growth 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 – raises the autonomous employment growth rate. Thus, recent employment growth would not have been possible if extraordinary high immigration as well as rising labour participation had not increased labour supply.

Fifth, a decrease in differenced quarterly working hours per employee by 1 hour – about 30 percent more than the average change – has a positive effect on autonomous employment growth by 0.04 percentage points. This result confirms that employment and working hours are substitutes in satisfying labour demand, indeed.

Finally, labour costs have a significant negative influence on the autonomous cycle as well. Quantitatively, an increase in differenced gross wages including social contributions per hour by 1 Euro (empirically, the average is one tenth of this) reduces employment growth by 0.37 percentage points. Thus, the wage moderation in the last decade is likely to have supported employment growth independently of GDP.

7 Summary and conclusions

Labour productivity per capita used to rise steadily in Germany. However, it fell more or less heavily during some economic downturns, among them the Great Recession in 2008/09 and the Eurozone recession 2011 to 2013. Thus, over time, firms translate GDP growth differently into employment decisions and Verdoorn´s law – which states a linear relationship between the two – appears not to be stable.

This study contributes to a more flexible modelling of time variation in macroeconomic relationships. In particular, it provides deeper insights into the time variation and persistence of the GDP-employment relation. Thereby, it takes into account that structural as well as cyclical reasons may cause that parameter instability. We employ an unobserved components model to disentangle the employment intensity of GDP growth into a stochastic trend – the permanent component – and a transitory cycle. Beyond GDP-dependence, we consider effects of a further autonomous component of employment growth.

Our main results can be summarized as follows: First, both GDP as well as factors unrelated to real output are important sources of variation in employment growth, with GDP losing ground. Second, time variation in the Verdoorn coefficient has pronounced effects on the labour market in certain episodes. Most prominently, the GDP elasticity of employment dramatically fell in the Great Recession. Since – interestingly enough – this reduction was caused by the coefficient's permanent component, the elasticity still remains at historical lows. GDP and employment growth have decoupled to some extent. Third, besides that period, cyclical variation in Verdoorn's law plays an important role. On average, employment adjusts somehow stronger to recessions than to expansions. Fourth, the development of the time-varying parameters crucially depends on structural change and also on labour availability and business expectations. Beyond structural change, working time, wages and tightness determine employment growth independently from GDP.

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 cyclical and structural change.

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