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Evidence from a Long Panel of Regional-Government Liabilities

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Timo Mitze and Florian Matz[1]

It's the Debt-Growth Nexus Again – Evidence from a Long Panel of Regional-Government Liabilities

Abstract

In this paper, we study the long- and short-run relationship between regional public debt and economic performance for a sample of German federal states over the period of four decades (1970-2010). By choosing a sample of regional entities with comparable institutional settings, we complement the large literature on the debt-growth nexus based on heterogeneous cross-country samples. We estimate a dynamic error correction model that accounts for slope heterogeneity among cross-sections and the presence of unobserved common factors. While – in line with the Keynesian view – our findings hint at a non-linear inverted U-shape relationship between changes in the public debt intensity and economic growth in the short-run, we get strong statistical evidence for linear negative relationship between regional public depth and per capita GDP in the long-run. By means of a simple though experiment, we show that these negative long-run effects are not negligible for the size of interregional differences in per capita GDP levels and are in line with most international evidence on the detrimental growth effects of high public debt levels. Finally, these results also underline the need for effective fiscal rules at the federal state level in Germany.

JEL Classification: C23, R11, R50, E62

Keywords: Government debt; economic growth; German states; panel data; unobserved common factors

March 2013

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1 Timo Mitze, University of Southern Denmark, RWI, and RCEA; Florian Matz, RWI. *– The authors acknowledge valuable comments from Torben Dall Schmidt and Christoph M. Schmidt. We are also grateful to Markus Eberhardt for helpful comments on the implementation of common correlated effects estimators in STATA.* *– All correspondence to Timo Mitze, University of Southern Denmark, Alsion 2, 6400 Sønderborg, Denmark, E-Mail: tmitze@sam.sdu.dk.*

1. Introduction

In times of crises, the role of public expenditures and government debt as driver of economic growth shows to be ambivalent. One the one hand, many countries fell back on an expansive public finance activity to combat the global crises in the short-run, when first signs of a global recession had started to crystallize (see IMF, 2010). From the perspective of economic theory, such as response of public finance is perfectly in line with a Keynesian view of public expenditures as an instrument to boost aggregate demand for goods and services and therefore foster economic growth (Elmendorf and Mankiw, 1999). Opposed to this Keynesian short-run perspective, on the other hand however, mainstream theory argues that high levels of public expenditure – and associated public indebtedness levels – are likely to crowd-out private investment and thus reduce economic growth in the long-run through a decline in the private capital stock (see Modigliani, 1961).

Another potentially hampering effect of debt on economic growth – which has recently been affirmed by the public debt crisis in Greece and further Eurozone countries – stems from the rising interweavement of governments and financial markets. As the recent financial and economic crisis had led governments to increase public expenditures, at the same time financial markets started to worry about the sustainability of public debts. This uncertainty has put a strong upward pressure on loan interest rates, scaled down private investment activity and thus exacerbated the economic slowdown in the global recession even further.

Consequently, the renewed increase of public expenditures throughout the global crises has fuelled the interest of economists to (re-)assess the public debt-growth nexus on empirical grounds. Some of these studies even try to establish a rule-of-thumb for policy conclusion with respect to the maximum level a country's public debt-to-GDP ratio up to which indebtedness may still be beneficial to economic growth and from which on it hampers growth instead. A seminal contribution in this respect is the extensive work of Reinhart and Rogoff (2010) based on a large international debt database (1790-2009), which is able to demonstrate two facts: [2] First, the overall relationship between a country's debt to GDP ratio and its growth performance is rather weak albeit negative. Second, by comparing growth rates in countries with low (above 30%) and high (above 90%) debt to GDP levels, the authors show that high debt levels are associated with notably lower growth outcomes compared to countries with low debt levels.

In fact, these results correspond with most other empirical analyses on this subject. Kumar and Woo (2010), using a panel of advanced and emerging economies over the period 1970-2007, find a negative relationship between initial debt and subsequent growth, where a 10 percentage point increase in the initial

[2] Altogether, the authors' work comprises a series of publications and books on this issue. See also, Reinhart and Rogoff (2009a, 2009b, 2011).

debt-to-GDP ratio slows down the annual real capital growth rate by 0.2 percentage points per year. Afonso and Jalles (2013) find a quantitatively similar negative relationship for a panel of 155 countries over the period 1970-2008. For the Euro area, Checherita and Rother (2010) report a non-linear relationship between debt and growth. Their estimated inverted U-shaped function indicates that a low debt-to-GDP ratio is helpful for GDP growth, but turns out to be negative as soon as a threshold of 90-100% is exceeded. Finally, Saint-Paul (1992) and Aizenman et al. (2007) also find a negative influence of the level of public debt on GDP growth when using endogenous growth model applications.

Although these findings thus seem to be quite robust across different datasets and estimation methods, they are not without academic critique though. In a fundamental critique that Germany's largest business newspaper *Handelsblatt* recently labeled as the "Clash of scholars over public debt", Nobel laureate Reinhard Selten and his co-author Robin Pope have argued that all such cross-country based tipping point studies face inter alia some severe biases (see Pope and Selten, 2012).[3] First of all, they ignore exchange rate movements or – more precisely – damages from exchange rate liquidity shocks as a single influential factor of economic growth across countries. Moreover, according to Pope and Selten (2012), most empirical studies do not distinguish high debt-to-GDP ratios that are due to excessive expenditures from those that result from a shortfall in revenues, as, for instance, it has been the case in the current Greek-Euro-crisis. In other words, similar institutional settings should be compared to each other in order to isolate the causal impact of public debt on economic growth.

2. Research Design and Data Issues

Accounting for the crucial points raised by Pope and Selten (2012), in this contribution we analyze the relationship between public regional debt levels and GDP growth for a sample of West German Federal states (*Länder*) in the time period 1970 – 2010. By using data for regional public finance within one national economy over a long time period, we seek to avoid the unsolved problem of heterogeneous growth measures due to alternative exchange rates patterns or institutional settings. Hence, our results may serve as a robustness check with regard to the identified role of government debt on economic growth in the previous studies based on cross-national data.

Moreover, we also augment the earlier empirical literature in a methodological dimension. While in the aforementioned studies economic growth is typically regressed on a proxy for the public debt intensity in a rather ad-hoc manner (see,

[3] See Handelsblatt, March 14th 2012, p. 16: "Gelehrten-Streit um die Staatsschuld" by Norbert Häring and Dirk Heilmann.

for instance, Checherita and Rother, 2010), no explicit account of the alternative short- and long-run dynamics is given – both with respect to the theoretical considerations mentioned above as well as the underlying time-series properties of the variables under study. Particularly the latter aspect may yield biased parameter estimates if the economic growth and the public debt intensity are not integrated of the same order. While economic growth is typically found to be a stationary process, in the case of the public debt intensity this is a priori not that clear given that the latter variable has grown considerably in recent years (and mostly stronger compared to the fundamental economic development, e.g., GDP per capita). Throughout the remainder of this study, we thus put a particular focus on investigating the order of integration of the underlying variables and their potential cointegration behavior.

To do so, we use panel data for 10 West German Federal states covering a long time period of 40 years (1970 – 2010). GDP per capita and its annual growth rate are the main outcome variables of interest as they serve as general measures for regional economic performance and well-being. To explain the evolution of per capita GDP (growth) over time, we employ the following set of explanatory variables in a dynamic production function approach: The debt-to-GDP ratio defined as percentage share of regional public debt in regional GDP and its squared value to check for non-linear impacts as highlighted in tipping point studies. Debt levels cover all public liabilities of German states borrowed at financial markets.[4]

Further, we use (log) capital and (log) labor as standard input factors in a stylized production function as well as trade and FDI openness in order to expand the model beyond a closed-economy form.[5] Trade openness is defined as the share of exports and imports in regional GDP, while FDI openness is the share of in- and outward FDI in regional GDP. Finally, to account for region specific time paths of industrial restructuring and structural change over time, we include sectoral shares of agricultural and manufacturing employment in total employment. A description of the data is given in Table 1. A graphical presentation of the debt intensities by German states is given in Figure 1. The graph shows that all states have increased their debt intensities over time. Moreover, we can observe a strong interregional heterogeneity in this evolution.

<< Table 1 about here >>

<< Figure 1 about here >>

[4] As a sensitivity check, financial market liabilities of municipalities in each state have been added to state level debt stocks. The empirical results remain unchanged.

[5] In the empirical model we include investment flows rather than regional capital stocks, which can be motivated by Fisher's (1930) theory of investment assuming that all capital is used up in the production process.

3. Econometric Specification

Since we have panel data with a long time dimension (T=40), the variables are likely to be non-stationary. To analyze this more precisely, we compute a set of panel unit root tests proposed by Breitung (2000) and Breitung and Das (2005), which are robust to cross-sectional correlation among states. The empirical results indicate that all variables are integrated of order $I(1)$ and are stationary for transformations into first differences. The test results for the panel unit root tests are shown in Table 1. The estimation of $I(1)$-variables has a long tradition in time-series modelling and has recently been adapted to panel data econometrics (see, e.g., Hamilton, 1994, Baltagi, 2008). As vehicle for our empirical analysis we thus conduct a two-step cointegration analysis in the spirit of Engle and Granger (1987). The long-run equation is thereby supposed to exhibit the following general form

$$(1) \qquad Y_{i,t} = \alpha_i + \beta_i{}'\mathbf{X}_{i,t} + u_{i,t} \quad \text{with} \quad u_{i,t} = \mathbf{f}_t + e_{i,t},$$

where Y_{it} is the dependent variable of the model for $i=1,2,\ldots,N$ cross-sections, $t=1,2,\ldots,T$ is the time dimension of the model. $\mathbf{X}_{i,t}$ is the vector of exogenous control variables; α_i denote cross-sectional fixed effects, β_i is a vector of (potentially heterogeneous, that is, for each cross-sectional unit individually estimated) slope coefficients and u_{it} is the model's residual term. That latter can be further split into a vector of non-stationary unobserved common shocks ($\mathbf{f}_t$) and a remainder *i.i.d.* error term ($e_{i,t}$). Both Y and $\mathbf{X}$ are assumed to be time-integrated of order $Y \sim I(1)$ and $\mathbf{X} \sim I(1)$. If $\mathbf{X}$ and Y are co-integrated, the error term u should be stationary as $u \sim I(0)$. We will test the residual term for this property throughout the empirical exercise.

As pointed out in the seminal work of Engle and Granger (1987), cointegration and error correction are mirror images of each other. We thus move from the long-run specification in eq.(1) to a dynamic specification in first differences, which nevertheless preserves the information of the variables in levels. The resulting error correction model (ECM) describes the dynamic process through which cointegrated variables are driven in the adjustment process to their long-run equilibrium. The dynamic specification can be stated as

$$(2) \qquad \Delta Y_{i,t} = \gamma_{0i} + \gamma_1 \Delta Y_{i,t-1} + \gamma_2 \Delta \mathbf{X}_{i,t-1} + \gamma_3 ec_{i,t-1} + \varepsilon_{i,t},$$

where Δ is the time series operator for transformation of variables into growth rates, $\varepsilon_{i,t}$ is the *i.i.d.* residual term of the short-run equation and $ec_{i,t-1}$ is the error correction terms that is computed as the one period lagged residual from eq.(1).

As argued above, the latter variable is stationary for the case of cointegrated long-run values of the variables and drives the system to its long-run equilibrium state if $ec_{i,t-1} < 0$ holds true.

To estimate eq.(1) and eq.(2), different econometric estimators are at the researcher's disposal. We apply pooled OLS (with panel corrected standard errors), fixed effects (FE) estimation as well as the dynamic OLS (DOLS) approach for cointegrated panel data as proposed by Kao and Chiang (2000), Mark and Sul (2003). While the above estimators impose homogenous slope coefficients over cross-sections, we also apply Pesaran's (2006) common correlated effects pooled (CCEP) and mean group estimators (CCEMG). Both estimators are consistent under cross-sectional dependence in the presence of unobserved common factors.

In empirical terms, the unobserved common factor structure is proxied by the inclusion of cross-sectional averages of the dependent and independent variables $(\overline{Y}_t, \overline{\mathbf{X}}_t)$ in the regression setup. Although these extra regressors cannot be interpreted in a meaningful way, they serve to consistently estimate the model parameters in the presence of unobserved common determinants for the sample of German regions (e.g. common global shocks) as well as interregional spillover effects. As an indicator for remaining cross-sectional dependence in the residuals we use the CD-Test proposed by Pesaran (2004).

Moreover, by means of a Hausman test for CCEP versus CCEMG we are able to check if parameter heterogeneity in the slope coefficients (β_i) matters. In this case that output responses vary over cross-sections, only the CCEMG estimation is consistent and – assuming a random coefficient model with $\beta_i = \beta + \eta_i$, where $\eta_i \sim i.i.d.(0, V_\beta)$ – general inference can be done by averaging the individual β_i estimates according to

$$\beta_{CCEMG} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_i . \quad (3)$$

4. Empirical Results[6]

Table 2 presents the empirical results for per capita GDP (in logs) according to eq.(1).[7] While estimators imposing slope homogeneity (FEM, PSCE and DOLS) basically find a positive and statistically significant coefficient for the debt

[6] All estimations have been done with STATA. For the DOLS estimator we have applied the user-written "xtdolshm"-routine by Diallo (2010). Empirical applications of the common correlated effects estimators are based on the user-written "xtmg"-routine by Eberhardt (2011).

[7] In line with most empirical production function models, GFCF enters as one-period lagged value to account for the *ex-ante* capital installation decision in each period yielding an estimation sample from 1971-2010 (Total number of observations = 390).

intensity as well as a negative one for its squared level (thus, an inverted U-shaped relationship), the CCEP model contrariwise reports some evidence for a U-shaped relationship between the variables. Finally, the CCEMG approach reveals a statistically significant negative, linear relationship between public debt and the per capita GDP. Given these conflicting predictions, the question is then, which estimation output is the most reliable? In order to judge upon the validity of these alternative predictions, we use two post-estimation tests in order to judge among the validity of the estimated parameters. In terms of a Kao (1997) type residual based test for cointegration to avoid the problem of a spurious regression, only for the DOLS, CCEP and CCEMG specifications we can reject the null hypothesis of no cointegration at reasonable confidence levels (5%).

Moreover, for all estimators that impose slope homogeneity among German states, we find a statistically significant cross-sectional correlation in the residuals when applying Pesaran's (2004) cross-sectional dependence (CD) test. This finding strongly hints at the need to apply estimators which are able to control for common unobserved factors that jointly influence the variables' time-specific evolution for the different German regions. While for both the CCEP and CCEMG estimators the test statistic is substantially reduced as shown in Table 2, only for the CCEMG estimator the null hypothesis of cross-sectional independence in the residuals can be rejected at the 1% confidence level. Moreover, if we finally compare the consistency and efficiency of pooled versus the mean group estimation, a Hausman test clear rejects the null hypothesis of consistent estimation results for the slope coefficients in the pooled CCEP regression approach. Thus, all in all, the long-run regression results favor the use of the CCEMG estimator as most appropriate estimation technique for cointegrated variables that are correlated among cross-sections. And, as outlined above, the latter estimator predicts a linear negative relationship between the regional public debt intensity and the evolution of per capita GDP, which is in line with the mainstream "crowding-out" theory of public debt.

The importance to control for unobserved common factors and allow for cross-sectional heterogeneity in the slope parameters is also reflected in the estimation output of the remaining regressors in the long-run equation. That is, while the homogeneous slope estimators find a positive long-run correlation of trade- and FDI-intensities with regional GDP per capita, in the CCEMG these variables are found to be statistically insignificant once we control for unobserved common factors such as global trade and FDI-expansion. The same holds for the sectoral employment share variables as proxies for the long-run influences of sectoral structural change on output evolution for German regions.

<< Table 2 about here >>

If we then focus on the CCEMG estimates for the dynamic short-run ECM-specification according to eq.(2), the empirical results in the last column of Table 3 reveal a non-linear, inverted U-shaped relationship between per capita GDP growth and changes in the debt intensity in turn.[8] This result coincides with most other studies that look at the short-run relationship between public debt and economic growth by calculating so-called “tipping points” as explicit threshold values from which on increasing debt accumulation turns from a growth supporting into a growth hampering factor. However, by combining the short- and long-run estimates our approach can even tell a richer story.

To do so, we insert the parameter estimates for the CCEMG from the long-run equation according to eq.(1) into the short-run models as in eq.(2) and calculate dynamic interim and cumulative long-run multipliers to visualize the impact of a change in the debt intensity on GDPpc growth and levels. The resulting multipliers are shown in Figure 2. The figure shows for the dynamic interim multiplier that in the first period after a permanent 1% increase in the debt intensity, GDPpc growth is boosted by approximately 0.02%. This immediate positive reaction of economic growth rises from the parameter estimates of the short-run equation, which are positive up to a threshold value of 46% (which is clearly within the in-sample range of our data). The estimated size of the immediate output response to an increase in the public debt intensity is in line with earlier findings such as Kumar and Woo (2010) as outlined above.

However, the increase in the debt intensity also disrupts the long-run equilibrium relationship between these variables. Thus, after the positive short-run effect has been absorbed by the system, the negative long-run correction effect comes into force. Given that the speed of adjustment is estimated to be around 12% per year as indicated by the coefficient of the error correction term in the short-run, it takes about 15 years until the new equilibrium is reached. This new equilibrium from a 1% increase in the public debt intensity is marked by a -0.018% lower GDPpc level as indicated by the estimated coefficient in the long-run equation and graphically shown by the time path of the cumulative long-run multiplier in Figure 2, which basically sums up over time the effects of the dynamic interim multiplier.

<< Table 3 about here >>

<< Figure 2 about here >>

[8] The existence of an inverted U-shaped relationship between changes in the debt-to-GDP ratio and per capital GDP growth is also supported by the other estimators, where only the FEM and DOLS results are found to statistically significant.

Taken together, the short-run results indicate that new indebtedness can spur economic growth temporary to some extent if the debt increase does not become too large. The negative coefficient for the error correction term in Table 3 indicates that the system is driven to its long-run cointegration path.[9] In the long-run, however, the debt burden is always negatively correlated with the regional income level. To check the robustness of this result, we also estimate a dynamic employment regression to seek whether similar threshold effects can be also observed for the creation of new jobs as further important target variable of policy making. As the long-run and ECM-based regression results in Table 4 nevertheless show, there is virtually no direct correlation between the debt-to-GDP ratio and employment both in the long- as well as short-run. However, since employment (growth) is positively correlated with GDP per capita (growth), there is an indirect transmission channel from the debt-to-GDP ratio on the regional evolution of employment.

<< Table 4 about here >>

5. Conclusion

In this paper, we have conducted a further analysis of the debt-growth-nexus. Using regional government and economic data for West German states over a long period of time from the 1970s up to 2010, we thereby extend the large cross-country evidence on impacts of government debt on economic growth. Focusing on the regional variation of debt intensities over time within one nation state, we are able to account for some of the points raised in a critical appraisal of this strand of the literature by Pope and Selten (2010), who argue that cross-country studies may suffer a severe estimation bias due to uncontrolled effects from exchange rate liquidity shocks as well as alternative sources of public indebtedness - as either a shortfall in revenues or excessive. Moreover, we depart from earlier empirical studies by using a combined long- and short-run modelling specification, which allows us to analyse the short- and long-run reaction of economic growth with respect to public indebtedness more carefully.

Our findings indicate that, in the short-run, new indebtedness can spur economic growth temporary to some extent if the debt increase does not become too large. The estimated inverted U-shaped relationship between changes in the debt intensity and the GDPpc growth rate underlines theoretical predictions from the Keynesian school and is in line with most empirical studies, which also find non-

[9] The size difference in the coefficient of the error correction term among estimators is due to its alternative information content according to eq.(1) and eq.(3), which restricts cross-estimator comparisons to a qualitative interpretation of the coefficient sign and its statistical significance.

linear output effects. However, in the latter studies an in-depth analysis of long-run effects is typically missing. Here our results confirm a hampering effect of public debt on per capita GDP. Our results show that a 1% increase in the debt-intensity lowers the long-run per capita GDP level by -0.018%. To see whether this effect is small or large, we can conduct a simple numerical example. In 2010, the difference between the state with the highest (Bremen, 63.3%) and lowest debt intensity (Baden Wurttemberg, 6.5%) was about 56.8 percentage points. If the highly indebted state would now be able to reduce its debt intensity by this amount, it would experience a roughly 1% increase in per capita GDP or approximate 3.300 €, which is one half of the standard deviation in German regional per capita income levels for this sample year.

All in all, the negative effect of public indebtedness on the regional income distribution on Germany is thus not negligible. Given that regional governments increasingly turn out to be the subject of credit ratings,[10] our results advocate the very careful use of public debt (if at all) as a policy instrument in order to boost (regional) economic development. The recent announcement that the German federal and state level governments will jointly issue so-called "Huckepack" (piggyback) bonds as a coordinated bond market strategy may be seen as one step into the right direction in order to bring down the borrowing costs of German states. As earlier empirical evidence on the German state level bond market has shown, issuing joint bonds with other states (Jumbos) has proven to significantly lower average spread rates compared to individual bond emission strategies (see Schulz and Wolff, 2008). Thus, future borrowing costs may be reduced by this coordinated policy action, helping to drive down new indebtedness.

The latter reduction, however, can only be achieved if the new "debt brake" for German federal state budgets, which has been introduced in 2009, is able to effectively constrain the build-up up of new public debt for the federal and the state level. In a recent assessment of the debt brake by Ciaglia and Heinemann (2012), the authors still found a considerable heterogeneity of budgetary rules across German states in spite of the existence of the overall federal constitutional rule. Particularly some of the highly indebted states were found to miss the opportunity of using their own legislation to make their fiscal regime more credible. In the light of the findings from this paper, thus more coordinated efforts should be undertaken to establish binding fiscal rules at the federal state level in Germany.

[10] For our sample of German states, 5 out of 10 states (namely Baden Wuerttemberg, Bavaria, Hesse, North Rhine-Westphalia and Schleswig-Holstein) are currently rated by at least one of the three global rating agencies (Moody's, S&P and Fitch).

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Table 1:
Data description and panel unit root tests for sample period 1970-2010

Variable	Description	Source	Mean	Std. Dev.	λ_{Level}	(*P*-Val.)	λ_{FD}	(*P*-Val.)
$GDPPC_{i,t}$	(Log) regional per capita GDP (in €, in real terms)	VGRdL (2012), Regional Accounts for German states	2.494	0.976	1.16	(0.87)	-2.12	(0.00)
$GFCF_{i,t}$	(Log) regional gross fixed capital formation (in Mio. €)	VGRdL (2012)	9.549	1.212	-0.26	(0.39)	-9.43	(0.00)
$Labor_{i,t}$	(Log) regional employment (in 1,000)	VGRdL (2012)	7.546	0.989	0.55	(0.71)	-9.58	(0.00)
$Trade_{i,t}$	Regional trade openness defined as (Vol. of exports + Vol. of imports)/2 as share of GDP (in %)	Statistisches Bundesamt (2012a), Außenhandel nach Bundesländern	23.07	10.81	1.17	(0.88)	-10.45	(0.10)
$FDI_{i,t}$	Regional FDI openness defined as (inward FDI + outward FDI stocks stocks)/2 as share of GDP (in %)	Deutsche Bundesbank (2012)	10.13	12.53	0.83	(0.79)	-8.34	(0.00)
$Agriculture_{i,t}$	Share of agricultural employment in total regional employment (in %)	VGRdL (2012)	3.63	3.04	1.37	(0.91)	-1.26	(0.10)
$Industry_{i,t}$	Share of industrial employment in total regional employment (in %)	VGRdL (2012)	33.02	8.27	2.48	(0.99)	-5.37	(0.00)
$Debt_{i,t}$	Debt-to-GDP ratio defined as regional public debt at financial markets as share of GDP (in%)	Statistisches Bundesamt (2012b), Fachserie 14, Reihe 5	16.89	10.93	1.59	(0.94)	-7.51	(0.00)

Notes: λ is the Breitung (2000), Breitung and Dos (2005) ADF-based robust test statistic for panel unit root tests, which is computed both for variables in levels as well as first differences (FD). The null hypothesis is that the variable in focus has a unit-root.

Table 2:
Long-run estimation results for per capita GDP levels by alternative estimators (1971-2010)

Dep.Variable: $GDPPC_{i,t}$	**FEM**	**PCSE**	**DOLS**	**CCEP**	**CCEMG**
$GFCF_{i,t-1}$	0.059***	0.116*	0.002	0.012	0.005
	(0.0213)	(0.0639)	(0.0271)	(0.0144)	(0.0084)
$Labor_{i,t}$	1.165***	0.279***	0.209	0.765	1.295**
	(0.4158)	(0.0693)	(0.5685)	(0.7468)	(0.5498)
$Trade_{i,t}$	0.747***	1.209***	1.361***	-0.237	0.161
	(0.2367)	(0.4370)	(0.3656)	(0.2148)	(0.1863)
$FDI_{i,t}$	-0.903***	0.629**	1.094***	0.180	0.063
	(0.1910)	(0.3053)	(0.2723)	(0.0102)	(0.1113)
$Agriculture_{i,t}$	-0.154***	-0.106***	-0.069***	0.007	-0.101
	(0.0130)	(0.0146)	(0.0266)	(0.0214)	(0.1213)
$Industry_{i,t}$	-0.073***	-0.042***	-0.032***	0.007	-0.005
	(0.0064)	(0.0036)	(0.0115)	(0.0086)	(0.0071)
$Debt_{i,t}$	**0.021*** **	**0.037*** **	**0.029*** **	**-0.029*** **	**-0.018** **
	(0.0071)	**(0.0077)**	**(0.0115)**	**(0.0084)**	**(0.0088)**
Debt $squared_{i,t}$	**-0.0001**	**-0.0003** **	**-0.0004** **	**0.0003** **	**-0.0001**
	(0.0001)	**(0.0001)**	**(0.0002)**	**(0.0001)**	**(0.0003)**
Obs.	390	390	350	390	390
R^2	0.94	0.83	0.84	0.98	0.98
No Cointegration	Not rejected	Not rejected	Rejected	Rejected	Rejected
Hausman test				32.39***	
CD	18.40	31.34	37.52	-4.29	-2.16

Notes: FEM = Fixed effects estimator, PSCE = OLS with panel corrected standard errors, DOLS = Dynamic OLS (with no. of lags = 2, no of leads = 1), CCEP = Common Correlated Effects Pooled estimator, CCEMG = Common Correlated Effects Mean Group estimator. The R^2 is calculated as the squared correlation between the dependent variable and its prediction. *No Coint.egration* reports the result of a residual based cointegration test with the the null hypothesis of non-stationary residuals (that is, no cointegration relationship). *Hausman* reports the result of a Hausman test for CCEP versus the CCEMG estimator. Under the null hypothesis the CCEP is both consistent and efficient, while under the alternative hypothesis only the CCEMG estimator is consistent. *CD* is the test statistic for the Pesaran (2004) test for cross-sectional dependence. Under the null hypothesis of cross-sectional independence the test statistic is distributed as $CD \sim N(0,1)$.

Table 3:
Dynamic ECM results for GDP growth (1973-2010)

Dep. Variable: Δ GDPPC$_{i,t}$	**FEM**	**PCSE**	**DOLS**	**CCEP**	**CCEMG**
Δ GDPPC $_{i,t-1}$	0.576***	0.570***	0.445***	0.626***	0.571***
	(0.4639)	(0.0849)	(0.0257)	(0.0442)	(0.0503)
Δ GFCF$_{i,t-2}$	-0.001	-0.001	-0.006***	0.001	-0.034**
	(0.0043)	(0.0098)	(0.0017)	(0.0039)	(0.0131)
Δ Labor $_{i,t-1}$	0.062	-0.058	0.455***	-0.039	-0.285
	(0.2594)	(0.4261)	(0.1067)	(0.2341)	(0.4583)
Δ Trade $_{i,t-1}$	-0.219***	-0.199	-0.012	-0.181**	-0.054
	(0.0758)	(0.1552)	(0.0252)	(0.0808)	(0.1609)
Δ FDI $_{i,t-1}$	-0.076	-0.081	0.075*	-0.053	0.042
	(0.0981)	(0.1172)	(0.0386)	(0.0950)	(0.0543)
Δ Agriculture $_{i,t-1}$	-0.061***	-0.052**	-0.045***	-0.052***	-0.027
	(0.0173)	(0.0204)	(0.0074)	(0.0145)	(0.0543)
Δ Industry $_{i,t-1}$	-0.012*	-0.011	-0.003	-0.014**	0.003
	(0.0051)	(0.01144)	(0.0028)	(0.0063)	(0.0065)
Δ Debt $_{i,t-1}$	**0.016*** **	**0.012**	**0.009*** **	**0.018*** **	**0.028** **
	(0.0051)	**(0.0074)**	**(0.0021)**	**(0.0046)**	**(0.0124)**
Δ Debt squared $_{i,t-1}$	**-0.0002** **	**-0.0001**	**-0.00007** **	**-0.0002** **	**-0.0006** **
	(0.0001)	**(0.00009)**	**(0.00003)**	**(0.00006)**	**(0.0003)**
ec $_{i,t-1}$	-0.035***	-0.019**	-0.031***	-0.158***	-0.124***
	(0.0109)	(0.0086)	(0.0044)	(0.0447)	(0.0110)
Obs.	370	370	340	370	370
R^2	0.35	0.53	0.58	0.53	0.84

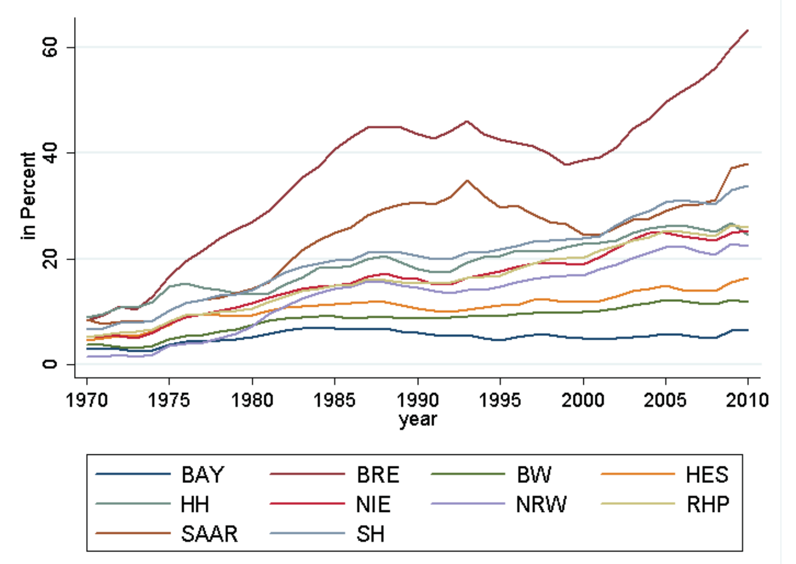
Notes: FEM = Fixed effects estimator, PSCE = OLS with panel corrected standard errors, DOLS = Dynamic OLS (with no. of lags = 2, no leads), CCEP = Common Correlated Effects Pooled estimator, CCEMG = Common Correlated Effects Mean Group estimator. Δ = Time series operator for transformation of variables into growth rates, $ec_{i,t-1}$ =Lagged error term from long-run regression according to eq.(2). The R^2 is calculated as the squared correlation between the dependent variable and its prediction.

Table 4:
CCEMG estimates for long- and short-run employment equation

Long-run equation		**Short-run equation**	
Dep. Variable:	**$Labor_{i,t}$**	**Dep. Variable:**	**Δ $Labor_{i,t-1}$**
$GDPPC_{i,t-1}$	0.069***	Δ $GDPPC_{i,t-1}$	0.077***
	(0.0223)		(0.0166)
$GFCF_{i,t-1}$	-0.001	Δ $GFCF_{i,t-2}$	-0.002
	(0.0027)		(0.0014)
$Trade_{i,t}$	-0.027	Δ $Trade_{i,t-1}$	0.027
	(0.0502)		(0.0397)
$FDI_{i,t-1}$	-0.032	Δ $FDI_{i,t-1}$	0.021
	(0.0206)		(0.0274)
$Agriculture_{i,t-1}$	-0.003	Δ $Agriculture_{i,t-1}$	0.001
	(0.0118)		(0.0078)
$Industry_{i,t-1}$	0.010***	Δ $Industry_{i,t-1}$	-0.004***
	(0.0022)		(0.0012)
$Debt_{i,t}$	**-0.0049**	**Δ $Debt_{i,t-1}$**	**-0.0002**
	(0.0038)		**(0.0024)**
Debt $squared_{i,t}$	**0.0003**	**Δ Debt $squared_{i,t-1}$**	**0.0001**
	(0.0002)		**(0.0001)**
		Δ $Labor_{i,t-1}$	0.401***
			(0.1350)
		$ec_{i,t-1}$	-0.086***
			(0.0142)
Obs.	390		370
No Cointegration	Rejected		
CD-Test	-2.54		-2.60

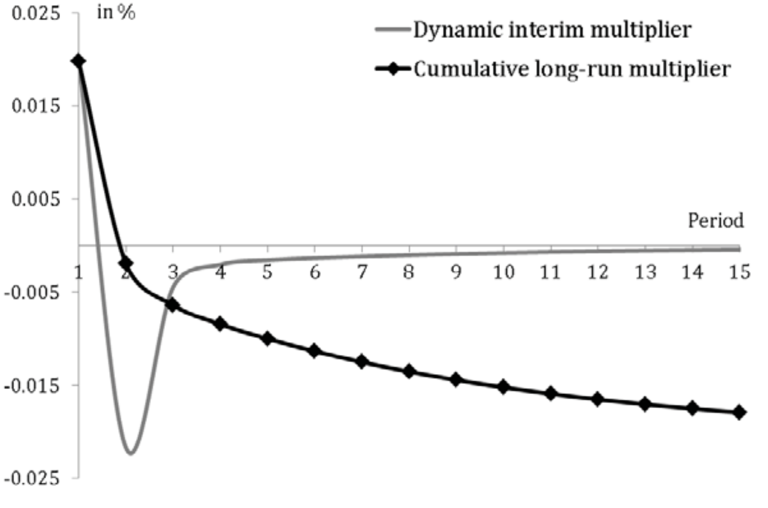
Notes: See Table 2 and Table 3 for explanations.

Figure 1: Debt intensities of German states in 1970-2010



Note: For a definition of the debt intensity see Table 1. West German States: BAY = Bavaria, BRE = Bremen, BW = Baden Wurttemberg, HES = Hessen, HH = Hamburg, NIE = Lower Saxony, NRW = North Rhine-Westphalia, RHP = Rhineland-Palatine, SAAR = Saarland, SH = Schleswig-Holstein.

Figure 2: Interims and cumulative multipliers of CCEMG estimates



Note: Multiplier analysis based on coefficient estimates from Table 2 and Table 3.