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Regional fiscal equalization in Germany - A simultaneous equation approach to assess the economic effects of fiscal policy

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Abstract:

Regional fiscal equalization in Germany aims to reduce fiscal disparities by allocating financial resources to less promising regions in order to support the supply of public goods. This paper aims to analyse secondary economic effects of regional fiscal equalization on several economic in- and output variables. Additionally, the paper examines the potential regional characteristics to influence the transformation of fiscal inputs into economic outcomes. Lastly, I compare the effects of fiscal equalization to these of the major German structural funding program GRW. My findings reveal a significant positive effect of fiscal equalization on the regional employment rate. Moreover, the findings suggest different transmission channels of fiscal equalization in East and West Germany. Particularly, I find higher effects in right-wing CDU/CSU preferring regions on the employment, human capital and private-sector investment rate. Finally, while structural funding affects more economic variables significantly, the magnitude of the estimated economic responses of fiscal equalization compared to these of German structural funding are not statistically different.

Keywords: fiscal equalization, regional economic growth, production function, political ideology, SpPVAR, impulse-response functions

JEL Classifications: C33, E62, R11, R58, O38, O47

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1. Introduction

In many countries and supranational entities such as the European Union (EU), regional policy explicitly aims to foster the economic progress of rather less affluent regions to warrant equal living conditions and economic balance. To this end, a large amount of public money is spent in terms of structural investment programs to trigger economic development in less promising regions – examples are the cohesion policy of the EU (e.g. European Commission, 2017) or, in Germany, the Joint Task for the Improvement of Regional Economic Structures (GRW) (e.g. Deutscher Bundestag, 2014).

In addition to structural (cohesion) funds, further important regional policy measures are fiscal equalization schemes. In Germany, fiscal equalization is provided, on the one hand, across federal states (Länderfinanzausgleich) and, on the other hand, across municipalities within a federal state. In this paper, I focus on the latter equalization scheme, which is of particular interest as it provides a high funding volume each year and is thus a crucial income source for German regional authorities. Between 2000 and 2011, on average, 23.51 billion euro in unconditional formula-based grants (Schlüsselzuweisungen) – the key funding mechanism for regional financial compensation – was provided annually to German municipalities.[1]

The basic purpose of regional equalization is to provide financial resources to needier municipalities to perpetuate the supply of public goods by explicitly considering the financial capacity and needs for fund allocation (e.g. Albouy, 2012; Lenk, Hesse, & Lück, 2013). Thus, regional equalization bridges financial gaps and features a distinct redistributive function of public financial resources (e.g. Lenk et al., 2013 for the German case of regional equalization). The redistribution aim is believed to reduce financial disparities and may affect, for example,

[1] Please note that this figures are based on own calculations using data from the Bundesamt für Bauwesen und Raumordnung (BBSR).

migration patterns and economic activity. Albouy (2012) argues that fiscal equalization enhances efficiency if public-good externalities are internalized and public expenditures are positively related to payments of the financial equalization scheme. In addition, equity is enhanced if funds are allocated to low income regions and regions with high costs for public goods, respectively (Albouy, 2012). Conversely, fiscal equalization may also offer incentives to live and remain in unproductive regions, thus leading to inefficiency rather than efficiency (e.g. Lehmann & Wrede, 2018 for a brief discussion).

Despite its economic relevance as important income source and the high annual financial volume, empirical evaluations of the economic effects of German regional fiscal equalization are sparse (e.g. Kalb, 2008; Henkel, Seidel, & Suedekum, 2018; Lehmann & Wrede, 2018). Therefore, the economic implications are hardly known, especially regarding potential economic secondary effects. Secondary effects are interpreted in this paper as additional (inadvertent) effects of an increase in formula-based grants on other economic variables in the regional production system – such as the per capita income, patent, investment, human capital and employment rate.

This paper aims to contribute to recent literature by addressing multiple features: The first question of interest is if fiscal equalization grants trigger economic development via secondary effects? Thereby, to provide multifaceted insights in the working and the transmission channels of German fiscal policy, I apply a simultaneous equation approach, which explicitly detects direct and indirect effects among the variables in the regional production system. This is, to the author's knowledge, the first study regarding regional fiscal equalization that applies this methodological approach. Secondly, studies evaluating structural and cohesion funds increasingly emphasize the relevance of conditioning factors (e.g. quality of government) as driver for an efficient use of public spending (e.g. Fratesi & Wishlade, 2017 for an overview in the context EU cohesion policy). Building upon this innovative string of literature, the second research question asks if potential secondary are uniform across regions or rather depending on political-economic conditions. To this end, German regions are subdivided according to a rather general (Eastern and Western German regions) as well as to a more specific (government ideologies) measure of political structures. Finally, I compare the estimated economic effects of fiscal equalization to the outcomes of the main German structural funding program GRW. In contrast to regional fiscal equalization, the GRW program is more industry-oriented (Deutscher Bundestag, 2014). Thus, the last research question raises the discussion as to whether or not the economic effects differ between regional fiscal equalization and the GRW program.

The findings show significant positive effects on regional employment, while further economic variables are unaffected by an increase in the formula-based grant intensity in the basic model. Furthermore, I find evidence for slightly different transmission channels of regional fiscal equalization in Eastern and Western German regions. In addition, an increase in the formula-based grant intensity leads to significantly higher effects on the employment, human capital and private-sector investment rate in regions that mainly support the rather pro-business and right-wing conservative parties Christian Democratic Party (CDU) and Christian Social Party (CSU). Lastly, differences in the implied economic effects of fiscal equalization and the GRW are not significant, however, the GRW triggers significant positive effects on the GDP, employment and human capital rate.

The reminder of the paper is organized as follows. In the next section, I provide information on the basic setup of regional fiscal equalization in Germany and discuss the state of academic debate. In section 3, theoretical considerations and research hypothesis are presented, while section 4 shortly describes the econometric strategy and data. Section 5 analyses the economic effects of German regional fiscal equalization and Section 6 summarizes and concludes.

2. The German regional fiscal equalization scheme

2.1 Institutional setup

German fiscal equalization is implemented at the federal level (Länderfinanzausgleich) as well as on the regional level, where equalization is provided across municipalities within a federal state. The paper on hand is focused on the regional fiscal equalization scheme, where the responsibility of detailed design and implementation is incumbent upon the particular federal state. The scheme aims to improve the financial resources of municipalities within a specific federal state to guarantee a sufficient endowment of public goods, especially by allocating funds predominantly to economic weaker municipalities with the highest need – indicating a highly redistributive character (e.g. Lenk et al., 2013).

Municipalities are the lowest level of regional government in Germany, notwithstanding they generally have notable autonomy (e.g. Kalb, 2008). Buettner & Holm-Hadulla (2008) name three general income sources of German municipalities: First, municipalities receive a share of income taxes and valued-added tax (VAT). Second, they raise local business and land taxes. Finally, they gain from fiscal transfers allocated by the federal state government. The distribution of these funds is, on the one hand, based on the fiscal capacity and, on the other hand, on the fiscal need of municipalities. If fiscal capacity exceeds fiscal need, no equalization funds are provided (abundant municipality) and they are net contributors. Conversely, if fiscal need is in excess of financial capacity, equalization funds are provided to balance a flexible part of this difference (Buettner & Holm-Hadulla, 2008). As explained by Lenk et al. (2013), the detailed setup and conceptualization differs across German federal states. However, the approximation of the financial conditions in the municipalities generally follows the above presented structure, i.e. counting the financial capacity against the financial need (see Figure 12 in Lenk et al., 2013 for an overview). To this end, the unconditional formula-based grants are the key funds for financial compensation of economically weaker municipalities, in doing so their use is most widely unconstrained. This implies that municipalities are widely free to make use of the formula-based grants according to their preferences (Lenk et al., 2013).

As regional fiscal equalization is also provided in many other countries according to a similar basis of calculation, the results of this study are, to some extent, also transferable to countries with similar equalization schemes.

2.2 State of debate

Based on the seminal work by Buchanan (1950), empirical studies predominantly focused on the effects of fiscal equalization on migration patterns and an efficient fund allocation.[2] Albouy (2012) applies data from Canadian provinces in 2001 to analyse the efficiency and equity purposes of the Canadian federal grant system. The author concludes that the grants increase public expenditures only moderately and thus miss the efficiency criterion. Moreover, federal grants are allocated to provinces with higher earnings and realized incomes, which is also contrary to the implied equity purpose (Albouy, 2012). Lehmann & Wrede (2018) adapt the empirical approach of Albouy (2012) to analyse the efficiency and equity aim of fiscal equalization in the German state Bavaria. Their findings suggest that fiscal equalization hampers efficiency, but satisfies equity conditions as the grants are allocated to regions with rather low income levels (productivity) and low realized incomes (Lehmann & Wrede, 2018).

Using data from the state of Baden-Württemberg from 1990 to 2004, Kalb (2008) analyses the effects of equalization grants on regional technical efficiency. The author argues that an increase in equalization grants rises technical inefficiency and results in a waste of public resources in supported regions (Kalb, 2008).

Henkel et al. (2018) apply a general equilibrium model and compare the present political reality with fiscal transfers to the counterfactual scenario without transfers across federal states

[2] I refer to the study by Albouy (2012) for a comprehensive listing of these studies.

and municipalities by using data from 411 German administrative districts (Landkreise). The results point at vast migration waves in the counterfactual situation without fiscal equalization. Approximately 3.2 million people would move from present recipient regions to more productive regions, resulting in a considerable increase of national labour productivity (5.8 %) and GDP per capita (3.7 %). The implied net migration is 32 times higher than the actual net migration in Germany observed between 2000 and 2010. Moreover, public goods quality would diverge across regions. Conversely, national welfare would only increase moderately, because more productive regions already suffer from an over-congestion that would worsen. Therefore, fiscal equalization may hamper national GDP per capita and labour productivity gains, but not welfare gains (Henkel et al., 2018).

3. The effects of fiscal equalization: the theoretical arguments

In this section, various theories of economic growth (Mankiw, Romer, & Weil, 1992; Rivera-Batiz & Romer, 1991; Romer, 1990) are used to derive hypotheses regarding the anticipated outcomes of an increase in the formula-based grant intensity. I presume the following regional production function for each German region *i*

$$Y_i = K_i^{\alpha} H_i^{\beta} Z_i^{\gamma} (A_i (\lambda_i P_i))^{1-\alpha-\beta-\gamma}, \tag{1}$$ [3]

which can be rewritten in terms of the economically active population (henceforth: workforce) as

$$y_i = k_i^{\alpha} h_i^{\beta} z_i^{\gamma} (A_i \lambda_i)^{1-\alpha-\beta-\gamma}. \tag{2}$$

Based on Equation (2), private k_i and public physical capital z_i, human capital h_i, technology A_i as well as the employment rate λ_i are the economic input factors to produce regional output per

[3] Y_i is the regional output, K_i denotes private physical and H_i human capital, Z_i is the public physical capital, A_i denotes the regional level of technology, while λ_i is the constant gross employment rate ($\lambda_i = L_i/P_i$, where L_i denotes labour) and P_i describes the economically active population (15 to 64 years), which grows exogenously with n_i (see Eberle et al., 2018a for additional details).

workforce y_i and determine the theory-based variable selection for the applied vector-autoregressive (VAR) model in this paper.[4]

3.1 General effects

Below, I derive theory-based expectations and hypothesis regarding the first research question: Do fiscal equalization grants trigger economic development via secondary effects? The general dynamics of the public capital stock z_i in region *i* can be expressed as (e.g. Eberle et al., 2018a)

$$\frac{z_i}{z_i} = s_{z,i}(k_i^{\alpha}\, h_i^{\beta}\, z_i^{\gamma-1}\, (A_i\lambda_i)^{1-\alpha-\beta-\gamma}) - (n_i+\delta), \tag{3}$$

where $s_{z,i}$ denotes the investment rate in the public capital stock and δ is the depreciation rate of public capital. Consequentially, an exogenous change in the formula-based grants directly affects the investment rate $s_{z,i}$ in Equation (3), which enables a region to provide a higher amount of public capital to the resident industry. The increase of the public investment rate may be higher if fiscal transfers induce additional public expenditures (efficiency purpose according to Albouy, 2012). Furthermore, changes of public investments may have additional secondary effects on further economic variables in Equation (2).

At first, I consider potential (short-run) effects on the gross employment rate λ_i.[5] Fiscal equalization may have considerable short-run effects on the labour input in regions as it affects migration patterns. As outlined, for example, by Henkel et al. (2018), fiscal transfers make initially poorer regions more attractive and either induce immigration or reduce emigration,

[4] Due to the unavailability of adequate regional data, I use the private $s_{k,i}$ and public physical capital investment rate $s_{z,i}$ instead of the respective capital stocks k_i and z_i. For the same reason, instead of the regional technological level A_i, the technological growth rate g_i is used for empirical analysis (e.g. Eberle et al., 2018a).

[5] Major growth models do not regard the labour dynamics in detail and, instead, assume that labour L_i grows exogenously (e.g. Mankiw et al., 1992) or is constant (e.g. Romer, 1990; Rivera-Batiz & Romer, 1991) in the long run.

respectively. This assumption is strongly underlined by the implied 32 times higher net migration rate in the estimated case without any fiscal equalization in the study by Henkel et al. (2018). Thus, an increase in the formula-based grant intensity is expected to positively affect regional migration behaviour, which leads to a higher labour supply and regional employment rate in the short run.

Secondly, the dynamics of physical capital k_i and human capital h_i are similar to the dynamics of public capital in Equation (3) (e.g. Mankiw et al., 1992). For this reason, an increase in the public investment rate is expected to have no effects on the fixed private-sector physical capital investment rate $s_{k,i}$. However, due to efficiency gains, a positive change in the public investment rate may have positive secondary effects on the accumulation of human capital h_i. However, in regard to the anticipated influence of formula-based grants on migration patterns, the effects on the human capital also depend in particular on the influence on the migration behaviour of high-skilled workers.

Thirdly, following the endogenous growth approaches by Romer (1990) or Rivera-Batiz & Romer (1991), regional technological growth g_i depends on the input factors (e.g. human capital, physical capital, labour) that are assigned to the research sector. Consequently, the effects on technological growth are ex-ante rather unclear and depend on the contingent development of other input factors.

Finally, changes in the regional GDP per workforce can be written as a function of changes in regional input variables (see Equation 2)

$$\frac{\dot{y}_i}{y_i} = (1-\alpha-\beta-\gamma)\,\frac{\dot{A}_i}{A_i} + (1-\alpha-\beta-\gamma)\,\frac{\dot{\lambda}_i}{\lambda_i} + \alpha\frac{\dot{k}_i}{k_i} + \beta\frac{\dot{h}_i}{h_i} + \gamma\frac{\dot{z}_i}{z_i}. \tag{4}$$

Merging all considerations in this section, the first hypothesis is:

Hypothesis I: *An increase of the formula-based grant intensity directly affects public investments $s_{z,i}$ and subsequently triggers positive secondary effects on the regional employment rate λ_i, human capital h_i and GDP per workforce y_i, while the effects on the* *patent intensity g_i are expected to be rather moderate. Moreover, no effects on the private-sector physical capital investment rate $s_{k,i}$ are presumed.*

3.2 Conditional effects: the influence of political-economic structures

With regard to the second research question, I try to answer if economic outcomes of regional fiscal equalization depend on the political-economic structure. To this end, I expand Equation (3) to (e.g. Eberle, Brenner, & Mitze, 2018b)

$$\frac{\dot{z}_i}{z_i} = \psi_i \left[s_{z,i}(k_i^{\alpha} h_i^{\beta} z_i^{\gamma-1} (A_i\lambda_i)^{1-\alpha-\beta-\gamma})\right] - (n_i+\delta), \qquad (5)$$

where ψ_i indicates a parameter with fixed values between 0 and 1 that influences the efficiency of public investments and, consequently, the degree of subsequent secondary effects emanated by public capital investments. Simply speaking, a higher value of ψ_i implies a higher share of efficiently used public investments (e.g. Eberle et al., 2018b).

One conditional factor that may influence ψ_i is the political-economic structure (ideology).[6] The theory of partisan politics argues that effects of macroeconomic policies are influenced by politicians and party ideologies (e.g. Hibbs, 1977). Based on this argumentation, I apply two measures for political-economic structures and ideologies in Germany.

At first, I compare the effects of fiscal equalization between Eastern and Western German regions.[7] Due to the German division till the year 1990, both parts of former divided Germany developed contrarious political-economic systems, with democracy and a market economy in Western and communism and a centrally planned economy in Eastern Germany (e.g.

[6] In the context of EU structural and cohesion funds, Rodríguez-Pose & Garcilazo (2015) conclude that the quality of government positively affects returns on (public) investments and regional growth.

[7] Please note that a comparison between Eastern and Western German regions does not only consider political differences, it rather includes a wide range of differing (political-)economic conditions. For example, after the German reunification, GDP per capita and labour productivity differed considerably between Eastern and Western regions (e.g. Barrell & te Velde, 2000). Moreover, by analysing new business performances in East and West Germany, Fritsch (2004) argues that the political-economic system in Eastern Germany left marks that still affects economic activities.

Fritsch, 2004). This is reflected by a different party system and fragmentation in East and West Germany after reunification – for example due to the popularity of the Party of Democratic Socialism (PDS, today 'Die Linke') in Eastern Germany (e.g. Kitschelt, 2003). Kitschelt (2003) shows that in Eastern Germany the share of votes for social parties in the federal elections 1998 and 2002 are higher than for rather conservative and pro-business parties. I relate the differing political-economic structures in former divided Germany to the regional fiscal equalization scheme and hypothesize:

Hypothesis II: *The anticipated effects in hypothesis 1 are assumed to primarily apply for Western German regions as these regions support rather pro-business parties and are more effective to transform public investments into economic growth (higher* ψ_i*).*

Secondly, I analyse the influence of political ideologies in German regions more specified. In line with partisan theories, Potrafke (2011) states that left-wing parties are more focused on the labour base, while, in contrast, right-wing parties rather act in accordance with capital owners. Using data from Western German federal states, Potrafke (2011) examines the effects of political ideologies on public expenditures. The results hint at no significant effects on overall public expenditures on education and cultural affairs. However, by decomposing public expenditures, left-wing parties positively influence public expenditures on schooling, while negatively affecting expenditures on cultural affairs. Conversely, rather right-wing parties increase public expenditures on universities. Thus, the findings show evidence that political ideologies and priorities influences budget composition of German federal states (Potrafke, 2011). Furthermore, a study by Pinto & Pinto (2008) finds evidence that left-wing governments positively influence the effects of foreign direct investments on wages in Organisation for Economic Cooperation and Development (OECD) countries. Taking the findings into account, I compare regions that support the rather left-wing Social Democratic Party (SPD) with right-wing and more pro-business CDU/CSU supporting regions by using the second votes for Bundestag elections:

Hypothesis III: *With exception of the regional employment rate, the economic effects are expected to be higher in regions supporting the pro-business CDU/CSU party (higher ψ_i).*

3.3 Different effects of structural funding

In contrast to the described targets of regional fiscal equalization in Germany, the GRW structural funding program explicitly aims to promote the economic development of the least prosperous German regions, therefore funding is restricted exclusively to these regions. The GRW mainly works via two funding channels: firstly, by providing grants to firms in order to set incentives for a higher private-sector investment rate and, secondly, by strengthening the local economic infrastructure (e.g. Deutscher Bundestag, 2014). Consequently, GRW funding is much more industry-oriented compared to the regional fiscal equalization scheme, leading to the fourth hypothesis:

Hypothesis IV: *The implied economic effects of regional fiscal equalization in hypothesis 1 are significantly lower compared to economic effects of the more industry-orientated GRW funding program.*

4. Data and empirical strategy

4.1 Data and variables

I use data for six economic in- and output factors covering the observation period 2000 to 2011. At the municipality level, data is available only inadequately, therefor data was collected on the basis of the 402 German districts (Landkreise). Thereupon, I aggregated the districts to 258 labour market regions (Arbeitsmarktregionen) that are defined by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). Labour market regions explicitly account for economic ties across the small-scale German Kreise (e.g. by regarding commuting traffic) and reduces the risk of measurement errors when constructing normalized variables as, for example, places of work and residence may differ using a classification according to the German Kreise.[8] The applied variables are normalized and converted in logarithmic form as specified in more detail in Table A1 in the Appendix.

Figure 1 illustrates the annual amount of total formula-based grants as well as the ratio of formula-based grants to GDP (formula-based grant intensity) in Germany. The funding volume and ratio respectively, are fairly constant over the covered time period, with a peak in the funding volume of 26.46 billion euro in 2009 and a ratio of 1.12 % of annual GDP in the year 2000.

<<< Figure 1 >>>

Figure 2 shows the spatial patterns of the formula-based grant intensity across German labour market regions. The figure illustrates the importance of formula-based grants especially for East Germany, where the ratio of formula-based grants to GDP is considerably higher compared to Western regions.[9]

<<< Figure 2 >>>

[8] One potential shortcoming regarding the data for the formula-based grants is related to changed labels of allocated funds within the fiscal equalization scheme. Regional authorities may receive the same overall amount of allocated funds, but under a different label. However, I assume that these changes are random and, moreover, I add time dummies to the regression models to account for potential effects of these changes in public fund labeling.

[9] In Figure 2, the respective ratio for each labour market region is calculated for the entire time period according to the following formula: $\text{Intensity}_i = (\sum_{n=2000}^{2011} \text{Formula-based grants}_i) / (\sum_{n=2000}^{2011} \text{GDP}_i)$. Moreover, when subdividing the sample in Eastern and Western regions, I compare the economic responses to an increase that is equal to one standard deviation and, additionally, to the same percentage rise in order to account for different formula-based grant intensities in Eastern and Western Germany. The same applies for the comparison of regions with different political ideologies (see Section 4).

The five labour market regions with the lowest ratio of formula-based grants to GDP include the economically prosperous regions of Munich and Düsseldorf as well as Berlin, Hamburg and Bremen. Conversely, the five highest ratios appear to be in East Germany, with the highest ratio of 0.0454 in Mansfeld-Südharz.[10]

<<< Table 1 >>>

Moreover, I include the spatial lag of each variable to the VAR model and refer to this setup as basic model.[11] Spatial autocorrelation is assumed to be an empirical issue that may result from a divergence between the applied regional scale (labour market regions) and the actual degree of spatial autocorrelation. For this reason, spatial dependencies are not discussed in Section 3, but spatial lags are included as control variables to the regressions models. Moreover, in a sensitivity check, I also investigate the total spatial indirect effects of formula-based grants.

Panel unit root tests according to the approach by Im, Pesaran, & Shin (2003) show that not all time series are stationary. The non-stationarity applies for the regional gross employment and human capital rate as well as for the spatial lags of these variables (see Table A2). Consequently, detrended values are used for estimation. Moreover, the panel unit-root test for the formula-based grant intensity indicates stationarity, but IRF analysis does not work without detrending. Thus, I also use the detrended variable for the formula-based grant intensity in all settings.

[10] The lowest ratio is observed for Berlin, which is the only labour market not receiving any formula-based grants in the covered time period. By definition, city states do not have fiscal equalization. In contrast to the other city states Hamburg and Bremen (Bremerhaven), the small-scale district Berlin is not aligned with other districts to a common labour market. Thus, as shown in Table 1, the respective grant intensity is higher than zero in Hamburg and Bremen, but they are also counted among the labour markets with the lowest grant intensities.

[11] A binary first-order neighborhood matrix is used for the calculation of the spatial matrix (e.g. Eckey and Kosfeld, 2005).

In order to detect potential effects of differences in political-economic structures and ideologies, I initially subdivide the labour market regions in former East and West German regions, while Berlin is excluded from this subdivision. Moreover, I use the share of second votes for the Bundestag elections in the year 1998 as a more specific approximation for the regional political ideology. I choose the Bundestag election in the year 1998 to guarantee pre-determinedness of the indicator.[12] Figure 3 shows that the SPD reached the highest share of votes in 153 German labour market regions, while in the remaining 105 regions the right-wing party CDU/CSU gained the highest share of votes. This figure also indicates that either the SPD or the CDU/CSU gain the highest share of votes in the 258 German labour market regions in Bundestag elections 1998 and thus allows to analyse the presented left-right ideology (e.g. Potrafke, 2011).[13]

<<< Figure 3 >>>

The applied indicator for political ideology has some drawbacks: First, the election behaviour may differ between Bundestag and local elections and may not reflect regional government. It may not always perfectly represent regional government composition and thus the results should be interpreted carefully. However, I assume that the share of second votes for the Bundestag elections is, for the most part, a proper approximation of regional political ideology.[14] Second, one political party is rarely able to govern without coalition partners. Nevertheless, I subdivide the regions according to the party with the highest share of votes as coalition

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[12] The subdivision and identification is likely to be exogenous, because parties on this administrative level do not influence the allocation regulations that are made on federal state level.

[13] Correlation coefficient $\rho_{SPD\text{-}East} = 0.2476$ indicates that the correlation between Eastern regions and SPD preferring regions is small, although SPD is slightly more favored in East German regions (Berlin is excluded for calculation). Thus, the correlation coefficient indicates an adequate level of independence between the two sub-samples.

[14] If, for example, in some regions a solely on regional level competing party like the *Free Voters (FW)* runs the regional government, the share of votes in the Bundestag elections still hints at the political influence of the national-wide operating German parties in the respective region.

partners vary, implying that the major party largely enforce the political agenda and significantly influence regional government. Third, the respective party with the highest share in 1998 may be replaced by another party in subsequent elections, leading to a misinterpretation of the results. To tackle this issue, I run a robustness check including only these regions, where the major party in 1998 also gains the highest shares of votes in the subsequent Bundestag elections 2002 and 2005 (Figure 4).

<<< Figure 4 >>>

Fourth, to some extent, labour market regions comprise multiple small-scale administrative Kreise and the popularity of the SPD and CDU/CSU within one labour market region may differ in the associated districts. To this end, I provide a further robustness test using only these labour markets regions, where the leading party has the highest share of votes in all associated administrative districts.

4.2 Econometric identification strategy

A simultaneous equation approach allows to analyse the total effects of formula-based grants on all variables in the described economic system by considering diverse transmission channels. Thus, besides direct effects that are usually measured by the estimated coefficient in a single equation approach, the applied VAR setup also accounts for indirect effects among the six variables in the regional system (structural VAR approach, see e.g. Rickman, 2010).[15] For example, formula-based grants may affect regional GDP per workforce not directly via the particular coefficient in the GDP equation, but indirectly via an increased human capital or employment rate that, in turn, affect the GDP per workforce.

Based on the theory-based variable selection in Section 3, I apply a structural spatial panel VAR model with six equations, comprising the following six endogenous variables: 1)

[15] For a discussion regarding causal inference of structural VAR approaches, I refer to the article by Hoover (2012).

public physical capital investment rate $\mathbf{s_{z,i}}$, 2) human capital $\mathbf{h_i}$, 3) patent intensity $\mathbf{g_i}$, 4) private physical capital investment rate $\mathbf{s_{k,i}}$, gross employment rate $\boldsymbol{\lambda_i}$, 6) output per workforce $\mathbf{y_i}$. Based on this, the applied structural spatial panel VAR model can be formulated in matrix notation as (e.g. Eberle et al., 2018a)

$$\mathbf{Ay}_t = \mathbf{By}_{t-1} + \mathbf{CWy}_{t-1} + \mu + \tau_t + \mathbf{De}_t, \tag{6}$$

where $\mathbf{y_t}$ is a vector that contains the six endogenous variables, **A** is a matrix of contemporaneous parameters, **B** and **C**, respectively, represent matrices of polynomials that connect time lagged as well as time-space lagged variables to contemporaneous variables, μ and τ_t are vectors covering region- and time fixed effects, **D** represents a diagonal matrix connecting the endogenous variables to exogenous shocks and $\mathbf{e_t}$ is a vector of orthogonal errors (e.g. Keating, 1992; Rickman, 2010; Mitze, Schmidt, Rauhut, & Kangasharju, 2018; Eberle et al., 2018a).[16] Using the moving average presentation of the spatial panel VAR model in Equation (6), I calculate the effects of an orthogonal increase in the formula-based grant intensity on the remaining economic in- and output factors by applying impulse-response-functions (IRF). Based on Monte Carlo simulations with 1000 repetitions, confidence intervals are constructed in order to make statements about the significance of the estimated responses (e.g. Love & Zicchino, 2006).

Finally, IRF analysis can be conducted separately for total spatially direct and total spatially indirect effects: on the one hand, by using the matrix **B** for the calculation of the isolated total spatially direct effects (changes in $\mathbf{y_{t-1}}$ on $\mathbf{y}$) and, on the other hand, by using the matrix **C** for the calculation of the isolated total spatially indirect effects (changes in $\mathbf{Wy_{t-1}}$ on $\mathbf{y}$) (e.g. Eberle et al., 2018a). While the focus of the empirical analysis is on the computation of the total

[16] A bias-corrected fixed effects estimator based on Everaert & Pozzi (2007) is used for estimation of the six equations. In order to prevent redundancy, the applied spatial panel VAR is explained only briefly here. Detailed information regarding the explicit model setup, causal ordering at time *t* (restrictions on **A**) and further estimation issues are given in the study by Eberle et al. (2018a). I also assume that the formula-based grants are the most endogenous variable in the described economic system, implying contemporaneous effects on all other variables at time *t*.

spatially direct effects (**B**), I also compute response functions of total spatially indirect effects in order to test if fiscal equalization schemes affect the spatial vicinity.

Finally, I run the presented VAR model separately for each sub-sample according to the East-West and SPD-CDU/CSU classification and, ex-post, I apply t-test analysis in order to test the null hypothesis of no statistical significant differences between the estimated responses (Eberle et al., 2018b)

$$t_t = \frac{IRF_{region1} - IRF_{region2}}{\sqrt{\frac{sd^2_{region1}}{N_{region1}} + \frac{sd^2_{region2}}{N_{region2}}}}. \qquad (7)$$

In Equation (7), $IRF_{region1}$ and $IRF_{region2}$, respectively, denote the estimated responses in the two sub-samples at year *t*, while $sd_{region1}$ $sd_{region2}$ are the standard deviations, which are approximated using the constructed confidence intervals. Finally, $N_{region1}$ and $N_{region2}$ express the amount of repetitions in the conducted Monte Carlo simulation (here: N = 1000) (Eberle et al., 2018b). I perform t-test analysis using the respective original shock in each subsample that is equal in relative terms (one standard deviation). In order to control for large differences of the initial shocks amounting to one standard deviation, I also conduct t-test analysis comparing the economic responses to an equal shock in terms of the same percentage rise in both sub-samples.

5. Empirical results

5.1 General effects

I start by analysing the economic effects of a formula-based grant intensity increase ("shock") for the defined set of variables with $\mathbf{y_t} = [\lambda_{it}, s_{k,it}, h_{it}, g_{it}, y_{it}, s_{z,it}]$. In Figure 5, in each case the continuous line shows the response of one particular economic variable to a one standard deviation increase in the formula-based grant intensity, while the associated dotted lines indicate the constructed error bands. Each response is multiplied by 100 in order to express the estimated effects as a percentage [%].

The estimated response of the regional gross employment rate λ_i implies significant positive effects, which is in line with hypothesis 1. The intuition is that formula-based grants may internalize public externalities and have positive effects on the migration behaviour, both leading to a higher labour supply and gross employment rate. Moreover, more financial resources may lead to higher levels of employment especially in the public sector. In line with the ex-ante expectations, the estimated magnitude of the private-sector physical capital investment rate $s_{k,i}$ is small and non-significant. In addition, the plotted IRFs suggest that mainly low-skilled workers are impacted by an increase in the formula-based grant intensity, while the stock of high-skilled workers remains unaffected by a change – expressed by a non-significant response of the human capital h_i. Consequently, the patent intensity g_i displays a non-significant response as well. Finally, an increase in the formula-based funding intensity is not transformed into a higher regional GDP per workforce y_i – despite the positive effects on the employment rate. Thus, the positive response of the employment rate appears to be driven predominantly by an increase of low-skilled workers or workers in the public sector with a rather low average productivity in industrial production.

<<< Figure 5 >>>

I provide two robustness checks regarding the basic model. First, I exclude the spatial lag $\mathbf{Wy_{t-1}}$ of the particular dependent variable in each of the six equations, because this variable is supposed to be weakly exogenous and may suffer from a bias in the applied fixed-effects estimator approach (see Figure A3 in the Appendix for the results).[17] Secondly, I add additive public investments as control variable to the regression models (see Figure A4). To this end, I collect data from additional funding programs and calculate the overall intensity (see Table A1

[17] The applied bias-corrected fixed-effects estimator is supposed to correct only for the bias in the time lag of the particular dependent variable $\mathbf{y_{t-1}}$ in each regression model. However, I assume that this bias is more severe than the potential bias of $\mathbf{Wy_{t-1}}$ for the respective dependent variable, which is also only included as control variable in the basic model.

for details). In addition, I also calculate the spatial lag of this additive public funding intensity and add both variables as controls to the spatial panel VAR model. The results of the two robustness checks emphasize that neither the exclusion of the particular spatial lag variable nor the inclusion of the public funding intensity of additive programs and its spatial lag leads to serious changes of the plotted IRFs. Thus, I find evidence that an increase in the formula-based funding intensity leads to robust significant positive effects on the regional employment rate, while further economic variables are not affected significantly.

Figure 6 shows the isolated total spatially indirect effects of an increase in the formula-based funding intensity. To this end, I use the same initial increase ("shock") in the grant intensity and I assume the same contemporaneous relationship across the six spatial lag variables compared to the non-spatial model (same **A** matrix). However, instead of the coefficient matrix **B**, I use the coefficient matrix **C** from Equation (6) for the calculation of the economic responses.[18] Finally, the estimated coefficients **C** as well as their variance-covariance matrix are used to construct confidence intervals (Love & Zicchino, 2006). The results hint at significant negative effects of an increase in the formula-based grant intensity in neighbouring regions on the grant-intensity in region *i*. This finding is in line with the institutional setup of the equalization program as an increase in the neighbourhood may be indirectly financed by region *i* (by receiving less formula-based grants). Therefore, regions are competing for formula-based grants. Moreover, the IRFs suggest that an increase in the formula-based grant intensity in neighbouring regions also leads to negative effects on the employment rate and the human capital, respectively, which may be explained by an extracting impact of a shock in the immediate spatial neighbourhood. However, a shock in neighbouring regions abates much faster than the spatially direct effects and the error belts suggest non-significant effects for almost all economic

[18] The definition of the spatial model (see Equation (5)) precludes contemporaneous effects from neighbouring regions on $\mathbf{y}_t$, for which reason they are 0 at time *t*.

variables. Thus, I find evidence for significant total spatially indirect effects only for the formula-based grant intensity variable.

<<< Figure 6 >>>

5.2 Conditional effects

In this section, I present the results of two continuative investigations. To this end, I subdivide the basic sample into subsamples, starting with comparing the plotted IRFs in Eastern and Western German regions. Due to its special status in the history of divided Germany, Berlin is excluded from analysis. In both setups, the two continuous lines (blue and grey) display the economic responses, while the dotted lines in grey and blue report the associated confidence intervals.

Figure 7 shows the responses of Eastern and Western German regions to a shock in the formula-based funding intensity. With regard to the significance and the magnitude of the estimated responses, the results hint at only minor differences for the human capital and the patent intensity between the sub-samples. However, the response of the employment rate to an increase in the formula-based grant intensity is significant positive only for Western German regions. Moreover, in the year of the funding increase, the magnitude of the response is significantly higher in West Germany (see Table A5). Additionally, the plotted IRFs suggest short-run significant negative effects on the GDP per workforce in East Germany. This finding is also supported by a significantly lower response in the year of the funding increase in Eastern German regions. Conversely, the findings hint at short-run significant positive effects on the private-sector physical capital investment rate in Eastern German regions, also reflected by a significant higher magnitude in the year of the funding change in these regions. However, this finding is limited to the year of the grant increase.

Based on the findings, I can confirm minor differences regarding the significance and magnitude of the estimated responses between Eastern and Western German regions to an increase in the formula-based grant intensity. The differences may be explained by a diverse conceptualization and implementation of fiscal equalization as well as by different political ideologies in East and West Germany. However, one should keep clearly in mind that the economic conditions in both parts of former divided Germany are also different. The marginal productivity of capital may be smaller in Western compared to Eastern Germany as regions are closer to their individual steady state level. Thus, West Germany may be more focused on the employment target, while Eastern German regions use the grants primarily to create incentives for firms to raise the private-sector investment rate. In addition, average wages are still lower in Eastern German regions, for which reason it may be more complex for them to influence the migration patterns of employees as they may prefer to move to the Western part of Germany. Finally, the short-run negative response of the GDP per workforce may be explained by short-run fluctuations and a less developed political-economic structures. However, the response becomes positive in subsequent years, which is why I do not overvalue this finding.

<<< Figure 7 >>>

In a second investigation, I deepen the analysis on the influence of political ideologies on the economic responses to an increase in the grant intensity by using the share of votes for the Germany parties. Figure 8 displays the differences in the use of fiscal grants between the relatively left-wing SPD and right-wing CDU/CSU. While the effects of SPD supporting regions are non-significant for all economic in- and output variables, CDU preferring regions trigger significantly positive effects on the gross employment, human capital and private-sector investment rate. Conversely, the findings also suggest short-term negative effects on the GDP per workforce. However, the response of the GDP per workforce turns into non-significant positive effects in subsequent years and thus I avoid an over-interpretation here. Consequentially, regions with a high share of votes for the right-wing and pro-business CDU/CSU transform an increase in the grant intensity not solely to more employment, but also to an increase of high-skilled employment (human capital).

<<< Figure 8 >>>

I run several robustness checks. At first, I use only these regions, where SPD and CDU/CSU, respectively, received the highest shares of votes in the Bundestag elections 1998, 2002 and 2005. While the number of regions for the CDU/CSU remains unchanged, the number of regions that primarily vote for the SPD is reduced from 153 to 113. Simply speaking, the SPD lost primacy in 40 regions after the Bundestag elections in 1998. However, the results of the IRF analysis remains robust and almost unchanged (see Figure A6). Secondly, I consider only these labour market regions, where either SPD or CDU/CSU received the highest share of votes in all inherent small-scale Kreise. The composition of the sub-samples remain almost unchanged: According to this classification, the SPD still received the highest share of votes in 143 labour market regions, while the CDU/CSU gained the majority in 96 labour market regions in the year 1998. This finding expresses a fairly homogeneous political ideology within German labour market regions. Accordingly, the plotted IRFs hint at only moderate changes due to this sub-classification (see Figure A7). Finally, I use only these regions for analysis, where the SPD or CDU/CSU received the highest share of votes in all inherent Kreise in the respective Bundestag elections of 1998, 2002 and 2005. Due to this strict definition, the CDU/CSU loses one labour market region (95) compared to the previous robustness check, while the number of SPD supporting regions decreases to 102. The IRFs in Figure A8 confirm that economic responses of CDU/CSU liked regions change only slightly, while the economic responses and associated confidence intervals of SPD supporting regions changes to a greater extend in this setting. The findings hint at significant positive effects of an increase in the grant intensity on the employment rate as well as on the regional GDP per workforce. However, the latter finding is only significant in the year of the shock. In subsequent years, the response becomes non-significant and negative, which is why I do not overvalue this finding. Finally, I consider the estimated economic responses shown in Figure A8 as the most robust sub-classification and, consequently, I use these responses to perform a t-test analysis. The plotted response of the GDP per workforce is significantly higher in SPD liked regions in the year of the funding increase, while the results hint at significantly higher short-term effects on the regional employment, human capital and investment rate in CDU/CSU liked regions (see Table A9). The analysis shows that the findings are well in line with the formulated expectations (hypothesis 3), although the estimated responses differ only moderately in the long run.

5.3 Economic effects of fiscal equalization compared to structural funding

This section determines potential differences between fiscal equalization and the structural funding program GRW. To this end, I initially estimate the economic effects of an increase in overall GRW funding intensity by also including the funding intensity of remaining public investments as control variable to the VAR setup. This approach is methodologically equal to the robustness check regarding formula-based grants illustrated in Figure A4. The plotted IRFs in Figure A10 show the responses to a one standard deviation increase in the overall GRW and formula-based grant intensity, respectively. The findings support the robustness of the results by Eberle et al. (2018a), suggesting significant positive effects on the employment and human capital rate as well as on regional GDP per workforce.

Furthermore, Table 2 shows the results of t-test analysis comparing the economic responses to an increase in the formula-based grant and GRW funding intensity, respectively. Using the estimated responses to an initially equal shock that amounts each to one standard deviation, the results hint at significantly higher effects of the GRW on the regional GDP per workforce, employment and human capital rate, while the differences on the patent activity and private-sector investment rate are not statistically different. However, calculating the economic responses based on an initial shock that amounts each to the same percent rise, the statistical difference in the magnitudes of the economic responses diminish. Thus, the findings suggest that GRW funding triggers significant positive effects on more economic variables compared to the formula-based grants, but the differences in the magnitudes are not statistically higher compared to these of regional fiscal equalization.

6. Conclusion

This paper adds to recent literature by analysing the economic effects of regional fiscal equalization in Germany. While the primary aim of regional fiscal equalization is to endow regions with a sufficient level of financial resources to provide public goods, potential secondary economic effects are widely disregarded so far. I explicitly consider three features of German regional fiscal equalization: Firstly, I account for a multifaceted character by applying a VAR approach and IRF analysis. Secondly, I examine conditional effects by subdividing the basic sample according to political-economic structures. Thirdly, I compare the effects to the economic outcomes of rather industry-oriented structural funding in Germany.

Using a sample comprising 258 German labour market regions as basic model, the plotted IRFs suggest robust significant positive effects on the regional employment rate. This finding may express the influence on migration patterns of rather low-skilled workers and on workers in the public sector as municipalities may use additional funds to increase employment. However, the overall secondary economic effects are moderate as further economic variables are not affected significantly. In this respect, one policy implication is that regional fiscal equalization triggers – in addition to its origin purpose – positive effects on the regional employment rate. In addition, political ideology also matters for single years. By subdividing the sample in East and West Germany, the results suggest significantly higher responses on the employment rate and GDP per workforce in Western regions, while the effects are higher on the private-sector investment rate in Eastern regions. However, the differences appear only for single years shortly after an increase in the funding intensity. Moreover, the results hint at significantly higher effects on the employment, human capital and investment rate for CDU/CSU preferring regions, while SPD supporting regions trigger higher effects on the GDP per workforce in the very short-run perspective. Thus, a second policy implication is that political-economic structures influence the working of formula-based grants especially in the short run and should be considered by federal states when defining additional purposes of fiscal equalization. Finally, a similar initial increase amounting to one standard deviation leads to significant higher effects of the GRW program on the GDP per workforce, the employment and human capital rate, while the significant differences diminish when using an initial change amounting to the same percentage increase of both policies. However, fiscal equalization affects only the employment rate significantly positive, while structural funding has additionally significant positive effects on the human capital rate and regional GDP per workforce. Based on this finding, I derive the last policy implication: If the policy objective is to increase the regional GDP and human capital endowment, policymakers should allocate structural funds rather than fiscal equalization payments to regions.

The analysis conducted in this paper is one contribution towards a comprehensive debate regarding the working of fiscal equalization in Germany. For future research, I point to the following aspects: First, additional research should gain detailed information about the quality of jobs that are created by an increase of formula-based grants. The quality and wage level of the created jobs as well as the sector may have important implications for regional economies. Secondly, I analysed fiscal equalization between German regions. It is also worth to determine the effects of fiscal equalization on the distribution within the (gaining) regions in future evaluation studies. My findings do not allow the making of statements regarding the effects on the distribution of incomes and, thus, needs further research. Thirdly, future research should focus on detailed analyses for particular federal states and identify differences of the working quality across them in order to define best practice characteristics.

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Tables

Table 1: German labour market regions with the highest and the lowest ratio of formula-based grants 2000-2011

	Labour market region	Ratio of formula-based grants to GDP
Low ratio	Berlin	0
	Munich	0.0008
	Düsseldorf	0.0012
	Hamburg	0.0015
	Bremen	0.0023
High ratio	Altenburg	0.0366
	Salzlandkreis	0.0379
	Wittenberg	0.0384
	Stendal	0.0418
	Mansfeld-Südharz	0.0454

Table 2: t-test analysis comparing economic responses to an increase in the formula-based grant and overall GRW intensity (based on Figure A10)

Funding increases are each equal to one standard deviation

Time	Response variable	Mean response eastern regions	Mean response western regions	Std. Dev. response eastern regions	Std. Dev. response western regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	lhk	-0.000026	-0.000282	0.0112	0.0112	0.5125	0.3042	0.6958	0.6084
1	lhk	0.000104	0.000729	0.0130	0.0136	-1.0500	0.8531	0.1469	0.2938
2	lhk	0.000071	0.001150	0.0150	0.0173	-1.4876	0.9315	0.0685	0.1370
3	lhk	0.000010	0.001256	0.0143	0.0186	-1.6812	0.9536	**0.0464**	0.0929
4	lhk	-0.000040	0.001200	0.0125	0.0180	-1.7880	0.9630	**0.0370**	0.0739
5	lhk	-0.000070	0.001069	0.0104	0.0166	-1.8380	0.9669	**0.0331**	0.0662
6	lhk	-0.000081	0.000913	0.0083	0.0146	-1.8658	0.9689	**0.0311**	0.0622
7	lhk	-0.000081	0.000758	0.0066	0.0128	-1.8398	0.9670	**0.0330**	0.0659
8	lhk	-0.000073	0.000617	0.0051	0.0109	-1.8157	0.9652	**0.0348**	0.0696
9	lhk	-0.000063	0.000494	0.0039	0.0091	-1.7815	0.9625	**0.0375**	0.0750
10	lhk	-0.000052	0.000391	0.0030	0.0076	-1.7084	0.9561	**0.0439**	0.0877
11	lhk	-0.000041	0.000306	0.0023	0.0063	-1.6454	0.9500	0.0500	0.1000
12	lhk	-0.000032	0.000238	0.0017	0.0051	-1.5892	0.9439	0.0561	0.1122
0	lemp	-0.000043	0.000231	0.0072	0.0072	-0.8514	0.8027	0.1973	0.3946
1	lemp	0.000490	0.000715	0.0082	0.0077	-0.6330	0.7366	0.2634	0.5268
2	lemp	0.000574	0.000874	0.0085	0.0089	-0.7694	0.7791	0.2209	0.4418
3	lemp	0.000494	0.000871	0.0071	0.0085	-1.0750	0.8587	0.1413	0.2825
4	lemp	0.000372	0.000794	0.0054	0.0076	-1.4231	0.9226	0.0774	0.1549
5	lemp	0.000259	0.000687	0.0040	0.0065	-1.7658	0.9612	**0.0388**	0.0776
6	lemp	0.000170	0.000577	0.0029	0.0054	-2.1008	0.9821	**0.0179**	**0.0358**
7	lemp	0.000105	0.000474	0.0022	0.0046	-2.3005	0.9892	**0.0108**	**0.0215**
8	lemp	0.000062	0.000384	0.0017	0.0038	-2.4513	0.9928	**0.0072**	**0.0143**
9	lemp	0.000034	0.000307	0.0013	0.0032	-2.4982	0.9937	**0.0063**	**0.0126**
10	lemp	0.000017	0.000243	0.0011	0.0027	-2.4751	0.9933	**0.0067**	**0.0134**
11	lemp	0.000006	0.000192	0.0009	0.0023	-2.3801	0.9913	**0.0087**	**0.0174**
12	lemp	0.000001	0.000150	0.0007	0.0019	-2.3044	0.9893	**0.0107**	**0.0213**
0	lgdp	-0.000112	-0.001325	0.0175	0.0176	1.5472	0.0610	0.9390	0.1220
1	lgdp	0.000023	0.000535	0.0220	0.0229	-0.5099	0.6949	0.3051	0.6102
2	lgdp	-0.000008	0.001510	0.0268	0.0305	-1.1824	0.8814	0.1186	0.2372
3	lgdp	-0.000080	0.001943	0.0267	0.0336	-1.4906	0.9319	0.0681	0.1362
4	lgdp	-0.000143	0.002049	0.0247	0.0349	-1.6220	0.9475	0.0525	0.1050
5	lgdp	-0.000182	0.001969	0.0220	0.0337	-1.6913	0.9545	**0.0455**	0.0909
6	lgdp	-0.000197	0.001793	0.0189	0.0315	-1.7124	0.9565	**0.0435**	0.0870
7	lgdp	-0.000193	0.001577	0.0157	0.0288	-1.7060	0.9559	**0.0441**	0.0882
8	lgdp	-0.000178	0.001352	0.0129	0.0252	-1.7078	0.9561	**0.0439**	0.0878
9	lgdp	-0.000157	0.001138	0.0104	0.0221	-1.6779	0.9532	**0.0468**	0.0935
10	lgdp	-0.000134	0.000944	0.0083	0.0191	-1.6392	0.9493	0.0507	0.1013
11	lgdp	-0.000111	0.000774	0.0066	0.0163	-1.5949	0.9445	0.0555	0.1109
12	lgdp	-0.000090	0.000629	0.0052	0.0137	-1.5538	0.9398	0.0602	0.1204

Funding increases are each equal to the same %

Time	Response variable	Mean response eastern regions	Mean response western regions	Std. Dev. response eastern regions	Std. Dev. response western regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	lhk	-0.000026	-0.000043	0.0112	0.0017	0.0471	0.4812	0.5188	0.9625
1	lhk	0.000104	0.000110	0.0130	0.0021	-0.0151	0.5060	0.4940	0.9880
2	lhk	0.000071	0.000174	0.0150	0.0026	-0.2139	0.5847	0.4153	0.8306
3	lhk	0.000010	0.000190	0.0143	0.0028	-0.3912	0.6521	0.3479	0.6957
4	lhk	-0.000040	0.000182	0.0125	0.0027	-0.5496	0.7087	0.2913	0.5826
5	lhk	-0.000070	0.000162	0.0104	0.0025	-0.6819	0.7523	0.2477	0.4954
6	lhk	-0.000081	0.000138	0.0083	0.0022	-0.8048	0.7895	0.2105	0.4210
7	lhk	-0.000081	0.000115	0.0066	0.0019	-0.9028	0.8166	0.1834	0.3667
8	lhk	-0.000073	0.000093	0.0051	0.0016	-0.9847	0.8375	0.1625	0.3249
9	lhk	-0.000063	0.000075	0.0039	0.0014	-1.0430	0.8515	0.1485	0.2971
10	lhk	-0.000052	0.000059	0.0030	0.0012	-1.0921	0.8625	0.1375	0.2749
11	lhk	-0.000041	0.000046	0.0023	0.0010	-1.1325	0.8712	0.1288	0.2575
12	lhk	-0.000032	0.000036	0.0017	0.0008	-1.1483	0.8745	0.1255	0.2510
0	lemp	-0.000043	0.000035	0.0072	0.0011	-0.3378	0.6322	0.3678	0.7355
1	lemp	0.000490	0.000108	0.0082	0.0012	1.4616	0.0720	0.9280	0.1440
2	lemp	0.000574	0.000132	0.0085	0.0013	1.6182	0.0529	0.9471	0.1058
3	lemp	0.000494	0.000132	0.0071	0.0013	1.5774	0.0574	0.9426	0.1149
4	lemp	0.000372	0.000120	0.0054	0.0012	1.4331	0.0760	0.9240	0.1520
5	lemp	0.000259	0.000104	0.0040	0.0010	1.1771	0.1197	0.8803	0.2393
6	lemp	0.000170	0.000087	0.0029	0.0008	0.8506	0.1975	0.8025	0.3951
7	lemp	0.000105	0.000072	0.0022	0.0007	0.4598	0.3228	0.6772	0.6457
8	lemp	0.000062	0.000058	0.0017	0.0006	0.0678	0.4730	0.5270	0.9459
9	lemp	0.000034	0.000046	0.0013	0.0005	-0.2787	0.6097	0.3903	0.7805
10	lemp	0.000017	0.000037	0.0011	0.0004	-0.5420	0.7060	0.2940	0.5879
11	lemp	0.000006	0.000029	0.0009	0.0003	-0.7426	0.7711	0.2289	0.4578
12	lemp	0.000001	0.000023	0.0007	0.0003	-0.8950	0.8146	0.1854	0.3709
0	lgdp	-0.000112	-0.000201	0.0175	0.0027	0.1582	0.4372	0.5628	0.8743
1	lgdp	0.000023	0.000081	0.0220	0.0035	-0.0829	0.5330	0.4670	0.9339
2	lgdp	-0.000008	0.000229	0.0268	0.0046	-0.2752	0.6084	0.3916	0.7832
3	lgdp	-0.000080	0.000294	0.0267	0.0051	-0.4344	0.6680	0.3320	0.6640
4	lgdp	-0.000143	0.000310	0.0247	0.0053	-0.5679	0.7149	0.2851	0.5702
5	lgdp	-0.000182	0.000298	0.0220	0.0051	-0.6716	0.7491	0.2509	0.5019
6	lgdp	-0.000197	0.000272	0.0189	0.0048	-0.7605	0.7765	0.2235	0.4471
7	lgdp	-0.000193	0.000239	0.0157	0.0044	-0.8389	0.7992	0.2008	0.4017
8	lgdp	-0.000178	0.000205	0.0129	0.0038	-0.8986	0.8155	0.1845	0.3690
9	lgdp	-0.000157	0.000172	0.0104	0.0033	-0.9509	0.8291	0.1709	0.3418
10	lgdp	-0.000134	0.000143	0.0083	0.0029	-1.0000	0.8413	0.1587	0.3174
11	lgdp	-0.000111	0.000117	0.0066	0.0025	-1.0302	0.8485	0.1515	0.3031
12	lgdp	-0.000090	0.000095	0.0052	0.0021	-1.0535	0.8539	0.1461	0.2922

Notes: diff = mean(formula-based grant intensity) - mean(overall GRW intensity); H_0: diff = 0; degrees of freedom = 1198

Figures

Figure 1: Annual formula-based grants and formula-based grant intensity, 2000 - 2011

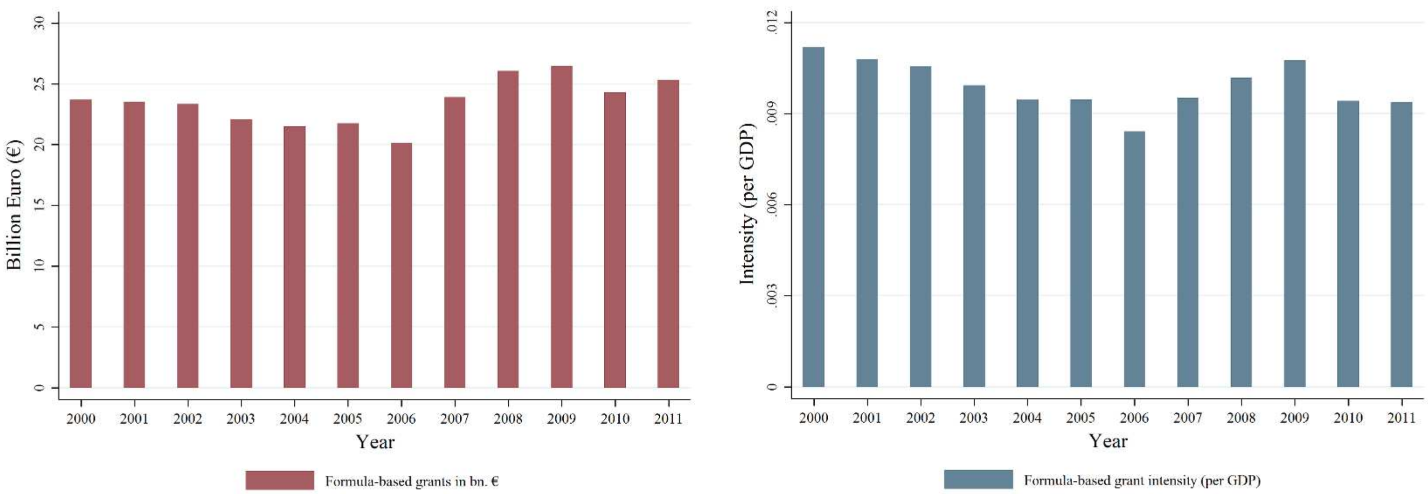


Figure 2: Formula-based grant intensities in German labour market regions, 2000 – 2011

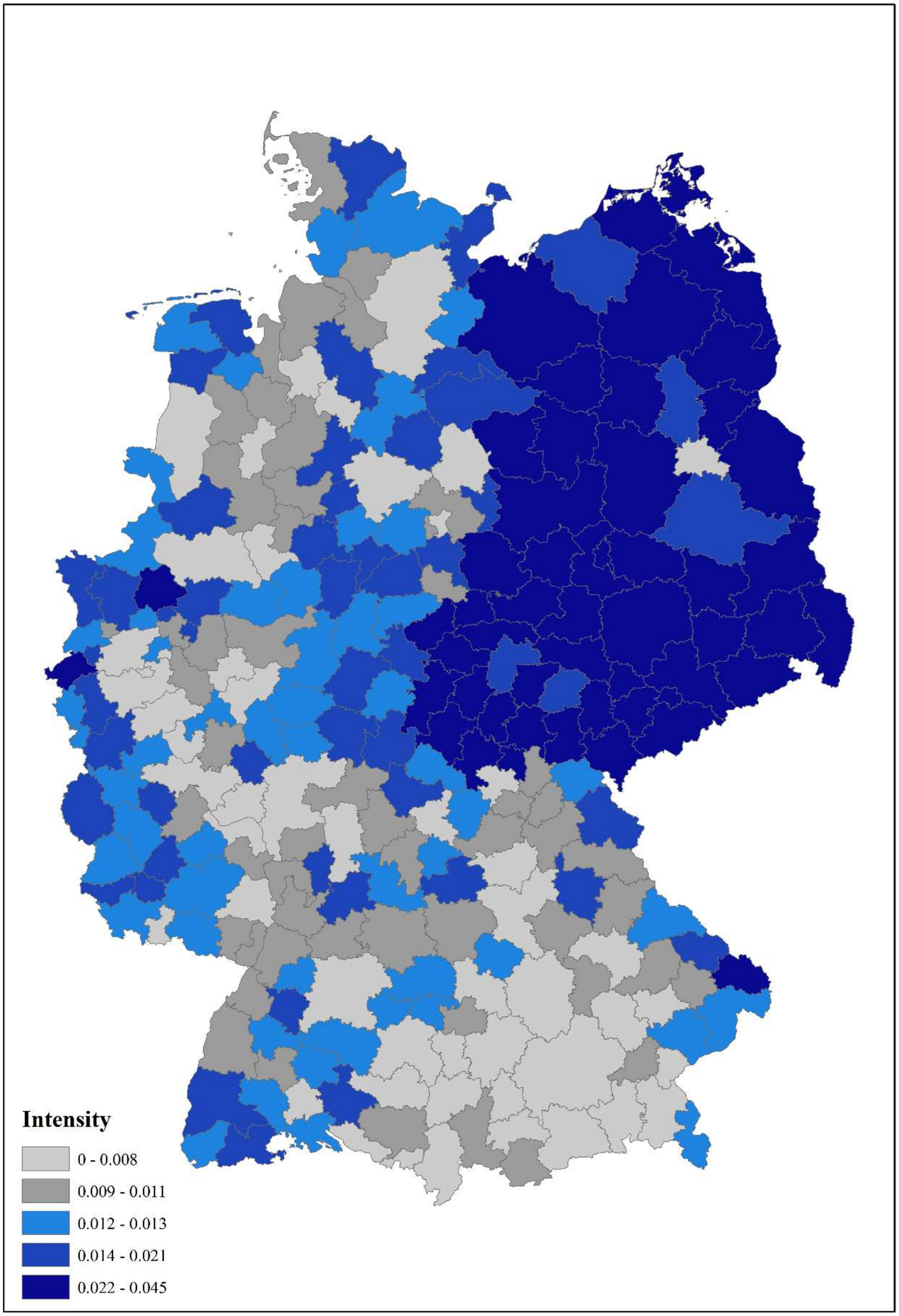


Figure 3: Spatial patterns highest share of second votes Bundestag elections 1998

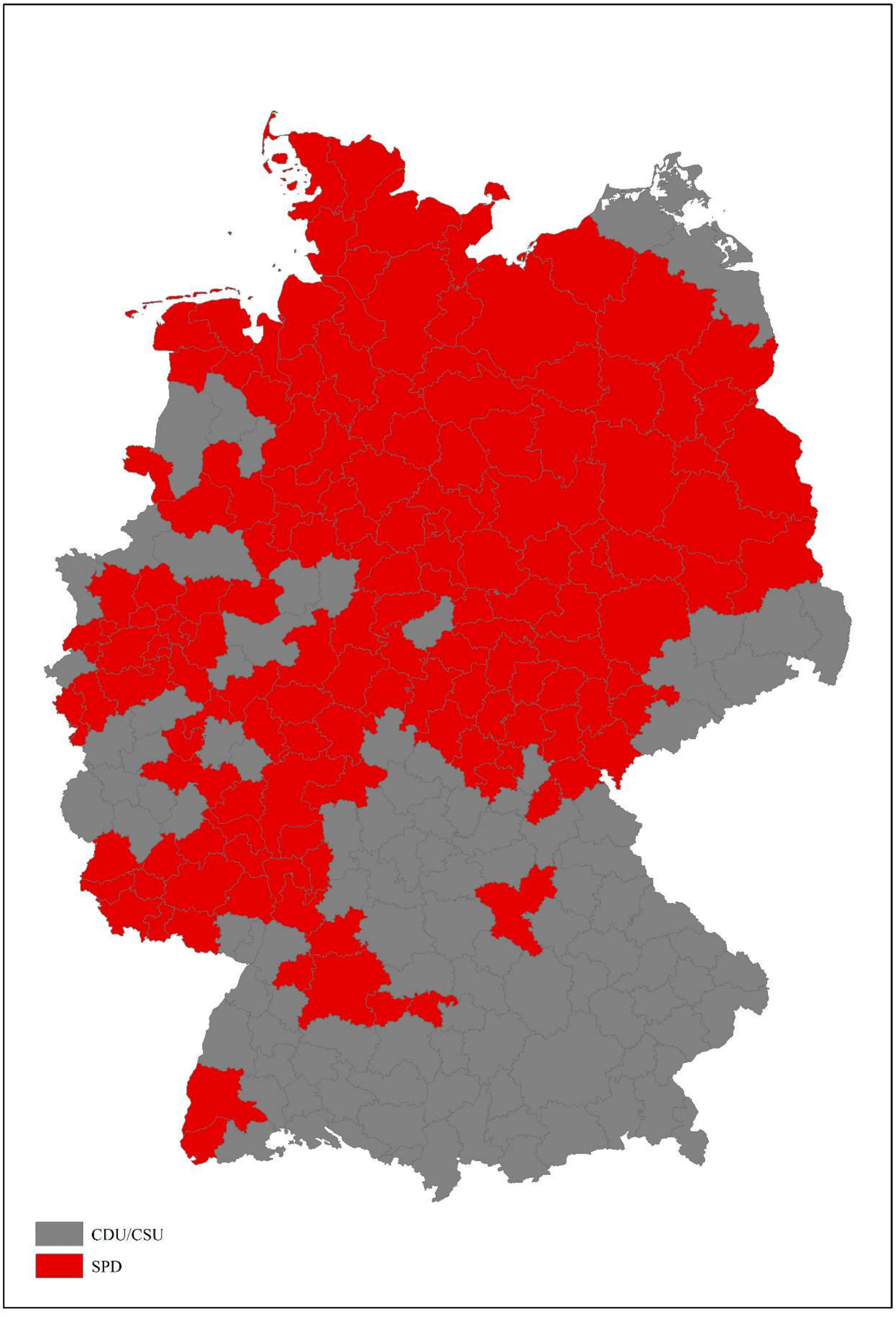


Figure 4: Spatial patterns highest share of second votes Bundestag elections 1998, 2002 and 2005

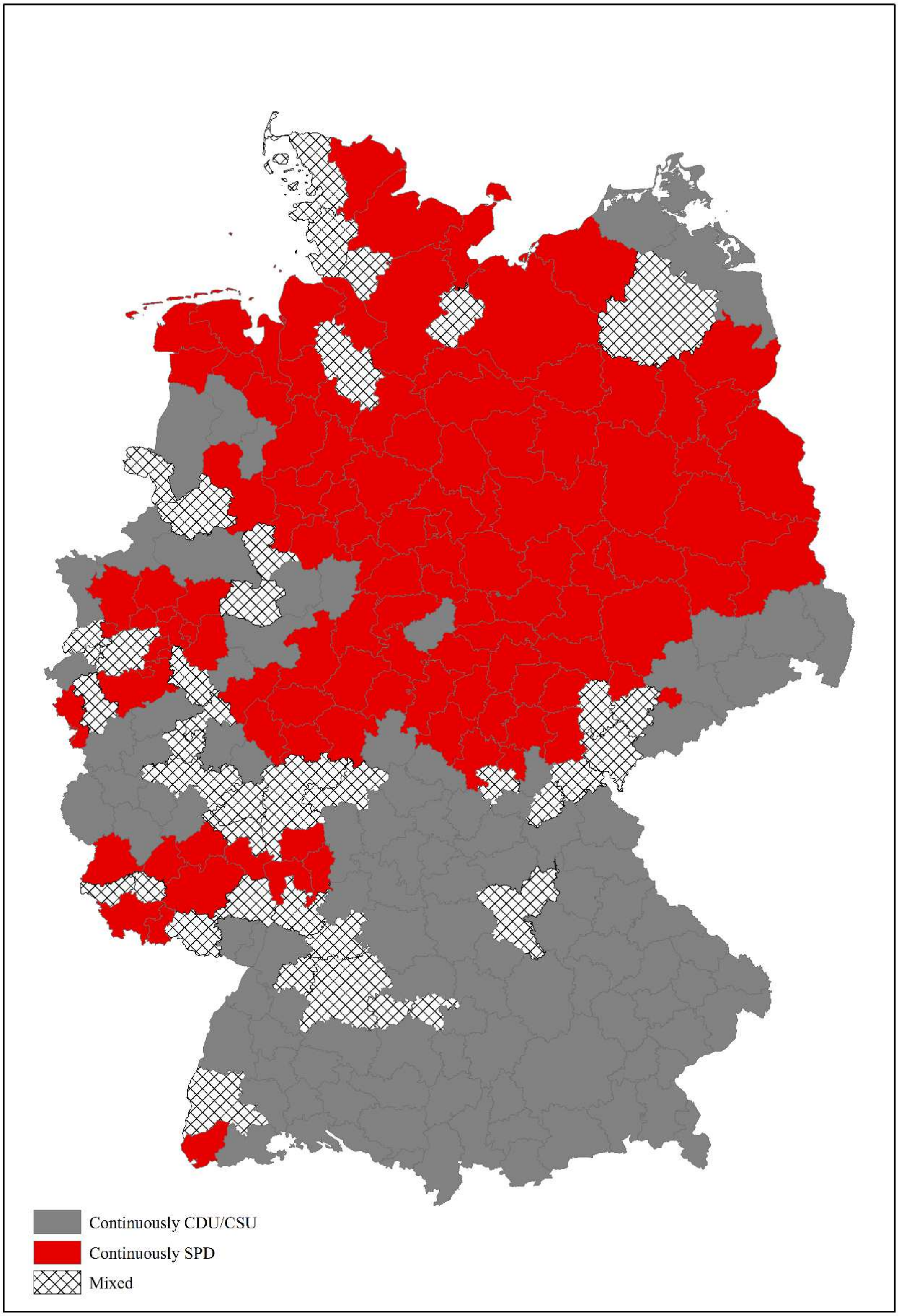
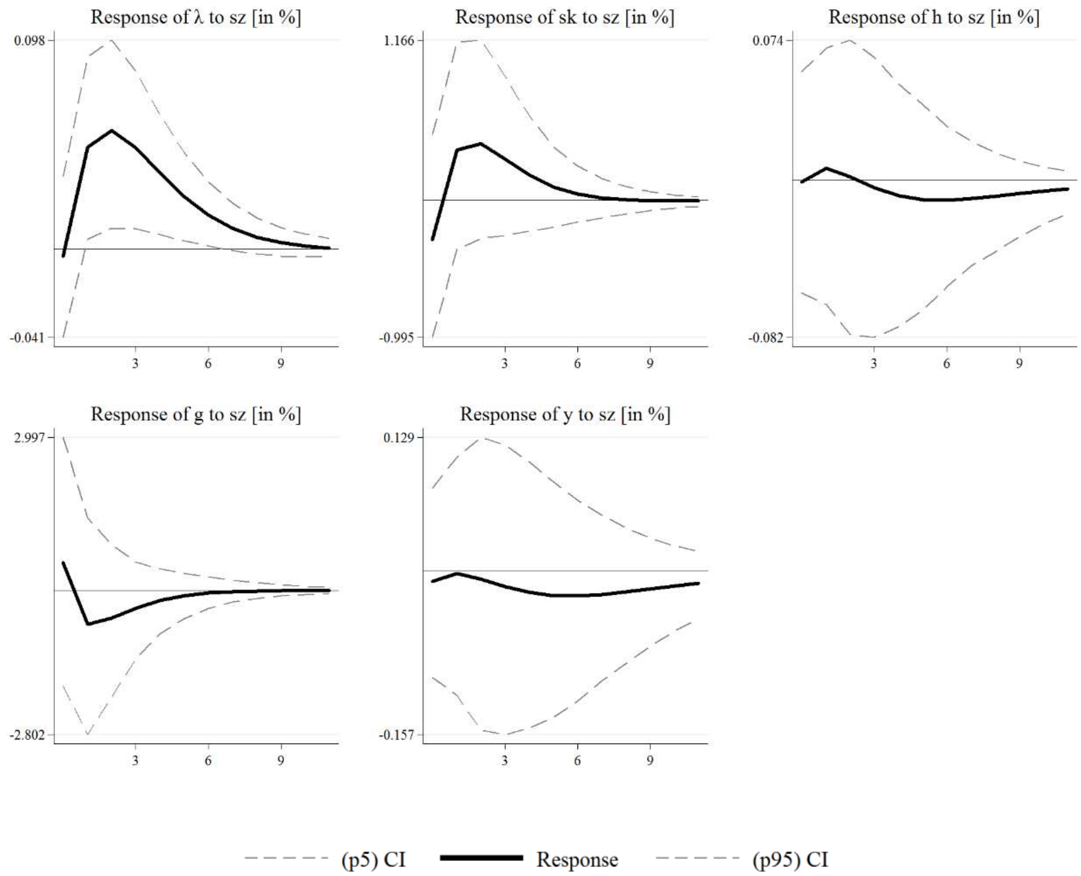
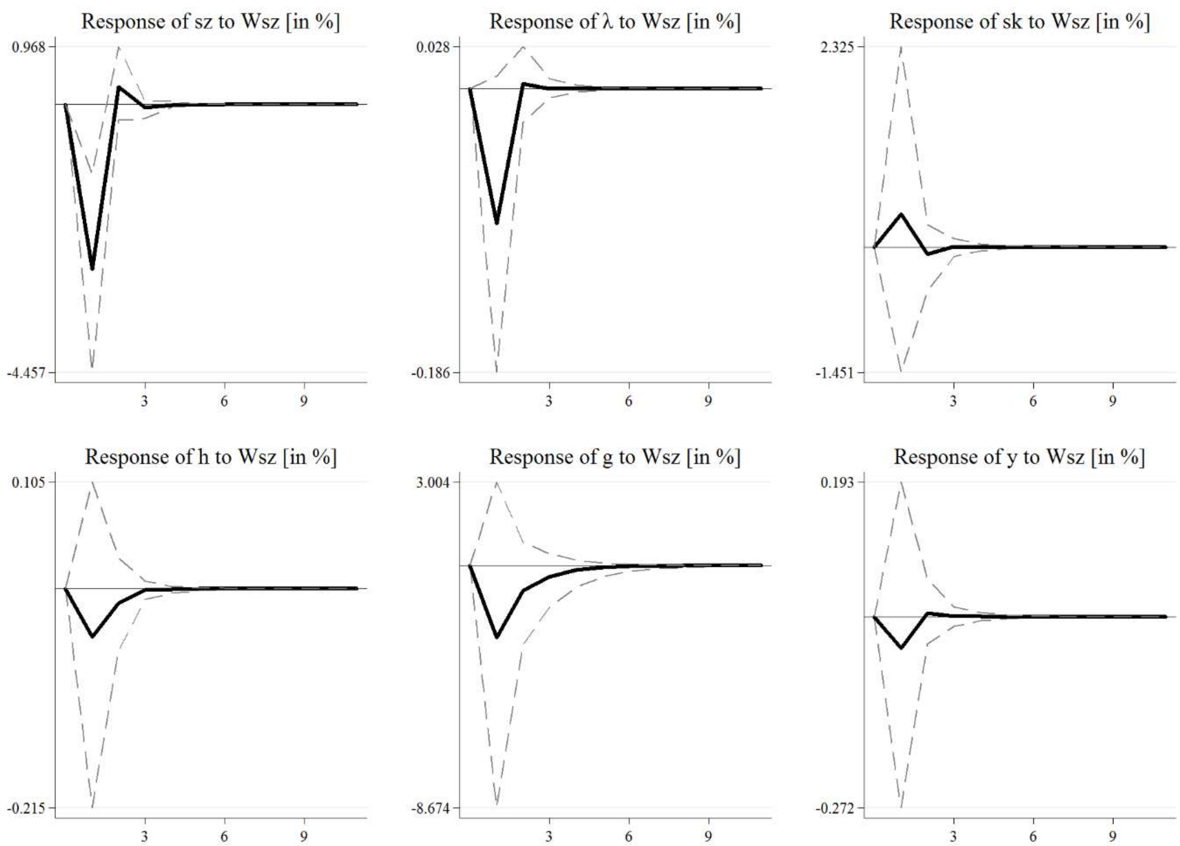


Figure 5: Impulse-response function analysis formula-based grants (spatially direct effects), basic model



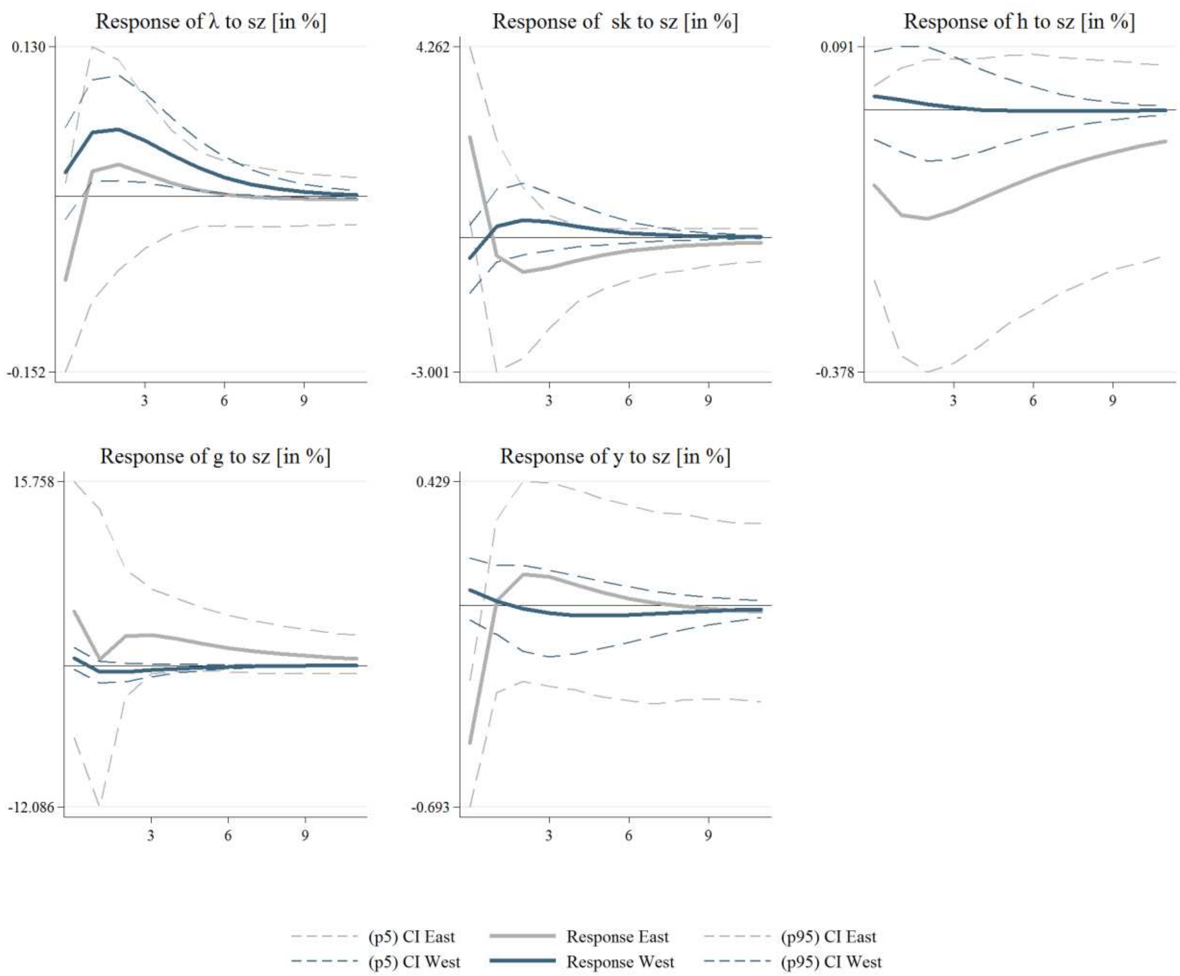
Notes: The solid lines present the responses to an increase in the formula-based grant intensity, the dotted lines show the confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure 6: Impulse-response function analysis formula-based grants (spatially indirect effects), basic model



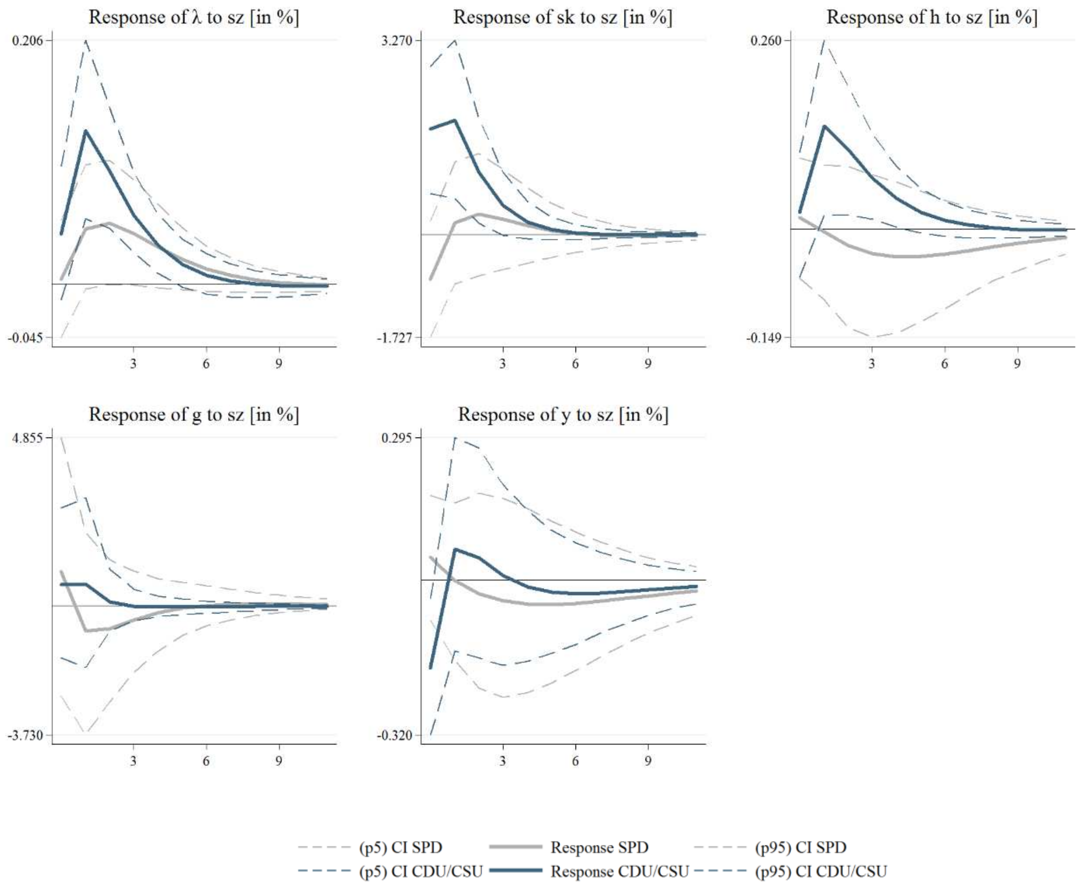
Notes: The solid lines present the responses to an increase in the formula-based grant intensity, the dotted lines show the confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure 7: Impulse-response function analysis formula-based grants, East – West German labour market regions



Notes: The solid lines present the responses to an increase in the formula-based grant intensity in East (grey) and West German regions (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure 8: Impulse-response function analysis formula-based grants, Share of votes SPD – CDU/CSU



Notes: The solid lines present the responses to an increase in the formula-based grant intensity in regions with a major share of voters for the SPD (grey) and the CDU/CSU (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Appendix

Table A1: Variable description and construction

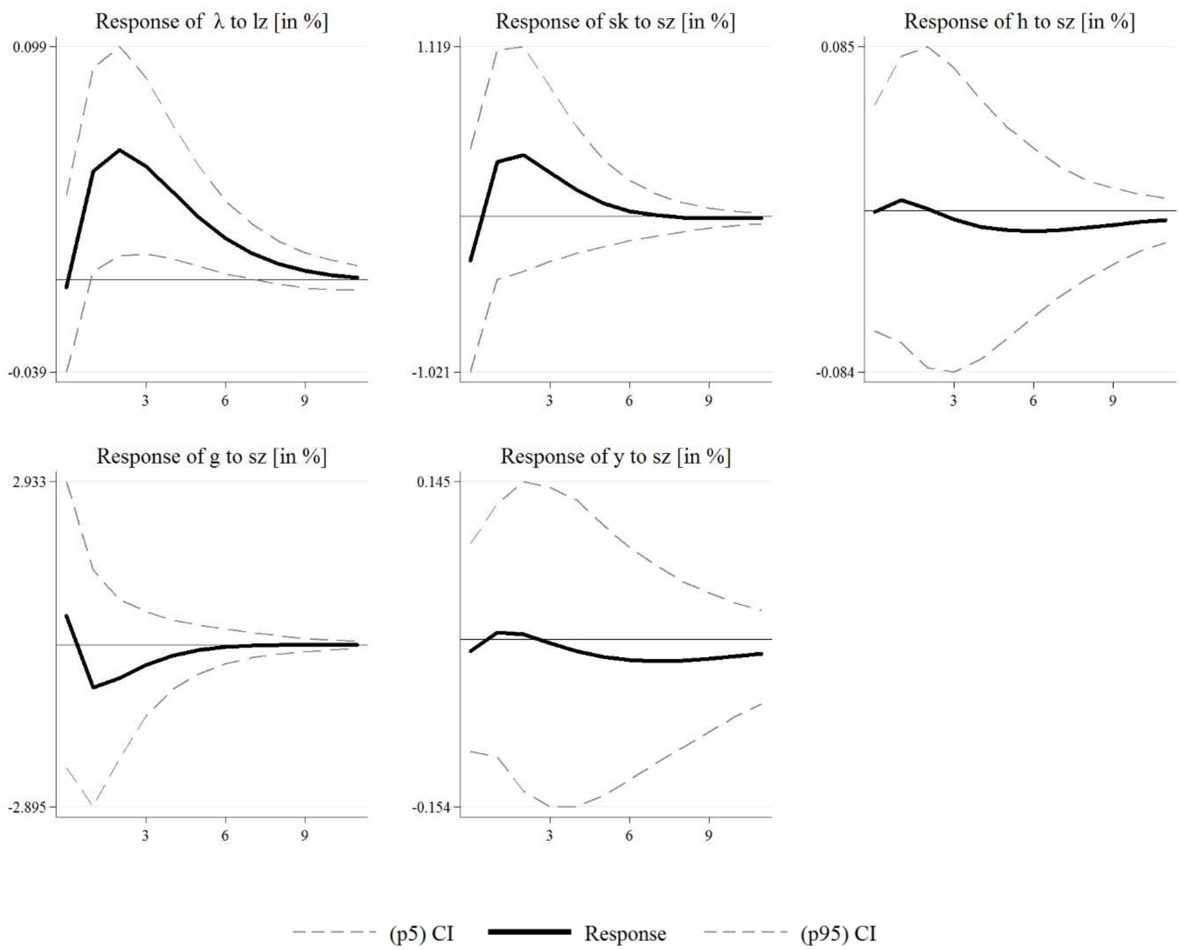
Description	Shortcut	Construction	Data source
Nominal GDP per economically active working population (workforce)	y	ln[GDP in € / (Population aged 15 to 64 years × Participation rate)] *Note*: Population data is based on the extrapolation of the census 1987. The participation rate is based on the same population data until the year 2011. From 2011, the participation rate is calculated based on the population data of the census 2011.	GDP: Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" (Status: August 2015) Population aged 15 to 64 years: Regionaldatenbank Deutschland (Based on the population census 1987) Partizipation rate: Statistik der Bundesagentur für Arbeit / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR)
Private-sector physical capital intensity (manufacturing, mining and quarrying sector)	s_k	ln[Industry investments in € / GDP in €] *Note*: Missing values for the industry investments are interpolated on the basis of an autoregressive process with 3 lags.	Bundesinstitut für Bau-, Stadt-, und Raumforschung (BBSR), laufende Raumbeobachtungen, various issues
Higher education rate	h	ln[Employees with university degree / (Population aged 15 to 64 years × Participation rate)] *Note:* Potential data imperfections related to the registration of the qualification of employees are assumed to be random.	Institute for Employment Research (IAB), Nuremberg
Gross employment rate	λ	ln[Employees total / (Population aged 15 to 64 years × Participation rate)]	Institute for Employment Research (IAB), Nuremberg
Patent intensity (in ln)	g	ln[Patents / GDP in Mio. €]	Own calculation from the PATSTAT database (Version October 2014, European Patent Office)
Formula-based grant intensity (in ln)	s_z	ln[Formula-based grants in € / GDP in €]	Bundesinstitut für Bau-, Stadt-, und Raumforschung (BBSR)
Spatial lag variables	Wx	Spatial lags for each variable are constructed in absolute values using the STATA command splagvar and a binary first-order neighborhood matrix. Thereupon, all spatial lag variables are normalized and ln-transformed similar to the non-spatial variables above.	
Further public funding intensity (control variable for formula-based grant intensity)		ln[Sum of further public funding programmes in € / GDP in €] *Note*: This variable covers regional investment data for the GRW program, urban development promotion programmes, project funding programmes of the Federal Ministry of Education and Research (BMBF) and further German Ministries as well as programmes of the Reconstruction Credit Institute (KfW) (Start-up, Infrastructure, Innovation, Environment and Living investments)	GRW: Federal Office for Economic Affairs and Export Control (BAFA) Further public funding programmes: Bundesinstitut für Bau-, Stadt-, und Raumforschung (BBSR)
Votes SPD and CDU/CSU Bundestag election 1998		Second votes SPD (CDU/CSU)/total second votes	Allgemeine Bundestagswahlstatistik des Bundes und der Länder/ INKAR
Overall GRW intensity (industry and infrastructure investments)	grw	ln[GRW funding volumes in € / GDP in €].	BAFA

Table A2: Panel unit-root test

Variable	Number of years	Test-statistic	p-value
Y	12	-4.122	0.000
Λ	12	-0.345	0.365
λ_detrended	12	-16.080	0.000
H	12	0.130	0.552
h_detrended	12	-17.616	0.000
Sk	12	-17.582	0.000
G	12	-17.446	0.000
Sz	12	-6.591	0.000
sz_detrended	12	-22.989	0.000
w_y	12	-3.376	0.000
w_λ	12	-1.410	0.079
w_λ_detrended	12	-17.756	0.000
w_h	12	0.011	0.504
w_h_detrended	12	-18.114	0.000
w_sk	12	-15.190	0.000
w_g	12	-13.691	0.000
w_sz	12	-4.567	0.000
Further public funding intensity	12	-17.276	0.000
w_further public funding intensity	12	-10.387	0.000

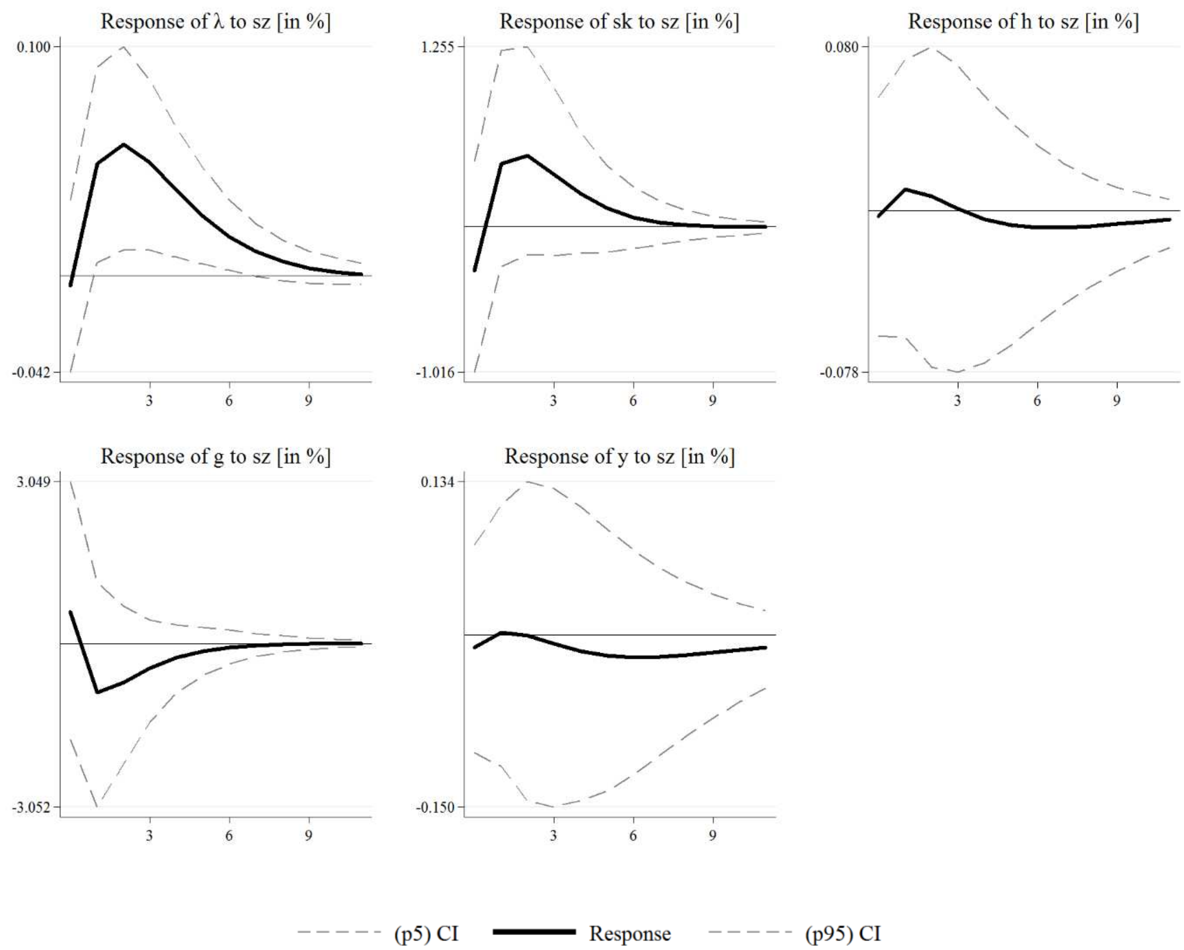
Notes: Panel unit-root test based on Im, Pesaran, & Shin (2003). H0: All panels contain unit roots. HA: Some panels are stationary. The suffix "_detrended" indicates a detrended variable.

Figure A3: Impulse-response function analysis formula-based grants, particular spatial lag depend variable excluded



Notes: The solid lines present the responses to an increase in the formula-based grant intensity, the dotted lines show the confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure A4: Impulse-response function analysis formula-based grants, control variables added



Notes: The solid lines present the responses to an increase in the formula-based grant intensity, the dotted lines show the confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Table A5: t-test analysis comparing economic responses to an increase in the formula-based grant intensity, East-West classification (based on Figure 7)

Funding increases are each equal to one standard deviation

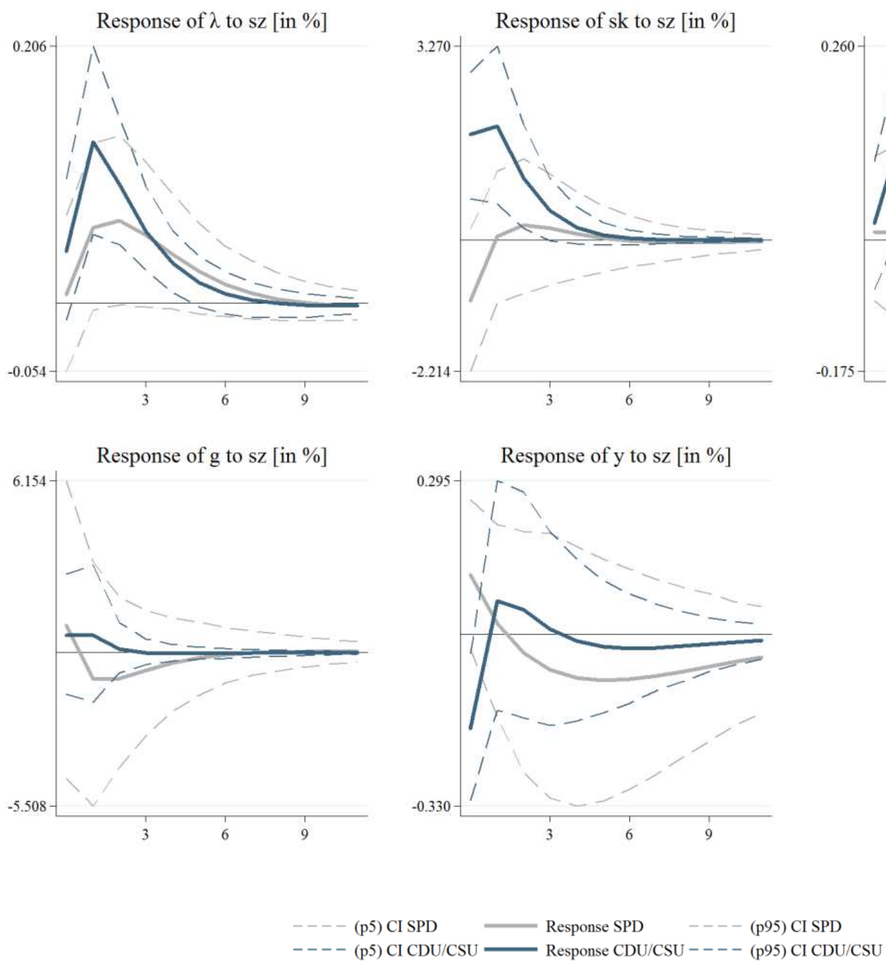
Time	Response variable	Mean response eastern regions	Mean response western regions	Std. Dev. response eastern regions	Std. Dev. response western regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	linvq	0.022494	-0.004710	0.3737	0.1453	2.1456	**0.0160**	0.9840	**0.0320**
1	linvq	-0.004048	0.002430	0.4966	0.1551	-0.3938	0.6531	0.3469	0.6938
2	linvq	-0.007782	0.003925	0.3664	0.1533	-0.9320	0.8243	0.1757	0.3514
3	linvq	-0.006760	0.003416	0.2416	0.1234	-1.1860	0.8821	0.1179	0.2358
4	linvq	-0.005180	0.002464	0.1653	0.0919	-1.2781	0.8993	0.1007	0.2014
5	linvq	-0.003910	0.001617	0.1299	0.0667	-1.1969	0.8843	0.1157	0.2315
6	linvq	-0.003006	0.001000	0.1120	0.0461	-1.0456	0.8521	0.1479	0.2959
7	linvq	-0.002371	0.000591	0.0986	0.0312	-0.9056	0.8174	0.1826	0.3653
8	linvq	-0.001914	0.000336	0.0898	0.0210	-0.7713	0.7797	0.2203	0.4406
9	linvq	-0.001574	0.000184	0.0801	0.0140	-0.6839	0.7529	0.2471	0.4941
10	linvq	-0.001312	0.000096	0.0744	0.0096	-0.5935	0.7236	0.2764	0.5529
11	linvq	-0.001104	0.000046	0.0701	0.0065	-0.5170	0.6974	0.3026	0.6052
12	linvq	-0.000935	0.000020	0.0657	0.0044	-0.4588	0.6768	0.3232	0.6464
0	lemp	-0.000728	0.000204	0.0156	0.0076	-1.6957	0.9549	**0.0451**	0.0901
1	lemp	0.000217	0.000553	0.0211	0.0085	-0.4666	0.6796	0.3204	0.6408
2	lemp	0.000275	0.000577	0.0175	0.0087	-0.4884	0.6873	0.3127	0.6253
3	lemp	0.000193	0.000480	0.0125	0.0074	-0.6266	0.7345	0.2655	0.5310
4	lemp	0.000111	0.000358	0.0086	0.0057	-0.7541	0.7746	0.2254	0.4509
5	lemp	0.000054	0.000249	0.0063	0.0042	-0.8172	0.7931	0.2069	0.4139
6	lemp	0.000018	0.000164	0.0053	0.0030	-0.7532	0.7743	0.2257	0.4514
7	lemp	-0.000003	0.000104	0.0051	0.0021	-0.6137	0.7303	0.2697	0.5395
8	lemp	-0.000015	0.000063	0.0047	0.0016	-0.4984	0.6909	0.3091	0.6183
9	lemp	-0.000022	0.000036	0.0043	0.0011	-0.4108	0.6594	0.3406	0.6812
10	lemp	-0.000026	0.000019	0.0041	0.0009	-0.3372	0.6320	0.3680	0.7360
11	lemp	-0.000027	0.000009	0.0039	0.0007	-0.2891	0.6137	0.3863	0.7725
12	lemp	-0.000027	0.000004	0.0038	0.0005	-0.2570	0.6014	0.3986	0.7972
0	lgdp	-0.004730	0.000549	0.0415	0.0204	-3.6109	0.9998	**0.0002**	**0.0003**
1	lgdp	0.000158	0.000166	0.0573	0.0230	-0.0043	0.5017	0.4983	0.9966
2	lgdp	0.001078	-0.000104	0.0663	0.0283	0.5188	0.3020	0.6980	0.6040
3	lgdp	0.000997	-0.000260	0.0674	0.0288	0.5428	0.2937	0.7063	0.5874
4	lgdp	0.000721	-0.000330	0.0665	0.0258	0.4659	0.3207	0.6793	0.6413
5	lgdp	0.000459	-0.000342	0.0657	0.0221	0.3653	0.3575	0.6425	0.7149
6	lgdp	0.000252	-0.000319	0.0649	0.0186	0.2676	0.3945	0.6055	0.7891
7	lgdp	0.000096	-0.000280	0.0635	0.0148	0.1827	0.4275	0.5725	0.8550
8	lgdp	-0.000018	-0.000236	0.0616	0.0117	0.1100	0.4562	0.5438	0.9125
9	lgdp	-0.000100	-0.000192	0.0597	0.0092	0.0481	0.4808	0.5192	0.9616
10	lgdp	-0.000159	-0.000153	0.0583	0.0072	-0.0033	0.5013	0.4987	0.9974
11	lgdp	-0.000199	-0.000119	0.0590	0.0056	-0.0429	0.5171	0.4829	0.9658
12	lgdp	-0.000226	-0.000091	0.0589	0.0043	-0.0722	0.5288	0.4712	0.9424

Funding increases are each equal to the same %

Time	Response variable	Mean response eastern regions	Mean response western regions	Std. Dev. response eastern regions	Std. Dev. response western regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	linvq	0.022494	-0.002257	0.3737	0.0697	2.0591	**0.0198**	0.9802	**0.0396**
1	linvq	-0.004048	0.001164	0.4966	0.0743	-0.3283	0.6286	0.3714	0.7427
2	linvq	-0.007782	0.001881	0.3664	0.0735	-0.8176	0.7932	0.2068	0.4137
3	linvq	-0.006760	0.001637	0.2416	0.0591	-1.0674	0.8570	0.1430	0.2859
4	linvq	-0.005180	0.001181	0.1653	0.0441	-1.1759	0.8801	0.1199	0.2398
5	linvq	-0.003910	0.000775	0.1299	0.0320	-1.1073	0.8659	0.1341	0.2683
6	linvq	-0.003006	0.000479	0.1120	0.0221	-0.9651	0.8327	0.1673	0.3346
7	linvq	-0.002371	0.000283	0.0986	0.0150	-0.8415	0.7999	0.2001	0.4001
8	linvq	-0.001914	0.000161	0.0898	0.0101	-0.7259	0.7660	0.2340	0.4680
9	linvq	-0.001574	0.000088	0.0801	0.0067	-0.6542	0.7435	0.2565	0.5130
10	linvq	-0.001312	0.000046	0.0744	0.0046	-0.5762	0.7177	0.2823	0.5646
11	linvq	-0.001104	0.000022	0.0701	0.0031	-0.5078	0.6942	0.3058	0.6117
12	linvq	-0.000935	0.000009	0.0657	0.0021	-0.4547	0.6753	0.3247	0.6494
0	lemp	-0.000728	0.000098	0.0156	0.0037	-1.6285	0.9482	0.0518	0.1036
1	lemp	0.000217	0.000265	0.0211	0.0041	-0.0701	0.5280	0.4720	0.9441
2	lemp	0.000275	0.000276	0.0175	0.0042	-0.0023	0.5009	0.4991	0.9982
3	lemp	0.000193	0.000230	0.0125	0.0036	-0.0913	0.5364	0.4636	0.9273
4	lemp	0.000111	0.000172	0.0086	0.0028	-0.2113	0.5837	0.4163	0.8327
5	lemp	0.000054	0.000119	0.0063	0.0020	-0.3139	0.6232	0.3768	0.7536
6	lemp	0.000018	0.000079	0.0053	0.0014	-0.3465	0.6355	0.3645	0.7290
7	lemp	-0.000003	0.000050	0.0051	0.0010	-0.3233	0.6267	0.3733	0.7465
8	lemp	-0.000015	0.000030	0.0047	0.0008	-0.3022	0.6187	0.3813	0.7625
9	lemp	-0.000022	0.000017	0.0043	0.0005	-0.2856	0.6124	0.3876	0.7752
10	lemp	-0.000026	0.000009	0.0041	0.0004	-0.2658	0.6048	0.3952	0.7904
11	lemp	-0.000027	0.000004	0.0039	0.0003	-0.2528	0.5998	0.4002	0.8004
12	lemp	-0.000027	0.000002	0.0038	0.0002	-0.2426	0.5958	0.4042	0.8083
0	lgdp	-0.004730	0.000263	0.0415	0.0098	-3.7036	0.9999	**0.0001**	**0.0002**
1	lgdp	0.000158	0.000080	0.0573	0.0110	0.0424	0.4831	0.5169	0.9662
2	lgdp	0.001078	-0.000050	0.0663	0.0136	0.5274	0.2990	0.7010	0.5980
3	lgdp	0.000997	-0.000125	0.0674	0.0138	0.5159	0.3030	0.6970	0.6060
4	lgdp	0.000721	-0.000158	0.0665	0.0124	0.4111	0.3405	0.6595	0.6811
5	lgdp	0.000459	-0.000164	0.0657	0.0106	0.2959	0.3837	0.6163	0.7673
6	lgdp	0.000252	-0.000153	0.0649	0.0089	0.1954	0.4226	0.5774	0.8451
7	lgdp	0.000096	-0.000134	0.0635	0.0071	0.1142	0.4546	0.5454	0.9091
8	lgdp	-0.000018	-0.000113	0.0616	0.0056	0.0488	0.4806	0.5194	0.9611
9	lgdp	-0.000100	-0.000092	0.0597	0.0044	-0.0042	0.5017	0.4983	0.9966
10	lgdp	-0.000159	-0.000073	0.0583	0.0035	-0.0463	0.5185	0.4815	0.9631
11	lgdp	-0.000199	-0.000057	0.0590	0.0027	-0.0762	0.5304	0.4696	0.9393
12	lgdp	-0.000226	-0.000044	0.0589	0.0020	-0.0979	0.5390	0.4610	0.9220

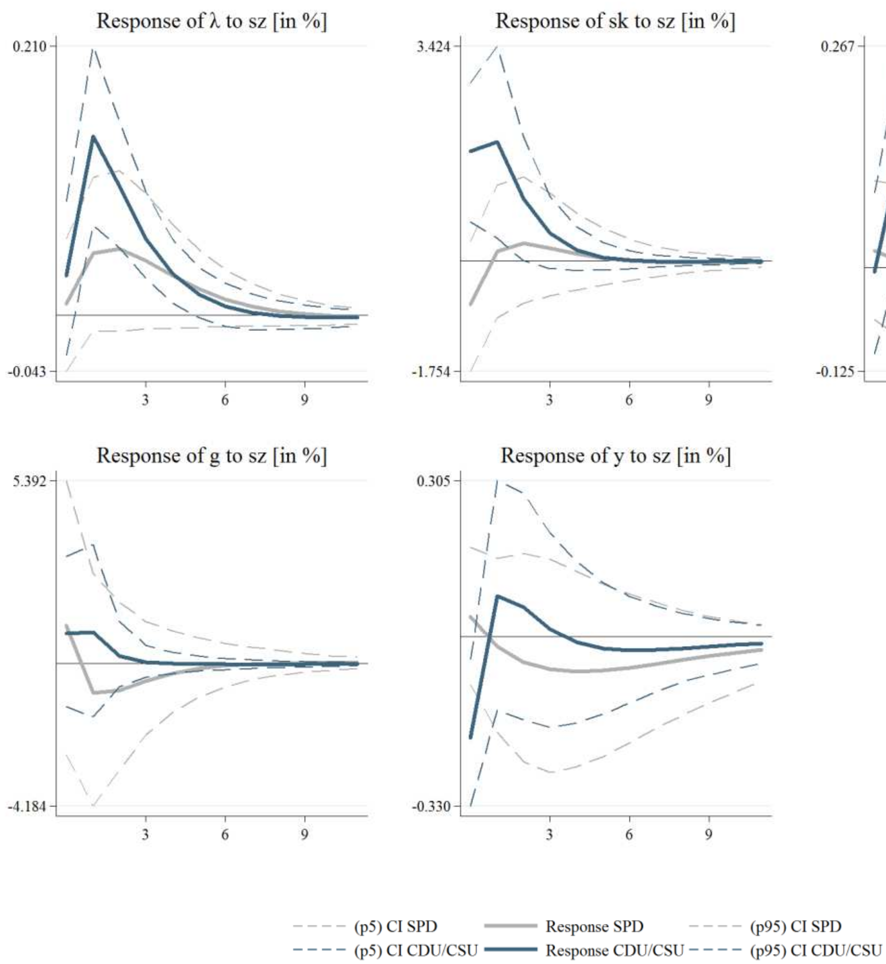
Notes: diff = mean(eastern_regions) - mean(western_regions); H_0: diff = 0; degrees of freedom = 1198

Figure A6: Impulse-response function analysis formula-based grants, Share of votes SPD – CDU/CSU considering subsequent Bundestag elections



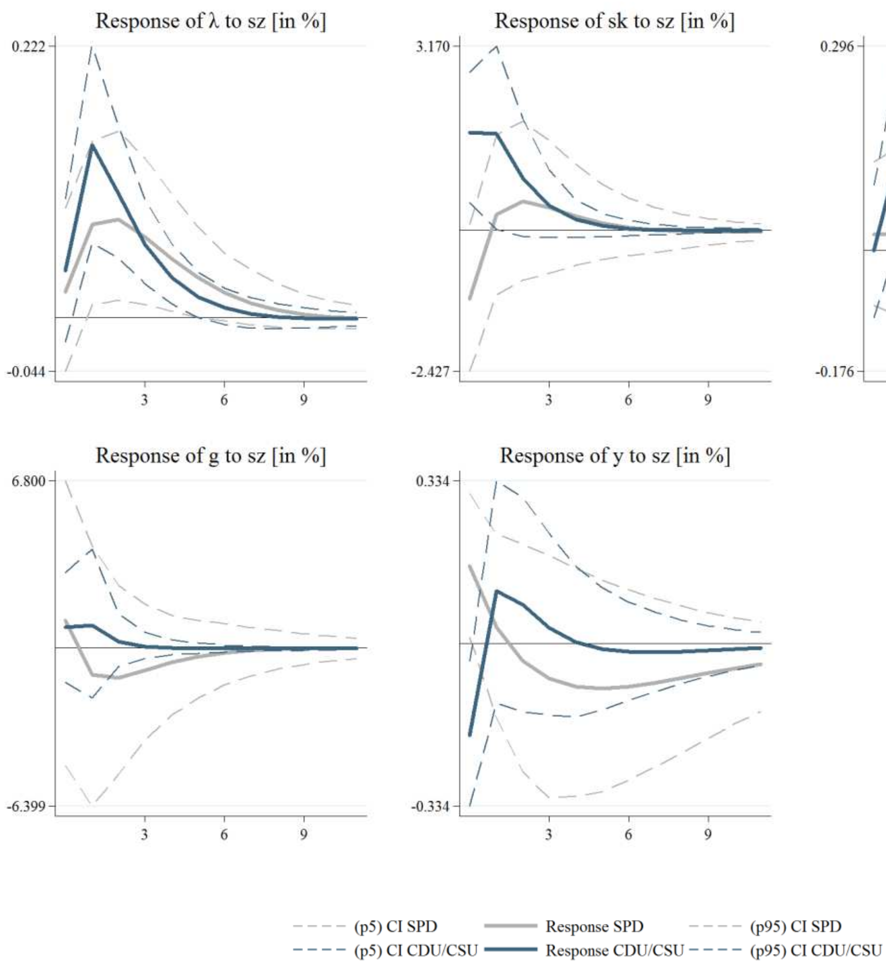
Notes: The solid lines present the responses to an increase in the formula-based grant intensity in regions with a major share of voters for the SPD (grey) and the CDU/CSU (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure A7: Impulse-response function analysis formula-based grants, Share of votes SPD – CDU/CSU considering inherent districts



Notes: The solid lines present the responses to an increase in the formula-based grant intensity in regions with a major share of voters for the SPD (grey) and the CDU/CSU (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

Figure A8: Impulse-response function analysis formula-based grants, Share of votes SPD – CDU/CSU considering inherent districts and subsequent Bundestag elections



Notes: The solid lines present the responses to an increase in the formula-based grant intensity in regions with a major share of voters for the SPD (grey) and the CDU/CSU (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.

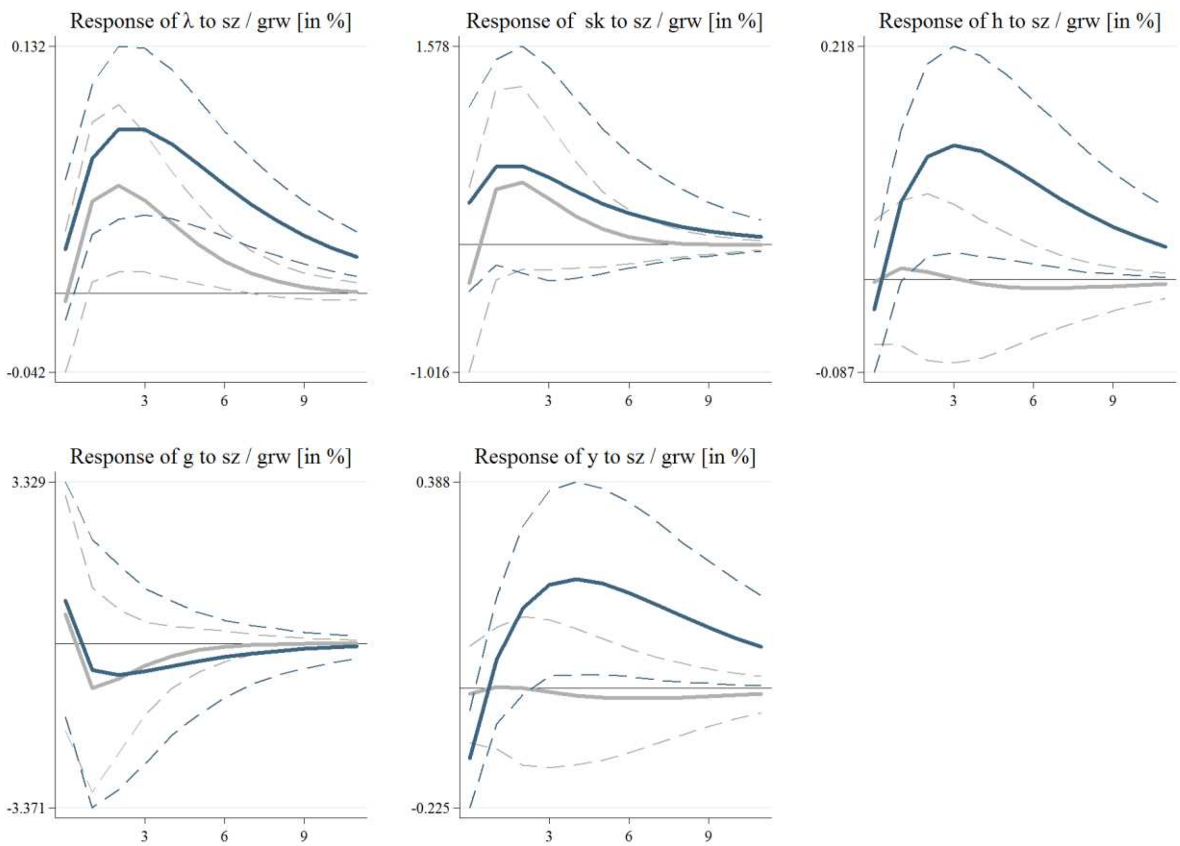
Table A9: t-test analysis comparing economic responses to an increase in the formula-based grant intensity, SPD-CDU/CSU classification (based on Figure A8)

Funding increases are each equal to one standard deviation									
Time	Response variable	Mean response SPD regions	Mean response CDU/CSU regions	Std. Dev. response SPD regions	Std. Dev. response CDU/CSU regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	lhk	0.000224	-0.000013	0.0200	0.0184	0.2762	0.3912	0.6088	0.7824
1	lhk	0.000240	0.001530	0.0238	0.0263	-1.1505	0.8750	0.1250	0.2501
2	lhk	0.000095	0.001180	0.0293	0.0200	-0.9684	0.8335	0.1665	0.3330
3	lhk	-0.000051	0.000746	0.0314	0.0137	-0.7350	0.7688	0.2312	0.4625
4	lhk	-0.000150	0.000442	0.0305	0.0093	-0.5865	0.7212	0.2788	0.5576
5	lhk	-0.000200	0.000250	0.0274	0.0067	-0.5043	0.6929	0.3071	0.6141
6	lhk	-0.000211	0.000134	0.0236	0.0049	-0.4538	0.6750	0.3250	0.6500
7	lhk	-0.000199	0.000067	0.0204	0.0038	-0.4044	0.6570	0.3430	0.6860
8	lhk	-0.000174	0.000029	0.0174	0.0030	-0.3639	0.6420	0.3580	0.7160
9	lhk	-0.000144	0.000008	0.0145	0.0023	-0.3278	0.6284	0.3716	0.7431
10	lhk	-0.000115	-0.000002	0.0122	0.0018	-0.2883	0.6134	0.3866	0.7731
11	lhk	-0.000088	-0.000007	0.0101	0.0014	-0.2511	0.5991	0.4009	0.8017
12	lhk	-0.000065	-0.000008	0.0083	0.0011	-0.2161	0.5855	0.4145	0.8289
0	linvq	-0.011851	0.016774	0.2425	0.2153	-2.7916	0.9974	**0.0026**	**0.0053**
1	linvq	0.002690	0.016540	0.2640	0.3029	-1.0900	0.8621	0.1379	0.2758
2	linvq	0.004998	0.008923	0.2623	0.1946	-0.3800	0.6480	0.3520	0.7040
3	linvq	0.003889	0.004191	0.2187	0.1115	-0.0389	0.5155	0.4845	0.9690
4	linvq	0.002339	0.001816	0.1671	0.0627	0.0927	0.4631	0.5369	0.9262
5	linvq	0.001146	0.000710	0.1241	0.0392	0.1060	0.4578	0.5422	0.9156
6	linvq	0.000394	0.000222	0.0949	0.0257	0.0552	0.4780	0.5220	0.9560
7	linvq	-0.000022	0.000023	0.0746	0.0178	-0.0185	0.5074	0.4926	0.9852
8	linvq	-0.000221	-0.000047	0.0566	0.0125	-0.0947	0.5377	0.4623	0.9246
9	linvq	-0.000293	-0.000063	0.0437	0.0093	-0.1628	0.5647	0.4353	0.8707
10	linvq	-0.000298	-0.000059	0.0340	0.0069	-0.2184	0.5864	0.4136	0.8272
11	linvq	-0.000271	-0.000048	0.0273	0.0054	-0.2530	0.5999	0.4001	0.8003
12	linvq	-0.000231	-0.000037	0.0219	0.0042	-0.2749	0.6083	0.3917	0.7834
0	lemp	0.000211	0.000381	0.0128	0.0112	-0.3155	0.6238	0.3762	0.7524
1	lemp	0.000760	0.001412	0.0128	0.0155	-1.0265	0.8476	0.1524	0.3048
2	lemp	0.000801	0.001010	0.0133	0.0103	-0.3933	0.6529	0.3471	0.6941
3	lemp	0.000660	0.000599	0.0115	0.0066	0.1458	0.4421	0.5579	0.8841
4	lemp	0.000482	0.000329	0.0092	0.0047	0.4692	0.3195	0.6805	0.6390
5	lemp	0.000325	0.000169	0.0071	0.0036	0.6187	0.2681	0.7319	0.5362
6	lemp	0.000205	0.000080	0.0053	0.0029	0.6572	0.2556	0.7444	0.5111
7	lemp	0.000119	0.000031	0.0044	0.0024	0.5600	0.2878	0.7122	0.5756
8	lemp	0.000062	0.000006	0.0034	0.0020	0.4502	0.3263	0.6737	0.6526
9	lemp	0.000027	-0.000005	0.0027	0.0016	0.3211	0.3741	0.6259	0.7482
10	lemp	0.000005	-0.000010	0.0022	0.0013	0.1828	0.4275	0.5725	0.8550
11	lemp	-0.000007	-0.000011	0.0018	0.0011	0.0613	0.4755	0.5245	0.9511
12	lemp	-0.000012	-0.000010	0.0015	0.0009	-0.0406	0.5162	0.4838	0.9676
0	lgdp	0.001583	-0.001895	0.0284	0.0285	2.7355	**0.0031**	0.9969	**0.0063**
1	lgdp	0.000335	0.001071	0.0363	0.0440	-0.4088	0.6587	0.3413	0.6827
2	lgdp	-0.000357	0.000799	0.0449	0.0423	-0.5925	0.7232	0.2768	0.5536
3	lgdp	-0.000721	0.000324	0.0478	0.0357	-0.5539	0.7101	0.2899	0.5797
4	lgdp	-0.000884	0.000027	0.0450	0.0297	-0.5346	0.7035	0.2965	0.5930
5	lgdp	-0.000923	-0.000120	0.0417	0.0241	-0.5272	0.7010	0.2990	0.5981
6	lgdp	-0.000886	-0.000175	0.0375	0.0193	-0.5334	0.7031	0.2969	0.5938
7	lgdp	-0.000809	-0.000182	0.0332	0.0158	-0.5398	0.7053	0.2947	0.5894
8	lgdp	-0.000713	-0.000167	0.0290	0.0125	-0.5470	0.7078	0.2922	0.5844
9	lgdp	-0.000612	-0.000143	0.0248	0.0100	-0.5562	0.7109	0.2891	0.5781
10	lgdp	-0.000515	-0.000117	0.0209	0.0081	-0.5620	0.7129	0.2871	0.5741
11	lgdp	-0.000427	-0.000094	0.0176	0.0065	-0.5609	0.7125	0.2875	0.5749
12	lgdp	-0.000349	-0.000073	0.0146	0.0052	-0.5619	0.7129	0.2871	0.5743

Funding increases are each equal to the same %									
Time	Response variable	Mean response SPD regions	Mean response CDU/CSU regions	Std. Dev. response SPD regions	Std. Dev. response CDU/CSU regions	t-value	Ha: diff > 0, Pr(T > t)	Ha: diff < 0, Pr(T < t)	Ha: diff != 0, (|T| > |t|)
0	lhk	0.000224	-0.000038	0.0200	0.0544	0.1431	0.4431	0.5569	0.8862
1	lhk	0.000240	0.004530	0.0238	0.0778	-1.6682	0.9523	**0.0477**	0.0954
2	lhk	0.000095	0.003494	0.0293	0.0591	-1.6293	0.9483	0.0517	0.1034
3	lhk	-0.000051	0.002209	0.0314	0.0407	-1.3906	0.9177	0.0823	0.1645
4	lhk	-0.000150	0.001308	0.0305	0.0274	-1.1236	0.8693	0.1307	0.2613
5	lhk	-0.000200	0.000740	0.0274	0.0199	-0.8784	0.8101	0.1899	0.3798
6	lhk	-0.000211	0.000398	0.0236	0.0147	-0.6942	0.7562	0.2438	0.4876
7	lhk	-0.000199	0.000198	0.0204	0.0112	-0.5392	0.7051	0.2949	0.5898
8	lhk	-0.000174	0.000085	0.0174	0.0088	-0.4215	0.6633	0.3367	0.6735
9	lhk	-0.000144	0.000024	0.0145	0.0068	-0.3324	0.6302	0.3698	0.7397
10	lhk	-0.000115	-0.000006	0.0122	0.0054	-0.2571	0.6014	0.3986	0.7971
11	lhk	-0.000088	-0.000020	0.0101	0.0042	-0.1961	0.5777	0.4223	0.8445
12	lhk	-0.000065	-0.000024	0.0083	0.0034	-0.1454	0.5578	0.4422	0.8844
0	linvq	-0.011851	0.049680	0.2425	0.6376	-2.8523	0.9978	**0.0022**	**0.0044**
1	linvq	0.002690	0.048987	0.2640	0.8973	-1.5654	0.9412	0.0588	0.1177
2	linvq	0.004998	0.026428	0.2623	0.5763	-1.0702	0.8577	0.1423	0.2847
3	linvq	0.003889	0.012414	0.2187	0.3302	-0.6807	0.7519	0.2481	0.4962
4	linvq	0.002339	0.005378	0.1671	0.1856	-0.3848	0.6498	0.3502	0.7004
5	linvq	0.001146	0.002102	0.1241	0.1161	-0.1779	0.5706	0.4294	0.8588
6	linvq	0.000394	0.000659	0.0949	0.0762	-0.0687	0.5274	0.4726	0.9452
7	linvq	-0.000022	0.000069	0.0746	0.0526	-0.0313	0.5125	0.4875	0.9750
8	linvq	-0.000221	-0.000140	0.0566	0.0370	-0.0378	0.5151	0.4849	0.9699
9	linvq	-0.000293	-0.000188	0.0437	0.0276	-0.0646	0.5258	0.4742	0.9485
10	linvq	-0.000298	-0.000174	0.0340	0.0205	-0.0989	0.5394	0.4606	0.9213
11	linvq	-0.000271	-0.000142	0.0273	0.0161	-0.1280	0.5509	0.4491	0.8981
12	linvq	-0.000231	-0.000109	0.0219	0.0125	-0.1520	0.5604	0.4396	0.8792
0	lemp	0.000211	0.001128	0.0128	0.0331	-0.8159	0.7927	0.2073	0.4147
1	lemp	0.000760	0.004181	0.0128	0.0458	-2.2737	0.9885	**0.0115**	**0.0231**
2	lemp	0.000801	0.002991	0.0133	0.0305	-2.0830	0.9813	**0.0187**	**0.0374**
3	lemp	0.000660	0.001774	0.0115	0.0196	-1.5530	0.9397	0.0603	0.1206
4	lemp	0.000482	0.000975	0.0092	0.0140	-0.9318	0.8242	0.1758	0.3516
5	lemp	0.000325	0.000502	0.0071	0.0106	-0.4369	0.6689	0.3311	0.6622
6	lemp	0.000205	0.000236	0.0053	0.0085	-0.0981	0.5391	0.4609	0.9218
7	lemp	0.000119	0.000092	0.0044	0.0072	0.1018	0.4595	0.5405	0.9189
8	lemp	0.000062	0.000019	0.0034	0.0059	0.2023	0.4199	0.5801	0.8397
9	lemp	0.000027	-0.000015	0.0027	0.0048	0.2418	0.4045	0.5955	0.8089
10	lemp	0.000005	-0.000029	0.0022	0.0039	0.2398	0.4052	0.5948	0.8105
11	lemp	-0.000007	-0.000031	0.0018	0.0031	0.2170	0.4141	0.5859	0.8282
12	lemp	-0.000012	-0.000029	0.0015	0.0026	0.1815	0.4280	0.5720	0.8560
0	lgdp	0.001583	-0.005614	0.0284	0.0844	2.5569	**0.0053**	0.9947	**0.0106**
1	lgdp	0.000335	0.003173	0.0363	0.1302	-0.6643	0.7467	0.2533	0.5066
2	lgdp	-0.000357	0.002365	0.0449	0.1252	-0.6473	0.7413	0.2587	0.5175
3	lgdp	-0.000721	0.000960	0.0478	0.1059	-0.4577	0.6764	0.3236	0.6472
4	lgdp	-0.000884	0.000080	0.0450	0.0880	-0.3084	0.6211	0.3789	0.7578
5	lgdp	-0.000923	-0.000354	0.0417	0.0713	-0.2175	0.5861	0.4139	0.8279
6	lgdp	-0.000886	-0.000519	0.0375	0.0572	-0.1699	0.5674	0.4326	0.8651
7	lgdp	-0.000809	-0.000540	0.0332	0.0467	-0.1484	0.5590	0.4410	0.8820
8	lgdp	-0.000713	-0.000495	0.0290	0.0369	-0.1473	0.5585	0.4415	0.8829
9	lgdp	-0.000612	-0.000423	0.0248	0.0295	-0.1555	0.5618	0.4382	0.8765
10	lgdp	-0.000515	-0.000347	0.0209	0.0238	-0.1679	0.5666	0.4334	0.8667
11	lgdp	-0.000427	-0.000277	0.0176	0.0192	-0.1816	0.5720	0.4280	0.8559
12	lgdp	-0.000349	-0.000217	0.0146	0.0154	-0.1957	0.5776	0.4224	0.8448

Notes: diff = mean(SPD_regions) - mean(CDU/CSU_regions); H_0: diff = 0; degrees of freedom = 1198

Figure A10: Impulse-response function analysis formula-based grant and overall GRW intensity, control variables added (see Figure A4)



Notes: The solid lines present the responses to an increase in the formula-based grant intensity (grey) and in the overall GRW intensity (blue), the dotted lines show the corresponding confidence intervals (CI) constructed by using Monte Carlo simulations (1000 repetitions). The estimated responses are based on the regression models explained in Section 4 and the variables described in Table A1.