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Absorptive capacity, economic freedom and the conditional effects of regional policy

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Abstract:

This paper analyzes the role played by regional conditioning factors, namely absorptive capacity and economic freedom, for the working of regional policy in Germany. We construct synthetic composite indicators to measure differences in these factors across German regions and stratify regions by their respective values. We then identify the subsample-specific transmission channels of regional policies in a spatial panel vector-autoregressive (VAR) framework and compare the direction and magnitude of effects by impulse-response function analysis and ex-post t-tests. The results point to two main channels of policy impact: While regions with low levels of absorptive capacity and economic freedom benefit from public funding only in terms of a traditional funding channel (i.e. higher investment rates and partly increased human capital levels), the link between regional policy, GDP and technology growth is very weak for these regions. In comparison, our findings hint at significant positive effects on regional GDP per workforce and patent activity for regions with a high absorptive capacity and economic freedom (i.e. a knowledge-based funding channel). This underlines the role of regional conditions for the direction and magnitude of funding effects and should be considered by policy makers as a means to trigger policy effectiveness in times of stagnating or decreasing funding volumes.

Keywords: regional policy, production function, absorptive capacity, economic freedom, SpPVAR, impulse-response functions

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

1. Introduction

A central objective of the European Union (EU) and its member states is to support the socio-economic development of less prosperous regions in order to reduce economic imbalances and foster territorial cohesion (e.g. European Commission, 2017). In Germany, the "Joint Task for the Improvement of Regional Economic Structures" (Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur, henceforth GRW) is the central instrument of regional policy to support a well-balanced economic development across German regions by stimulating additional investments in lagging ones (Deutscher Bundestag, 2014). This study aims at analyzing the dynamic economic effects of the GRW in order to make statements about funding effectiveness and provide valuable input for future policy design. The need for an effective public support is unambiguous as a large amount of taxpayers' money is spent on this matter.[1]

While numerous empirical investigations have been published on the GRW that basically cater to the same goal, the present study is novel in three respects:[2] First, we explicitly account for the fact that regional policy is, by definition, a multifaceted policy that seeks to address different socio-economic objectives (Fratesi and Wishlade, 2017). We do so by means of identifying policy effects on the basis of an econometric systems approach that allows capturing the mutual transmission channels of GRW funding on regional economic outcomes. Specifically, we build a spatial panel vector-autoregressive (VAR) model and use Impulse-Response Function (IRF) analysis to estimate the direct and indirect GRW funding effects for the regional economy (Eberle et al., 2018).

Second, we account for the fact that the effects of regional policy are not uniform across regions and may depend on the regions' ability to transform (policy) inputs into socio-economic out-

[1] For additional details on the connection to EU structural funds, the institutional setup and the budgetary framework of GRW funding, we refer to studies of Alecke et al. (2012 & 2013) and Eberle et al. (2018) among others. For information regarding EU cohesion policy, we refer, for example, to Fiaschi et al. (2018).

[2] Prior empirical studies include Schalk and Untiedt (2000), Blien et al. (2003), Eckey and Kosfeld (2005), Alecke and Untiedt (2007), Eggert et al. (2007), Röhl and von Speicher (2009), Alecke et al. (2012 & 2013), Mitze et al. (2015), von Ehrlich and Seidel (2015), Dettmann et al. (2016), Rhoden (2016), Eberle et al. (2018) among others.

comes. Specifically, we build on the emerging literature on the role of 'conditioning factors' (here: regional absorptive capacity and economic freedom) for the success of funding programs, for instance, related to foreign aid (e.g. Burnside and Dollar 2000), federal spending in the US (e.g. Suárez Serrato and Wingender, 2016) or – most closely related to the study at hand – the EU Structural Funds (see, e.g., Beugelsdijk and Eijffinger, 2005; Ederveen et al., 2006 for country-level evidence as well as Cappelen et al., 2003; Becker et al., 2013; Fratesi and Perucca, 2014; Rodriguez-Pose and Garcilazo, 2015; Gagliardi and Percoco, 2017; Breidenbach et al., 2018 for regional analyses). Despite this growing evidence on the importance of regional contexts for funding success, little is known about the role of conditional effects in the German context so far (except for exploratory studies by Röhl and von Speicher, 2009; Rhoden, 2016).

Third, we finally also account for the fact that policy interventions in different policy fields may have heterogeneous impacts and operate with different time lags (Fratesi and Wishlade, 2017). Although our analysis cannot distinguish among the whole range of policy fields addressed by the GRW, we are nonetheless able to separate the working of its two main pillars, namely, investment grants to private firms, on the one hand, and investment support to the local public infrastructure, on the other hand. In the empirical analysis we combine this dimension with the above discussed stratification of regional units to provide a comprehensive picture of the transmission channels of funding by policy field and regional context (Eberle et al., 2018).

Based on these novel contributions, three central research questions can be formulated: 1) To what extent do economic responses to changing GRW funding intensities depend on key conditioning factors such as a region's absorptive capacity and economic freedom? 2) Do these conditional effects vary between economic outcome variables? and 3) Do these effects also vary by type of funding, that is, do the identified transmission effects of investment support to private firms and public infrastructure support work differently in alternative regional contexts? Providing answers to these three questions can be seen as particularly helpful for policy makers as it can effectively contribute to future policy design or, as Fratesi and Wishlade (2017, p. 819) phrase it: *"[…] knowing that some policies have a greater impact in certain contexts can provide a basis for more efficient use of funds*". Particularly in times of stagnating or even decreasing funding volumes for regional policy in the EU (Breidenbach et al., 2018) and Germany (Eberle et al., 2018), this analysis may guide policy makers on creating fertile regional conditions that can improve funding effectiveness or focusing the available funds on regions with higher effectiveness. Moreover, the approach here may be replicated for analyzing the working of structural funds within other countries or within supra-national systems such as the EU.

The reminder of this paper proceeds as follows. Section 2 provides a short overview of recent empirical studies. Section 3 presents the underlying theory and develops research hypotheses. Thereafter, the econometric approach (Section 4) and the data (Section 5) are introduced. Section 6 presents the empirical results for the role of conditioning factors on regional funding effectiveness together with a series of robustness tests. Finally, section 7 summarizes and concludes the paper.

2. State of debate

So far, little is known about the conditional effects of German regional policy as regional heterogeneities are mainly disregarded in the empirical evaluation literature on GRW funding effectiveness. Prior evidence on the role of the regional context is – to a limited extent – reported by Röhl and von Speicher (2009), who analyze growth effects of GRW funding for data on 113 East German regions over the period 1996-2006 using a four-type classification of regional settlement structures as conditioning factor. While the authors find positive effects for all four different types of German regions on sectoral gross value added (GVA) in the manufacturing sector, the magnitude of the effect is observed to differ across region types with the highest effect observed for highly agglomerated regions followed by rural areas (Röhl and von Speicher, 2009). The study of Rhoden (2016) runs a cross-sectional analysis for 402 German regions over the aggregated time period 2000-2012. Different from Röhl and von Speicher (2009), however, Rhoden (2016) does not find evidence for significant differences in the GRW funding effects across region types with different settlement structure.[3]

Looking beyond the scarce literature on German regional policy, there is now a growing international literature that stresses the role of the conditional effects in the working of public funding and

[3] The study of Eberle et al. (2018) provides a detailed survey of methods, used data and results of recent GRW studies.

transfer programs (e.g. Burnside and Dollar, 2000; Cappelen et al., 2003; Beugelsdijk and Eijffinger, 2005; Ederveen et al., 2006; Becker et al., 2013; Fratesi and Perucca, 2014; Rodríguez-Pose and Garcilazo, 2015; Gagliardi and Percoco, 2017; Breidenbach et al., 2018; see Table A1 in the Appendix for additional information). Most closely related to the scope of this study is surely the large evaluation literature on EU Structural Funds effectiveness: In a seminal contribution, Ederveen et al. (2006) analyze the conditional effects of EU Structural Funds on national economic growth using institutional quality (institutional quality index, inflation, trust, openness and corruption) as important national context indicator. The authors conclude that EU funding has higher positive effects in countries with proper institutions, a higher openness and less corruption (Ederveen et al., 2006). Beugelsdijk and Eijffinger (2005) consider the degree of corruption of countries – measured by the perceptions of business people, analysts and the general population regarding the degree of corruption. However, different from Ederveen et al. (2006), the results do not indicate significant effects of the national degree of corruption on GDP growth.

At the regional level, Cappelen et al. (2003) analyze the conditional effects of EU Structural Funds for NUTS1/NUTS2 regions in ten EU countries over the period 1980 to 1997 by means of changing sample design: Specifically, the authors contrast the estimation results for the full sample of regions with a restricted sample which excludes regions from Spain, Greece and Portugal. The results point to stronger effects of EU Structural Funds in the restricted sample, thus indicating a more efficient use of EU Structural Funds in regions within a more advanced economic environment (Cappelen et al., 2003).

More recent studies on EU Structural Funds effectiveness further refine the use of conditioning factors by employing measures for the absorptive capacity of regions (Becker et al., 2013), regional territorial capital (Fratesi and Perucca, 2014), the regional government quality (Rodríguez-Pose and Garcilazo, 2015; Breidenbach et al., 2018) and settlement structure (Gagliardi and Percoco, 2017). Becker et al. (2013) analyze the conditional EU funding effectiveness for NUTS2 regions over three different multi-annual funding periods between 1989 and 2006. As conditioning factor the authors employ different measures for the regions' absorptive capacity, proxied by human capital endowments and the quality of government. The authors find that a sufficient level of regional absorptive capacity is crucial for translating objective 1 payment from the EU Structural Funds into positive per capita GDP growth and investment rates. Similarly, the authors find that social capital proxied through voter turnout at European Parliamentary Elections has a similar conditioning role on the effectiveness of EU regional policy in different regional contexts (Becker et al., 2013).

The findings by Becker et al. (2013) are supported by Fratesi and Perucca (2014) as well as Rodríguez-Pose and Garcilazo (2015) and Breidenbach et al. (2018) indicating that the presence of territorial capital in the region and a high quality of government increase policy effectiveness. Finally, Gagliardi and Percoco (2017) use data for small-scale NUTS3 regions to show that regional settlement structures matter for observed funding effects. Thereby, regional growth in rural regions close to a city is found to be most significantly triggered by objective 1 payment (Gagliardi and Percoco, 2017). This result, which points at the role played by access to agglomeration forces in the geographical proximity to large urban agglomerations as a means to productively use funding inputs, is broadly in line with earlier findings for German GRW funding as reported by Röhl and von Speicher (2009).[4]

3. Theoretical considerations and predictions

Consistent with the well-established literature on VAR modelling, we deliberately keep the theoretical underpinnings of our regional economic model at a minimum. Specifically, we use elements from growth theory to highlight variable selection and to formulate research hypotheses, while we avoid making (false) assumption on the functional relationship among certain variables in the system. To start with, we specify a regional production function as (Eberle et al., 2018)

$$Y_i(t) = K_i(t)^{\alpha} H_i(t)^{\beta} Z(t)_i^{\gamma} (A_i(t) L_i(t))^{1-\alpha-\beta-\gamma}. \quad (1)$$

[4] Most of the above findings for the conditional effects of EU regional policy are also consistent with the broader international literature on funding and transfer programs. Studying the conditional effects of foreign aid by using country data for the time period 1970 to 1993, Burnside and Dollar (2000) conclude higher effects in countries with an adequate policy environment. Finally, using county data, Suárez Serrato and Wingender (2016) analyze the conditional effects of federal spending programs in the United States. The results show that federal spending has higher effects in counties with smaller employment and income growth rates, implying some decreasing effects on regional imbalances (Suárez Serrato and Wingender, 2016).

In equation (1), $Y_i(t)$ expresses output of region *i* at time period *t*, $H_i(t)$ indicates regional human capital, while $K_i(t)$ and $Z_i(t)$ are private and public physical capital stocks, respectively; $A_i(t)$ denotes the regional level of technology and $L_i(t)$ is labor.[5] By multiplying equation (1) with P_i^{-1}, where P_i defines the economically active population (henceforth: workforce), we can state the production function in intensive form as

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

While equation (2) describes a production process where private and public inputs are combined to create $y_i(t)$, the dynamics of a regional economy is typically much more complex and characterized by mutual feedback relationships (Eberle et al., 2018). We capture this dynamics by specifying additional functional equations for each input variable included in equation (2). This results in a six variable system including GDP per workforce (y_i), the human (h_i), private physical (k_i) as well as public physical capital (z_i) per workforce, regional technology (A_i) and the gross employment rate (λ_i).[6] Technical details of the VAR specification and estimation will be given in the next section.

The central objective of this analysis is to shed light on the conditional effects of changes in the investment support to private firms and local public infrastructure on the economic growth dynamics of a regional economic system. As the literature review has shown, these differences may chiefly depend on the regions' ability to transform (public) inputs productively into output, in other words, regions should have a sufficiently high absorptive capacity. As Becker et al. (2013) argue, an essential dimension of absorptive capacity relates to the regions' equipment with human capital as a low amount of high skilled workers in the region may cause a low return on public funding. A similar argumentation holds for the case of the region's technology level. One way to include these latter effects in the dynamic presentation of a regional economic system as outlined above is to extent the underly-

[5] Following Eberle et al. (2018), we define $L_i(t)$ as: $L_i(t) = \lambda_i(t)\, P_i(0)e^{n_i t}$. Based on this definition, $P_i(t)$ expresses the economically active population at the age of 15 to 64 years that grows exogenously with the rate n_i and $\lambda_i(t)$ represents the ratio of employed population ($L_i(t)/P_i(t)$), which is constant in the long-run perspective (Eberle et al., 2018).

[6] As explained by Eberle et al. (2018), useful regional data for the physical capital stocks (private and public) and the technological level is unavailable. For this reason, we apply data for private ($s_{k,i}$) and public physical capital investments ($s_{z,i}$) and the patent rate as proxy for the regional technological growth rate (g_i) (Eberle et al., 2018).

ing equations for private and public physical capital accumulation as stated in Eberle et al. (2018) by an efficiency parameter θ_i as

(3) $$\frac{\dot{k}_i}{k_i} = \theta_i \, [s_{k,i} \, (A_i(t)\lambda_i(t)^{1-\alpha-\beta-\gamma} \, k_i(t)^{\alpha-1} \, h_i(t)^{\beta} \, z_i(t)^{\gamma}] - (n_i+\delta) \text{ and}$$

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

where θ_i measure the degree of region *i*'s absorptive capacity. This implies that the efficient share of saved and invested income $\frac{s_{k,i}\, y_i}{k_i}$ and $\frac{s_{z,i}\, y_i}{z_i}$ depends on the region's absorptive capacity: A fully efficient region ($\theta_i = 1$) exploits the complete saved income and follows the predicted growth path of the Solow model. Regions with lower levels of absorptive capacity ($\theta_i < 1$) are not able to fully exploit the total saved income due to inefficiencies. This results in lower growth rates of the capital stocks than it is predicted in the augmented Solow model (see Mankiw et al., 1992). Consequentially, these differences in the growth rate of private and public capital stocks have additional effects on the remaining variables of the system (see Eberle et al., 2018 for a detailed exposition of this issue). In addition, the moderating role of absorptive capacity for a region's development path may also run through additional channels such as efficient (lifelong) learning and knowledge diffusion, thereby affect the regions' technology, employment and output growth (e.g. Roper and Love, 2006). Taken together, the following hypothesis on the role of absorptive capacity for regional economic development can be formulated:

> *H1: Regions with higher levels of* ***absorptive capacity*** *experience higher returns on (public and private) physical capital investments. Together with further transmission channels such as efficient learning and knowledge diffusion, this carries over into positive technology, employment and output growth.*

Another strand of the theoretical and empirical growth literature stresses the role of institutions and economic freedom as an important conditioning factor for economic development. At the country level, the institutional environment (economic freedom) is found to be a key driver for economic growth (e.g. Doucouliagos and Ulubasoglu, 2006; Williamson and Mathers, 2011). Based on a meta-analysis of the contemporaneous empirical literature on the nexus between economic freedom and growth, Doucouliagos and Ulubasoglu (2006) find evidence for an overall positive direct connection between the national economic freedom and economic growth together with a positive indirect effect running through the stimulation of physical capital.[7] Although institutional characteristics are typically more homogeneous at the regional level, Spruk and Keseljevic (2018) have recently shown for the case of Germany that greater economic freedom is also beneficial for local prosperity. The authors find that a higher regional economic freedom is associated with a higher per capita income and economic growth (Spruk and Keseljevic, 2018). Accordingly, it can be expected that economic freedom acts as a similar catalyst for regional economic development as absorptive capacity does, mainly by increasing the regional efficiency in utilizing physical investments, labor market capacities and the available knowledge stock. Hence, we can extend H1 to the case of economic freedom as

> *H2: Regions with higher levels of* ***economic freedom*** *experience higher returns on (public and private) physical capital investments. Together with further transmission channels such as efficient learning and knowledge diffusion, this carries over into positive technology, employment and output growth.*

4. Identification and Econometric Strategy

Pre-estimation - identification strategy

In the empirical estimations, we aim at comparing the regional economic effects of GRW funding for regions with low and high levels of absorptive capacity and economic freedom. In a first approximation, we therefore construct composite indicators for both concepts and build subsamples of regions based on the median of both indicators. As a robustness check, we then also stratify regions along the quintiles of the distribution in order detect potential non-linearities in the moderating role of absorptive capacity and economic freedom for funding effectiveness. Moreover, in order to warrant comparability to previous GRW studies (e.g. Röhl and von Speicher, 2009; Rhoden, 2016), we also

[7] The authors provide an extensive survey of the findings of previous studies showing the nexus between economic freedom on economic growth (Doucouliagos and Ulubasoglu, 2006).

sub-classify regions according to the official classification of the *Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)* as an additional robustness check.

In order to measure regional absorptive capacity as a multi-dimensional construct, we follow Becker et al. (2013) who identify the regional human capital (education) as one central conditional factor for the region's ability to efficiently transform inputs into regional output. Additionally, Baldwin and Okubo (2006) point to the potential role played by agglomeration economies in the working of public subsidies as the most efficient firms typically tend to sort themselves into urban agglomerations, while public subsidies mainly attract the less efficient firms to relocate to the periphery. Hence, we use the population density as second measure for the regional absorptive capacity as we expect that firm productivity is higher in urban areas as in rural regions. Similarly, the regional patent intensity and start-up rates in high-tech, medium high-tech manufacturing sectors and knowledge intensive services (KIS) are used as further input factors for the construction of a composite indicator for regional absorptive capacity. These variables can mainly be seen as proxies for the efficient use of knowledge stocks and high business dynamics.

With regard to the measurement of economic freedom, we essentially use the regions' overall tax revenues, regional public debts and public employment as key input factors chosen in the related literature (e.g. Potrafke, 2013; Spruk and Keseljevic, 2018). Additionally, we include voter turnout at federal elections as an indicator related to the regions' social capita, i.e. the predisposition to exert individual rights (Becker et al., 2013). The latter variable can also be linked the large literature on individual rights and economic freedom. While government ideology could be considered as a further source for differences in economic freedom (i.e. right-wing governments are typically found to propagate higher economic freedom), Potrafke (2013) has shown for German federal states that this relationship only holds for West Germany but cannot be extended to East Germany. Since East German regions are significant recipients of GRW funding, we do not include the shares of votes for right-wing parties as an additional indicator in order to avoid a too strong overlap between the policy variable and the conditioning factor.[8]

[8] Please note that it seems not reasonable to analyze the conditional effects according to the institutional quality or a corruption index using regional data for only one country – the studies of Beugelsdijk and Eijffinger (2005)

In order to construct (synthetic) composite indicators for absorptive capacity and economic freedom, we apply principal component analysis (PCA).[9] Groups of regions with high and low levels of absorptive capacity and economic freedom are then stratified according the moments of the distribution of both indicators (median, quintiles).

Estimation - Spatial panel VAR approach and IRF analysis

Based on this sub-sample stratification strategy, we run regressions for each selected group of regions using a six equation spatial panel VAR (SpPVAR) model including 1) GDP per workforce, 2) the physical capital investment rate, 3) the higher education rate (human capital), 4) the gross employment rate, 5) the patent rate and 6) the GRW funding intensity. As shown in Eberle et al. (2018) this approach allows us to adequately deal with the system's inherent space-time dynamics, the presence of feedback effects among variables and the existence of indirect impact channels of GRW funding. We will use impulse-response functions (IRF) together with standard error belts calculated on the basis of Monte Carlo simulations (Love and Zicchino, 2006) in order to analyze the responses of regional economic variables to a positive shock in the GRW intensity. While we keep the technical description of the SpPVAR model, its estimation and IRF analysis at a minimum here, a detailed exposition is given in Eberle et al. (2018).[10]

Post-estimation – t-tests

In order to detect statistical differences in the estimated responses to a GRW shock between regional subgroups, we run a series of ex-post *t*-tests for each sample period *t* as

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or Ederveen et al. (2006) use national data of European countries. On the one hand, the differences within a country are expected to be much smaller as between countries and, on the other hand, it is difficult to collect such data on a small-scale regional level in Germany.

[9] Individual components are normalized to takes values between 0 and 1 prior to PCA application in order to correct for possibly exorbitant variation in the various components (see Spruk and Keseljevic (2018) for additional information). The data will be described in Section 5.

[10] Please note that the included spatial lag variable $\mathbf{Wy_{t-1}}$ of the particular dependent variable is biased in our fixed effects model. To test the effects of this bias on the six core variables, we perform a robustness check by excluding $\mathbf{Wy_{t-1}}$ from the specific dependent variable in the models using the median and BBSR classification for subdivision. The results of the robustness check show that the bias and, therefore, the differences between the associated IRF analyses are negligible.

(4) $$t_t = \frac{IRF_{low} - IRF_{high}}{\sqrt{\frac{sd^2_{low}}{N_{low}} + \frac{sd^2_{high}}{N_{high}}}},$$

where IRF_{low} is the estimated response in below median regions in t, IRF_{high} is the estimated response in above median regions in year t; sd_{low} and sd_{high} denote the associated standard deviations (calculated from the simulated error bands) and N_{low} and N_{high} is the number of repetitions (= 200) in the Monte Carlo simulations. While the null hypothesis of these tests is that the estimated IRFs between regions with low and high levels of absorptive capacity (economic freedom) do not differ, a rejection of the null hypothesis indicates that the regional effects of GRW funding are sensitive to the regional context. Our identification and econometric strategy are summarized in Figure 1.

< *Figure 1 here* >

5. Data and PCA analysis

The empirical analysis is conducted for 258 German labor market regions over the time period 2000-2011. Labor market regions have been chosen as units of analysis as they depict the *de facto* administrative level used by German regional policy to decide on the eligibility of GRW funding receipt (Deutscher Bundestag, 2014). Variables used for the SpPVAR analysis have been gathered from different data sources as shown in Table A2 in the Appendix. All variables are used in logarithmic transformation.

Moreover, we calculate spatial lags for all variables included in the VAR model in order to control for spatial autocorrelation across variables. The employment and human capital rate together with their spatial lags have been detrended as they have shown signs for non-stationarity (see Im et al., 2003 for the applied test procedure). Table 1 reports summary statistics for the variables.

< *Table 1 here* >

A description of the underlying variables used to conduct the synthetic composite indicators for absorptive capacity and economic freedom is given in Table A3. In order to ensure the predeterminedness of absorptive capacity and economic freedom as conditioning factor for GRW effectiveness, both composite indicators have been constructed for the initial sample period in 2000. Only the variable public employment is based on observations in 2006 due to a structural break in the public employment statistical and regional voter turnouts are taken from the federal parliament elections in 1998.

The PCA-based factor loadings used to construct two composite indicators for absorptive capacity (Z^{AC}) and economic freedom (Z^{EF})[11] are shown below, where ~ indicates that the variables are standardized:

Z^{AC} = 0.5108 (~ higher education rate) + 0.3893 (~ patent rate) + 0.4315 (~ population density) + 0.2953 (~ start-up rate high-tech sectors) + 0.5605 (~ start-up rate KIS)

Z^{EF} = 0.5549 (~ overall tax revenues) + 0.3772 (~ public debt) - 0.2726 (~ public employment) + 0.6896 (~ voter turnout)

The reported factor loadings are based on the first principal component, which is typically used as the best synthetic indicator that combines or condenses the information originally dispersed over the input factors (e.g. Spuk and Keseljevic, 2018). As the PCA results show, the absorptive capacity indicator is positively correlated with all input factors, where the highest weights are given to the regions' human capital endowment and KIS start-up rate. In line with Spruk and Keseljevic (2018), the PCA results for economic freedom show that the synthetic indicator positively correlates with tax revenues, public debt levels and voter turnout, while higher levels of public employment are associated with a lower degree of economic freedom. Moreover, if we calculate a simple correlation coefficient ρ for both indicators, the result, $\rho = 0.3901$, shows that this correlation is positive small and thus both indicates measure different dimensions of regional context conditions. This is underlined by

[11] Due to data issues (see Table A3), factor loadings are calculated without the labor market regions Hamburg, Bremen, Bremerhaven and Berlin.

Figure 2, which shows the distribution of absorptive capacity and economic freedom across German regions based on the quintiles of both composite indicators.[12]

< *Figure 2 here* >

6. Empirical Results

The presentation of the empirical results is primarily based on a graphical IRF analysis. Statistical inference can be made with the help of the plotted standard error belts. By stratifying our sample as outlined above, the main focus rests on a comparison of economic responses to a GRW shock in regions with high (blue lines) and low (grey lines) indicator values. It is important to note that the initial (temporary) GRW shock is measured in terms of a positive temporary increase in the funding intensity by one standard deviation (henceforth: shock). Thus, shocks are sample-specific. However, when we use *t*-test to detect systematic differences in the estimated responses across groups, we work with "comparable" GRW shock as a robustness check (that is, the absolute initial shock for regions in the 'high' group is rescaled to equal the absolute level of shock for regions in the 'low' group). We report the empirical results both at the aggregate level of GRW funding as well as separately for GRW industry and infrastructure funding. At the aggregate level, we also present the results for subcategories of regions according to the quintiles of the distribution for both composite indicators.

Absorptive capacity

The upper part of Figure 3 (panel a) illustrates the responses to a one-period shock in the GRW industry funding, while the middle (panel b) and lower part (panel c) shows the responses to a change in the GRW infrastructure and overall GRW intensity, respectively.

The reactions of employment rate and human capital to a one-period increase in GRW industry funding are quite similar for regions with low and high absorptive capacity (blue and grey lines in Figure 3a): there is a significant medium-run increase in the employment rate and a non-significant

[12] The structural types of German labor market regions are based on a subdivision of the BBSR. 118 (45.74 %) of the labor market regions are classified as urban regions, 61 (23.64 %) as rural regions with some agglomeration tendencies (intermediate regions) and 79 (30.62 %) as rural regions.

medium-run increase in human capital. Hence, GRW industry funding leads to more employment independent of the absorptive capacity in the regions. This seems to come along with an increase in human capital, but this finding is not statistically significant. There is a decrease of human capital in regions with high absorptive capacity in the year of increased GRW industry funding, which seems to be more than compensated by later increases and is therefore not further discussed here (although this causes the reactions to significantly depend on the absorptive capacity in regions). The results for the other economic variables differ significantly (see Tables 2 and A4) between regions with high and low absorptive capacity. In regions with high absorptive capacity GRW industry funding seems to trigger medium-term increases in GDP and short-term (in the same year) increases in the patent activity. Conversely, GRW industry funding seems to trigger medium-term private investments in regions with low absorptive capacity. This may hint at the fact that different transmission channels of funding operate in regions with different regional contexts: While a traditional funding channel, mainly running through an increase in the private-sector investment rate, play a dominant role in regions with a low absorptive capacity, regions with a high absorptive capacity mainly benefit through a knowledge-based funding channel, which also seems to lead to increases in GDP.

< Table 2 here >

Panel b of Figure 3 shows the various responses to changes in GRW infrastructure funding. Again, we find quite similar reactions (no significant differences according to our t-tests in Tables 2 and A4) for the two types of regions of employment rate and human capital to GRW infrastructure funding: There are medium-run increases that are all significant. GRW infrastructure funding is also able to trigger additional employment coming along with higher human capital. In contrast to GRW industry funding, we do not find any significant effect of GRW infrastructure funding on private physical capital investments, which seems plausible because firms are not directly supported for investing as in the case of GRW industry funding. The effects on GDP and patent activity differ significantly (see Tables 2 and A4 for the t-test results) dependent on the regions' absorptive capacity: In regions with low absorptive capacity patent activity decreases, while in regions with high absorptive capacity GDP increases. These results match the findings for GRW industry funding and confirm the presence of different transmission channels of the GRW policy in regions with high and low absorptive capacity. The findings for the overall GRW funding (Figure 3c) match the results for the two main pillars of funding and do not provide additional information.

< *Figure 3 here* >

In order to identify potential non-linearities in the moderating role of absorptive capacity for GRW funding effects, we finally stratify the regions in five subgroups (quintiles) in order to gain more insights of the effectiveness of the overall GRW intensity. For the sake of readability, we focus on a graphical presentation of the results for a shock in the overall GRW intensity and reduce the information content in Figure 4 (solid lines denote significant responses, while the non-solid lines indicate non-significant responses). The results basically confirm the results discussed above but provide some refined information. First, again all significant findings for effects on employment rate and human capital are positive and medium-term. However, insignificant effects are rather found in the middle quintiles (the second and third quintile for human capital and second quintile for the employment rate). This suggests that GRW funding increases employment and human capital especially in regions with very low and very high absorptive capacity. The findings for private investment and patent activity match the above findings: Private investment is triggered by GRW funding only in the regions with the lowest absorptive capacity, while it has a negative impact on regions of the fourth quintile (high absorptive capacity). Patent activity seems to benefit from GRW funding in regions with high absorptive capacity (fourth and fifth quintile) and is decreased by GRW funding in regions with very low absorptive capacity. The results for GDP are more mixed. At least, we find significant positive effects (third and fourth quintile) or no significant effects, so that GRW funding has with exception of quintile 2 in sum positive effects on GDP.[13] There is no clear tendency in the differences between the subsamples so that we avoid over-interpreting these results. However, carefully speaking, the findings indicate that traditional funding channels which mainly target the firms' physical investment rate as intermediate output variable are rather less effective compared to knowledge-based funding channels.

< *Figure 4 here* >

[13] Please note that the response is significant negative in the year of the increase for the first quintile.

Economic freedom

If we separate regions according to economic freedom (Figure 5a), again we find little difference in the effects of GRW industry funding on employment rate and human capital, although the effects on employment are insignificant for regions with low economic freedom and significantly lower (t-test, see Tables 3 and A5) compared to regions with a high economic freedom. In contrast, the effects on GDP, patent activity and private investment differ significantly (t-test, see Tables 3 and A5): GRW industry funding has a significant positive medium-term effect on GDP and short-term effect on patent activity in regions with high economic freedom, while it has a medium-term positive effect on private investment and negative effect on patent activity in regions with low economic freedom. These results are quite similar to the finding for absorptive capacity, although the regions in the subsamples are quite different. This interesting finding will be further discussed below.

< *Table 3 here* >

Regarding the responses to a shock in GRW infrastructure funding (Figure 5b), we find similar results for the effects on employment rate and human capital: There are positive medium-run increases which are significant for human capital in both sub-samples and for regions with high economic freedom in the case of employment. Again, significant differences (t-test, see Tables 3 and A5) between the two subsamples are found for private investments and partially for the employment rate. Moreover, in regions with high economic freedom GRW infrastructure funding leads to significant medium-term increases in GDP and decreases in private investment. Conversely, in regions with low economic freedom GRW infrastructure funding leads to significant short-term decreases in patent activity and medium-term increases in private investment. This fits again quite well the results for separating the regions according to absorptive capacity. Economic freedom seems to have as similar effect on the transmission channels of GRW funding as absorptive capacity. Considering the sum of GRW funding (Figure 5c) again matches the results above and does not provide additional insights.

< *Figure 5 here* >

Finally, Figure 6 reports quantile-specific IRFs for a shock in the overall GRW intensity. These provide some interesting details. Similar to the finding for subgroups according to absorptive capacity, the employment rate benefits from GRW funding especially in regions with very high and very low economic freedom. The regions with high values in both indicators – absorptive capacity and economic freedom – are West German regions, while the regions with low values in both indicators are mainly the economically weak regions in East Germany and East Bavaria. These regions seem to benefit most from the GRW funding in terms of employment.

In contrast to the results for the subsamples according to absorptive capacity, only the regions with very low economic freedom show significant positive effects of GRW funding on human capital. However, the impulse response functions for the regions with higher economic freedom are quite similar, except of being not significant, so that we should not over-interpret this finding. Significant positive effects on the patent activity arise only in the fifth quintile (highest economic freedom), while the effects are negative in the lowest three quintiles (significant for the lowest quintile). Thus, in East Bavaria and in regions in East Germany with low values in both indicators, GRW funding leads to decreases in the patent activity, while it is increased especially in supported West German regions.

The results for the effects on GDP are in line with the above finding in the case of two subgroups: GDP is (non-significantly) increased by GRW funding mainly in regions with high economic freedom.[14] In combination with the observed dependence on absorptive capacity, GRW funding has positive effects on GDP in regions in West Germany, however, the positive effects may also arise in East German regions with low economic freedom but an adequate level of absorptive capacity.

The opposite is found for the effects on private investment: Only regions with lower economic freedom seem to benefit, significant positive effects are only found for the two lowest quintiles. Combining this with the result that GRW funding increases private investments most in regions with very low absorptive capacity, the economically weak regions in West Germany (North-East of Bavaria) and regions with low absorptive capacity and economic freedom in East Germany seem to benefit most in this way.

< Figure 6 here >

The findings are summarized in Table 4. In addition to the above discussed differences between the different types of regions, it also becomes obvious that GRW industry funding has more

[14] Please note that the response is significant negative in the year of the increase for the fifth quintile.

impact on private investment and patent activity, while GRW infrastructure funding has more impact on human capital. Both influence GDP and employment in a similar way.[15]

< Table 4 here >

7. Conclusions and policy implications

This paper has investigated the influence of regional context factors, namely the regional absorptive capacity and economic freedom, for the ability of regions to use GRW funding effectively. In the empirical analysis, we have applied a SpPVAR approach and an associated IRF analysis for various regional subsamples. These subsamples have been created based on the moments (median, quintiles) of the distribution of two synthetic composite indicators for regional absorptive capacity and economic freedom. Moreover, we have used ex-post *t*-tests to determine significant differences between the estimated average responses in the subsamples.

Our empirical results shed new light on the multifaceted effects of the GRW policy and claim for a detailed focus on the regional conditions of supported regions. Regional absorptive capacity and economic freedom significantly affect the effectiveness of GRW across regional groups. While we find evidence for the working of a traditional funding channel for regions with low levels of absorptive capacity and economic freedom, mainly working through an increased investment rate, no evidence is found for growth enhancing effects of this transmission channel in these regions (e.g. measured in terms of GDP per workforce). In contrast, GRW funding is found to boost GDP per workforce through a knowledge-based funding channel in regions with a high absorptive capacity and economic freedom. Furthermore, both kinds of regions show a higher employment rate as a reaction to GRW funding, but

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[15] We use the subdivision of the BBSR as an additional robust check (see Figure A6 in the Appendix). For the most part, the results support the previous results. The findings show that the private-sector investment rate is positively affected only by rural regions (all GRW funding measures) and even negative in urban regions for GRW infrastructure funding, while the human capital is positively affected especially in intermediate regions (applies for all GRW funding measures). The employment rate is positively affected by all kinds of GRW funding in urban regions as well as in rural regions (GRW infrastructure funding). Finally, the patent activity is positively affected by urban regions (GRW industry and overall funding) or intermediate regions (GRW infrastructure funding), respectively, and the overall GRW investments have significant positive effects on the regional GDP per workforce only in urban regions.

this effect is strongest in the regions with high and very low indicator values for absorptive capacity and economic freedom.

Based on the empirical findings, we derive two main policy implications. First, GRW is a multifaceted policy that i) affects several economic variables simultaneously and ii) has heterogeneous effects in different regional contexts. Accordingly, an assessment of the effective use of public funding chiefly depends on the specific policy objective in focus. However, what can said on the basis of our SpPVAR results is that traditional policy impact channels of German regional policy, e.g. operating through increased private-sector investment rates or specific labor market policies, are less effective to stimulate regional economic growth compared to knowledge-based transmission channels. The latter funding channel is particularly active in regions with a high absorptive capacity and economic freedom.

Secondly, in times of decreasing GRW funding volumes, regional context factors including the absorptive capacity and economic freedom should come to the fore of policy makers as a fertile ground for the implementation of policy objectives. As such, proper initiatives that are able to positively affect these context conditions may yield a higher return to public spending than compensating for lack of these regional 'assets' through large-scale funding schemes. While good-functioning regional institutions, educational opportunities, low bureaucratic hurdles, a dynamic entrepreneurship community and a local civil society can surely contribute to such positive regional context conditions, more research is needed to fully understand the fundamental mechanisms that drive their interplay with policy instruments to support the socio-economic development of regions in the long run.

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Tables

Table 1: Summary Statistics

Variable	Mean	Standard Deviation	Min	Max
bip	49341.59	12938.38	22936.38	116626.4
emp	0.6141	0.0901	0.3902	0.9473
hk	0.0566	0.0291	0.0155	0.2067
invq	0.0254	0.0167	0.0027	0.2240
pat	0.0067	0.0052	0	0.0356
grw_ind	0.0012	0.0028	0	0.0576
grw_infra	0.0004	0.0014	0	0.0337
grw	0.0016	0.0037	0	0.0761
w_bip	54087.27	12065.66	28247.57	93912.85
w_emp	0.6456	0.0556	0.4803	0.8291
w_hk	0.0700	0.0253	0.0224	0.1649
w_invq	0.0235	0.0092	0.0057	0.0932
w_pat	0.0069	0.0038	0.0004	0.0210
w_grw_ind	0.0010	0.0019	0	0.0179
w_grw_infra	0.0004	0.0008	0	0.0111
w_grw	0.0014	0.0025	0	0.0216

Notes: t = 12; i = *258;* N = 3096. Variables are normalized according to Table 1. Summary statistics are presented before taking the ln and detrending. For estimation, zero values are replaced by a very small number before taking the ln.

Table 2: T-tests using estimated average responses in subsamples at time *t* (absorptive capacity, initial changes in the GRW intensity are equal in relative terms)

		GRW industry funding				GRW infrastructure funding				Overall GRW funding			
Time	**Response variable**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**
0	lhk	1.8602	**0.0318**	0.9682	0.0636	1.5036	0.0667	0.9333	0.1335	1.9375	**0.0267**	0.9733	0.0534
1	lhk	1.0205	0.1540	0.8460	0.3081	1.0968	0.1367	0.8633	0.2734	1.0657	0.1436	0.8564	0.2872
2	lhk	0.5364	0.2960	0.7040	0.5920	0.8274	0.2042	0.7958	0.4085	0.4903	0.3121	0.6879	0.6242
3	lhk	0.3586	0.3601	0.6399	0.7201	0.6702	0.2516	0.7484	0.5031	0.2036	0.4194	0.5806	0.8387
4	lhk	0.2587	0.3980	0.6020	0.7960	0.5427	0.2938	0.7062	0.5877	0.0328	0.4869	0.5131	0.9739
5	lhk	0.1985	0.4214	0.5786	0.8428	0.4267	0.3349	0.6651	0.6699	-0.0844	0.5336	0.4664	0.9328
6	lhk	0.1552	0.4384	0.5616	0.8767	0.3317	0.3701	0.6299	0.7403	-0.1755	0.5696	0.4304	0.8608
7	lhk	0.1228	0.4512	0.5488	0.9024	0.2352	0.4071	0.5929	0.8142	-0.2498	0.5986	0.4014	0.8028
8	lhk	0.0958	0.4619	0.5381	0.9238	0.1486	0.4410	0.5590	0.8820	-0.3081	0.6209	0.3791	0.7581
9	lhk	0.0762	0.4697	0.5303	0.9393	0.0716	0.4715	0.5285	0.9430	-0.3506	0.6369	0.3631	0.7261
10	lhk	0.0605	0.4759	0.5241	0.9518	0.0027	0.4989	0.5011	0.9979	-0.3926	0.6526	0.3474	0.6949
11	lhk	0.0488	0.4805	0.5195	0.9611	-0.0570	0.5227	0.4773	0.9546	-0.4229	0.6637	0.3363	0.6726
12	lhk	0.0409	0.4837	0.5163	0.9674	-0.1065	0.5424	0.4576	0.9152	-0.4357	0.6683	0.3317	0.6633
0	lpat	0.1891	0.4251	0.5749	0.8501	-1.6751	0.9526	**0.0474**	0.0947	-0.3923	0.6525	0.3475	0.6950
1	lpat	-0.6377	0.7380	0.2620	0.5240	-1.2411	0.8924	0.1076	0.2153	-0.8929	0.8138	0.1862	0.3725
2	lpat	-0.8812	0.8106	0.1894	0.3788	-2.4348	0.9923	**0.0077**	**0.0153**	-1.1873	0.8821	0.1179	0.2358
3	lpat	-1.0421	0.8510	0.1490	0.2980	-2.0881	0.9813	**0.0187**	**0.0374**	-1.3346	0.9086	0.0914	0.1828
4	lpat	-1.1342	0.8713	0.1287	0.2574	-1.6115	0.9461	0.0539	0.1079	-1.3745	0.9150	0.0850	0.1701
5	lpat	-1.1731	0.8793	0.1207	0.2415	-1.2925	0.9015	0.0985	0.1969	-1.2563	0.8951	0.1049	0.2097
6	lpat	-1.1640	0.8774	0.1226	0.2451	-1.0759	0.8587	0.1413	0.2826	-1.2338	0.8910	0.1090	0.2180
7	lpat	-1.1324	0.8709	0.1291	0.2581	-0.9229	0.8217	0.1783	0.3566	-1.2355	0.8913	0.1087	0.2174
8	lpat	-1.0536	0.8537	0.1463	0.2927	-0.8150	0.7922	0.2078	0.4155	-1.1426	0.8731	0.1269	0.2539
9	lpat	-1.0145	0.8445	0.1555	0.3110	-0.6935	0.7558	0.2442	0.4884	-1.0793	0.8594	0.1406	0.2811
10	lpat	-0.9847	0.8373	0.1627	0.3254	-0.6017	0.7261	0.2739	0.5477	-0.9741	0.8347	0.1653	0.3306
11	lpat	-0.9429	0.8268	0.1732	0.3463	-0.5400	0.7052	0.2948	0.5895	-0.8788	0.8100	0.1900	0.3800
12	lpat	-0.8474	0.8013	0.1987	0.3973	-0.5132	0.6959	0.3041	0.6081	-0.7874	0.7843	0.2157	0.4315
0	linvq	1.5773	0.0578	0.9422	0.1155	0.4656	0.3209	0.6791	0.6417	1.7512	**0.0403**	0.9597	0.0807
1	linvq	3.2298	**0.0007**	0.9993	**0.0013**	1.7014	**0.0448**	0.9552	0.0897	2.7944	**0.0027**	0.9973	**0.0055**
2	linvq	2.9540	**0.0017**	0.9983	**0.0033**	1.5803	0.0574	0.9426	0.1148	2.5168	**0.0061**	0.9939	**0.0122**
3	linvq	2.7199	**0.0034**	0.9966	**0.0068**	1.2691	0.1026	0.8974	0.2052	2.1385	**0.0165**	0.9835	**0.0331**
4	linvq	2.3913	**0.0086**	0.9914	**0.0173**	0.8002	0.2120	0.7880	0.4241	1.8203	**0.0347**	0.9653	0.0695
5	linvq	2.0586	**0.0201**	0.9799	**0.0402**	0.3376	0.3679	0.6321	0.7358	1.4800	0.0698	0.9302	0.1397
6	linvq	1.7099	**0.0440**	0.9560	0.0881	-0.0005	0.5002	0.4998	0.9996	1.2155	0.1124	0.8876	0.2249
7	linvq	1.4258	0.0773	0.9227	0.1547	-0.2213	0.5875	0.4125	0.8250	1.0082	0.1570	0.8430	0.3140
8	linvq	1.1859	0.1182	0.8818	0.2364	-0.3332	0.6304	0.3696	0.7391	0.7954	0.2134	0.7866	0.4269
9	linvq	0.9677	0.1669	0.8331	0.3338	-0.4110	0.6593	0.3407	0.6813	0.6210	0.2675	0.7325	0.5350
10	linvq	0.7716	0.2204	0.7796	0.4408	-0.4520	0.6743	0.3257	0.6515	0.4719	0.3186	0.6814	0.6372
11	linvq	0.6126	0.2702	0.7298	0.5405	-0.4561	0.6757	0.3243	0.6486	0.3337	0.3694	0.6306	0.7388
12	linvq	0.4712	0.3189	0.6811	0.6377	-0.4598	0.6770	0.3230	0.6459	0.2197	0.4131	0.5869	0.8262
0	lemp	1.1472	0.1260	0.8740	0.2520	0.3171	0.3757	0.6243	0.7513	2.0216	**0.0219**	0.9781	0.0439
1	lemp	0.1536	0.4390	0.5610	0.8780	-0.8436	0.8003	0.1997	0.3994	0.3738	0.3544	0.6456	0.7088
2	lemp	0.0245	0.4902	0.5098	0.9805	-0.7820	0.7827	0.2173	0.4347	-0.1696	0.5673	0.4327	0.8654
3	lemp	0.0905	0.4640	0.5360	0.9280	-0.5175	0.6974	0.3026	0.6051	-0.3220	0.6262	0.3738	0.7476
4	lemp	0.1895	0.4249	0.5751	0.8498	-0.1940	0.5769	0.4231	0.8462	-0.3700	0.6442	0.3558	0.7116
5	lemp	0.2965	0.3835	0.6165	0.7670	0.0560	0.4777	0.5223	0.9554	-0.3952	0.6535	0.3465	0.6929
6	lemp	0.3780	0.3528	0.6472	0.7056	0.1837	0.4272	0.5728	0.8544	-0.4107	0.6592	0.3408	0.6815
7	lemp	0.4335	0.3325	0.6675	0.6649	0.1949	0.4228	0.5772	0.8456	-0.4232	0.6638	0.3362	0.6724
8	lemp	0.4681	0.3200	0.6800	0.6400	0.1343	0.4466	0.5534	0.8932	-0.4387	0.6694	0.3306	0.6611
9	lemp	0.4718	0.3186	0.6814	0.6373	0.0511	0.4797	0.5203	0.9593	-0.4413	0.6704	0.3296	0.6593
10	lemp	0.4906	0.3120	0.6880	0.6239	-0.0388	0.5154	0.4846	0.9691	-0.4418	0.6706	0.3294	0.6589
11	lemp	0.4966	0.3099	0.6901	0.6197	-0.1204	0.5479	0.4521	0.9042	-0.4371	0.6689	0.3311	0.6623
12	lemp	0.4915	0.3117	0.6883	0.6234	-0.1874	0.5743	0.4257	0.8515	-0.4401	0.6700	0.3300	0.6601
0	lgdp	-2.7546	0.9969	**0.0031**	**0.0061**	-1.3947	0.9181	0.0819	0.1639	-2.8183	0.9975	**0.0025**	**0.0051**
1	lgdp	-3.2450	0.9994	**0.0006**	**0.0013**	-1.7433	0.9590	**0.0410**	0.0821	-3.4058	0.9996	**0.0004**	**0.0007**
2	lgdp	-2.5925	0.9951	**0.0049**	**0.0099**	-1.4597	0.9274	0.0726	0.1452	-2.8523	0.9977	**0.0023**	**0.0046**
3	lgdp	-2.1269	0.9830	**0.0170**	**0.0340**	-1.1979	0.8842	0.1158	0.2317	-2.4665	0.9930	**0.0070**	**0.0141**
4	lgdp	-1.8336	0.9663	**0.0337**	0.0675	-1.0299	0.8482	0.1518	0.3037	-2.1763	0.9849	**0.0151**	**0.0301**
5	lgdp	-1.5990	0.9447	0.0553	0.1106	-0.8923	0.8136	0.1864	0.3728	-2.0342	0.9787	**0.0213**	**0.0426**
6	lgdp	-1.4007	0.9190	0.0810	0.1621	-0.8381	0.7988	0.2012	0.4025	-1.8803	0.9696	**0.0304**	0.0608
7	lgdp	-1.2542	0.8947	0.1053	0.2105	-0.7791	0.7818	0.2182	0.4364	-1.7907	0.9630	**0.0370**	0.0741
8	lgdp	-1.1434	0.8732	0.1268	0.2536	-0.7486	0.7727	0.2273	0.4546	-1.6951	0.9546	**0.0454**	0.0908
9	lgdp	-1.0513	0.8531	0.1469	0.2938	-0.7187	0.7636	0.2364	0.4727	-1.5931	0.9440	0.0560	0.1119
10	lgdp	-0.9846	0.8373	0.1627	0.3254	-0.6833	0.7526	0.2474	0.4948	-1.5008	0.9329	0.0671	0.1342
11	lgdp	-0.9074	0.8176	0.1824	0.3648	-0.6515	0.7424	0.2576	0.5151	-1.4299	0.9232	0.0768	0.1535
12	lgdp	-0.8266	0.7955	0.2045	0.4090	-0.6320	0.7361	0.2639	0.5278	-1.3458	0.9104	0.0896	0.1791

Notes: diff = mean(low_regions) - mean(high_regions); H_0: diff = 0; degrees of freedom = 398

Table 3: T-tests using estimated average responses in subsamples at time *t* (economic freedom, initial changes in the GRW intensity are equal in relative terms)

		GRW industry funding				GRW infrastructure funding				Overall GRW funding			
Time	**Response variable**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**
0	lhk	1.4491	0.0741	0.9259	0.1481	0.3100	0.3784	0.6216	0.7568	1.1384	0.1278	0.8722	0.2557
1	lhk	1.1563	0.1241	0.8759	0.2483	-0.1866	0.5740	0.4260	0.8520	0.8462	0.1990	0.8010	0.3979
2	lhk	0.6633	0.2537	0.7463	0.5075	-0.1169	0.5465	0.4535	0.9070	0.4088	0.3414	0.6586	0.6829
3	lhk	0.4110	0.3407	0.6593	0.6813	0.1496	0.4406	0.5594	0.8812	0.1627	0.4354	0.5646	0.8709
4	lhk	0.2369	0.4064	0.5936	0.8128	0.4055	0.3427	0.6573	0.6853	-0.0112	0.5045	0.4955	0.9910
5	lhk	0.1184	0.4529	0.5471	0.9058	0.6103	0.2710	0.7290	0.5420	-0.1429	0.5568	0.4432	0.8864
6	lhk	0.0257	0.4898	0.5102	0.9795	0.7418	0.2293	0.7707	0.4586	-0.2432	0.5960	0.4040	0.8079
7	lhk	-0.0464	0.5185	0.4815	0.9630	0.7906	0.2148	0.7852	0.4296	-0.3173	0.6244	0.3756	0.7512
8	lhk	-0.0984	0.5392	0.4608	0.9216	0.8242	0.2052	0.7948	0.4103	-0.3686	0.6437	0.3563	0.7126
9	lhk	-0.1385	0.5550	0.4450	0.8899	0.8044	0.2108	0.7892	0.4216	-0.4019	0.6560	0.3440	0.6879
10	lhk	-0.1680	0.5667	0.4333	0.8667	0.7864	0.2161	0.7839	0.4321	-0.4270	0.6652	0.3348	0.6696
11	lhk	-0.1907	0.5756	0.4244	0.8488	0.7575	0.2246	0.7754	0.4492	-0.4485	0.6730	0.3270	0.6541
12	lhk	-0.1974	0.5782	0.4218	0.8436	0.7036	0.2410	0.7590	0.4821	-0.4504	0.6737	0.3263	0.6527
0	lpat	-0.4359	0.6684	0.3316	0.6632	-1.2024	0.8850	0.1150	0.2299	-1.1807	0.8808	0.1192	0.2384
1	lpat	-1.6456	0.9497	0.0503	0.1006	-0.6952	0.7563	0.2437	0.4873	-1.5667	0.9410	0.0590	0.1180
2	lpat	-2.0114	0.9775	**0.0225**	**0.0450**	-1.6169	0.9467	0.0533	0.1067	-1.8856	0.9700	**0.0300**	0.0601
3	lpat	-2.2876	0.9887	**0.0113**	**0.0227**	-1.5026	0.9331	0.0669	0.1337	-2.1503	0.9839	**0.0161**	**0.0321**
4	lpat	-2.1922	0.9855	**0.0145**	**0.0289**	-1.2905	0.9012	0.0988	0.1976	-2.0780	0.9808	**0.0192**	**0.0383**
5	lpat	-2.1443	0.9837	**0.0163**	**0.0326**	-1.1795	0.8806	0.1194	0.2389	-2.0250	0.9782	**0.0218**	**0.0435**
6	lpat	-1.9072	0.9714	**0.0286**	0.0572	-1.0213	0.8461	0.1539	0.3078	-1.8307	0.9661	**0.0339**	0.0679
7	lpat	-1.6672	0.9519	**0.0481**	0.0963	-0.9224	0.8216	0.1784	0.3569	-1.6279	0.9478	0.0522	0.1043
8	lpat	-1.4896	0.9314	0.0686	0.1371	-0.8624	0.8055	0.1945	0.3890	-1.4466	0.9256	0.0744	0.1488
9	lpat	-1.3382	0.9092	0.0908	0.1816	-0.7881	0.7845	0.2155	0.4311	-1.3008	0.9030	0.0970	0.1941
10	lpat	-1.1995	0.8845	0.1155	0.2311	-0.7568	0.7752	0.2248	0.4496	-1.1563	0.8759	0.1241	0.2482
11	lpat	-1.0224	0.8464	0.1536	0.3072	-0.7459	0.7719	0.2281	0.4562	-1.0161	0.8449	0.1551	0.3102
12	lpat	-0.8972	0.8149	0.1851	0.3702	-0.7128	0.7618	0.2382	0.4764	-0.8874	0.8123	0.1877	0.3754
0	linvq	3.2228	**0.0007**	0.9993	**0.0014**	1.9503	**0.0259**	0.9741	0.0518	3.3220	**0.0005**	0.9995	**0.0010**
1	linvq	2.9957	**0.0015**	0.9985	**0.0029**	2.5416	**0.0057**	0.9943	**0.0114**	2.9425	**0.0017**	0.9983	**0.0034**
2	linvq	2.2660	**0.0120**	0.9880	**0.0240**	2.5710	**0.0053**	0.9947	**0.0105**	2.1610	**0.0156**	0.9844	**0.0313**
3	linvq	1.9624	**0.0252**	0.9748	0.0504	2.5661	**0.0053**	0.9947	**0.0107**	1.7971	**0.0365**	0.9635	0.0731
4	linvq	1.6860	**0.0463**	0.9537	0.0926	2.4302	**0.0078**	0.9922	**0.0155**	1.5555	0.0603	0.9397	0.1206
5	linvq	1.4382	0.0756	0.9244	0.1512	2.0521	**0.0204**	0.9796	**0.0408**	1.3239	0.0931	0.9069	0.1863
6	linvq	1.2314	0.1094	0.8906	0.2189	1.7562	**0.0399**	0.9601	0.0798	1.1123	0.1334	0.8666	0.2667
7	linvq	1.0719	0.1422	0.8578	0.2844	1.3614	0.0871	0.9129	0.1741	0.9665	0.1672	0.8328	0.3344
8	linvq	0.9002	0.1843	0.8157	0.3685	1.0810	0.1402	0.8598	0.2803	0.8053	0.2106	0.7894	0.4212
9	linvq	0.7116	0.2386	0.7614	0.4771	0.8892	0.1872	0.8128	0.3744	0.6628	0.2539	0.7461	0.5079
10	linvq	0.6124	0.2703	0.7297	0.5407	0.7201	0.2360	0.7640	0.4719	0.5659	0.2859	0.7141	0.5718
11	linvq	0.5290	0.2986	0.7014	0.5971	0.6204	0.2677	0.7323	0.5354	0.4886	0.3127	0.6873	0.6254
12	linvq	0.4703	0.3192	0.6808	0.6384	0.5452	0.2930	0.7070	0.5859	0.4278	0.3345	0.6655	0.6690
0	lemp	-0.2441	0.5964	0.4036	0.8073	-0.4964	0.6900	0.3100	0.6199	-0.3427	0.6340	0.3660	0.7320
1	lemp	-0.5107	0.6951	0.3049	0.6098	-1.8825	0.9698	**0.0302**	0.0605	-0.7264	0.7660	0.2340	0.4680
2	lemp	-0.7056	0.7596	0.2404	0.4808	-2.0381	0.9789	**0.0211**	**0.0422**	-0.9564	0.8303	0.1697	0.3395
3	lemp	-0.9619	0.8317	0.1683	0.3367	-1.8479	0.9673	**0.0327**	0.0654	-1.2537	0.8947	0.1053	0.2107
4	lemp	-1.2015	0.8849	0.1151	0.2303	-1.4852	0.9309	0.0691	0.1383	-1.5191	0.9352	0.0648	0.1295
5	lemp	-1.4569	0.9270	0.0730	0.1459	-1.0689	0.8571	0.1429	0.2858	-1.8017	0.9638	**0.0362**	0.0724
6	lemp	-1.7187	0.9568	**0.0432**	0.0864	-0.7056	0.7596	0.2404	0.4809	-2.0208	0.9780	**0.0220**	**0.0440**
7	lemp	-1.8828	0.9698	**0.0302**	0.0605	-0.4569	0.6760	0.3240	0.6480	-2.1240	0.9829	**0.0171**	**0.0343**
8	lemp	-1.9622	0.9748	**0.0252**	0.0504	-0.2917	0.6147	0.3853	0.7706	-2.1918	0.9855	**0.0145**	**0.0290**
9	lemp	-1.9655	0.9750	**0.0250**	0.0500	-0.2087	0.5826	0.4174	0.8348	-2.1631	0.9844	**0.0156**	**0.0311**
10	lemp	-1.9184	0.9721	**0.0279**	0.0558	-0.1625	0.5645	0.4355	0.8710	-2.0114	0.9775	**0.0225**	**0.0450**
11	lemp	-1.8797	0.9696	**0.0304**	0.0609	-0.1417	0.5563	0.4437	0.8874	-1.9275	0.9727	**0.0273**	0.0546
12	lemp	-1.8252	0.9656	**0.0344**	0.0687	-0.1307	0.5520	0.4480	0.8961	-1.7616	0.9605	**0.0395**	0.0789
0	lgdp	-1.2563	0.8951	0.1049	0.2097	-1.5796	0.9425	0.0575	0.1150	-1.4986	0.9326	0.0674	0.1348
1	lgdp	-2.2395	0.9872	**0.0128**	**0.0257**	-1.2518	0.8943	0.1057	0.2114	-2.5168	0.9939	**0.0061**	**0.0122**
2	lgdp	-2.1797	0.9851	**0.0149**	**0.0299**	-1.0104	0.8435	0.1565	0.3129	-2.4384	0.9924	**0.0076**	**0.0152**
3	lgdp	-2.1992	0.9858	**0.0142**	**0.0284**	-0.8001	0.7879	0.2121	0.4242	-2.4944	0.9935	**0.0065**	**0.0130**
4	lgdp	-2.1689	0.9847	**0.0153**	**0.0307**	-0.6160	0.7309	0.2691	0.5382	-2.4416	0.9925	**0.0075**	**0.0151**
5	lgdp	-2.1472	0.9838	**0.0162**	**0.0324**	-0.5127	0.6958	0.3042	0.6085	-2.4672	0.9930	**0.0070**	**0.0140**
6	lgdp	-2.1079	0.9822	**0.0178**	**0.0357**	-0.4385	0.6694	0.3306	0.6613	-2.4319	0.9923	**0.0077**	**0.0155**
7	lgdp	-2.0333	0.9787	**0.0213**	**0.0427**	-0.3770	0.6468	0.3532	0.7064	-2.2711	0.9882	**0.0118**	**0.0237**
8	lgdp	-1.9291	0.9728	**0.0272**	0.0544	-0.3358	0.6314	0.3686	0.7372	-2.2474	0.9874	**0.0126**	**0.0252**
9	lgdp	-1.8513	0.9676	**0.0324**	0.0649	-0.2954	0.6161	0.3839	0.7679	-2.1775	0.9850	**0.0150**	**0.0300**
10	lgdp	-1.7747	0.9616	**0.0384**	0.0767	-0.2690	0.6060	0.3940	0.7881	-2.0388	0.9789	**0.0211**	**0.0421**
11	lgdp	-1.7103	0.9560	**0.0440**	0.0880	-0.2472	0.5976	0.4024	0.8049	-1.8432	0.9670	**0.0330**	0.0660
12	lgdp	-1.5826	0.9428	0.0572	0.1143	-0.2315	0.5915	0.4085	0.8170	-1.7489	0.9595	**0.0405**	0.0811

Notes: diff = mean(low_regions) - mean(high_regions); H_0: diff = 0; degrees of freedom = 398

Table 4: Summary significant findings

			lgdp	lemp	linvq	lpat	lhk
Absorptive Capacity	GRW industry funding	Low	-	+	+		
		High	+	+	-	+	-
		Diff. relative	**H**		**L**		L
		Diff. absolute	**H**		**L**		L
	GRW infrastructure funding	Low		+		-	+
		High	+	+			+
		Diff. relative	H		L	H	
		Diff. absolute	H			H	
	Total GRW funding	Low	-	+	+		+
		High	+	+		+	- +
		Diff. relative	**H**	L	**L**		L
		Diff. absolute	**H**	L	**L**		L
Economic Freedom	GRW industry funding	Low	-		+	-	+
		High	+	+		+	
		Diff. relative	**H**	**H**	**L**	**H**	
		Diff. absolute	**H**	**H**	**L**	**H**	
	GRW infrastructure funding	Low			+	-	+
		High	+	+	-		+
		Diff. relative		H	**L**		
		Diff. absolute		H	**L**		
	Total GRW funding	Low	-		+	-	+
		High	+	+		+	
		Diff. relative	**H**	**H**	**L**	**H**	
		Diff. absolute	**H**	**H**	**L**	**H**	

Notes: + indicates short-term (less than 4 years during the considered time period) and + long-term (at least 4 years) significant positive effects, - indicates short-term and - long-term significant negative effects. L denotes short-term (less than 4 years during the considered time period) and **L** long-term (at least 4 years) significant higher economic responses in regions with a low indicator score, H (short-term) and **H** (long-term) indicates significant higher economic responses in regions with a high indicator score.

Figures

Figure 1: Summary identification and econometric strategy

Pre-estimation

Principal component analysis (PCA)

↓

Calculation of absorptive capacity and economic freedom indicators
Building of subsamples according to the indicators

↓

Estimation

Estimation of subsample specific VAR models

↓

IRF analysis

↓

Post-estimation

Comparing of subsample specific responses by using t-tests

Figure 2: Subgroups absorptive capacity and economic freedom

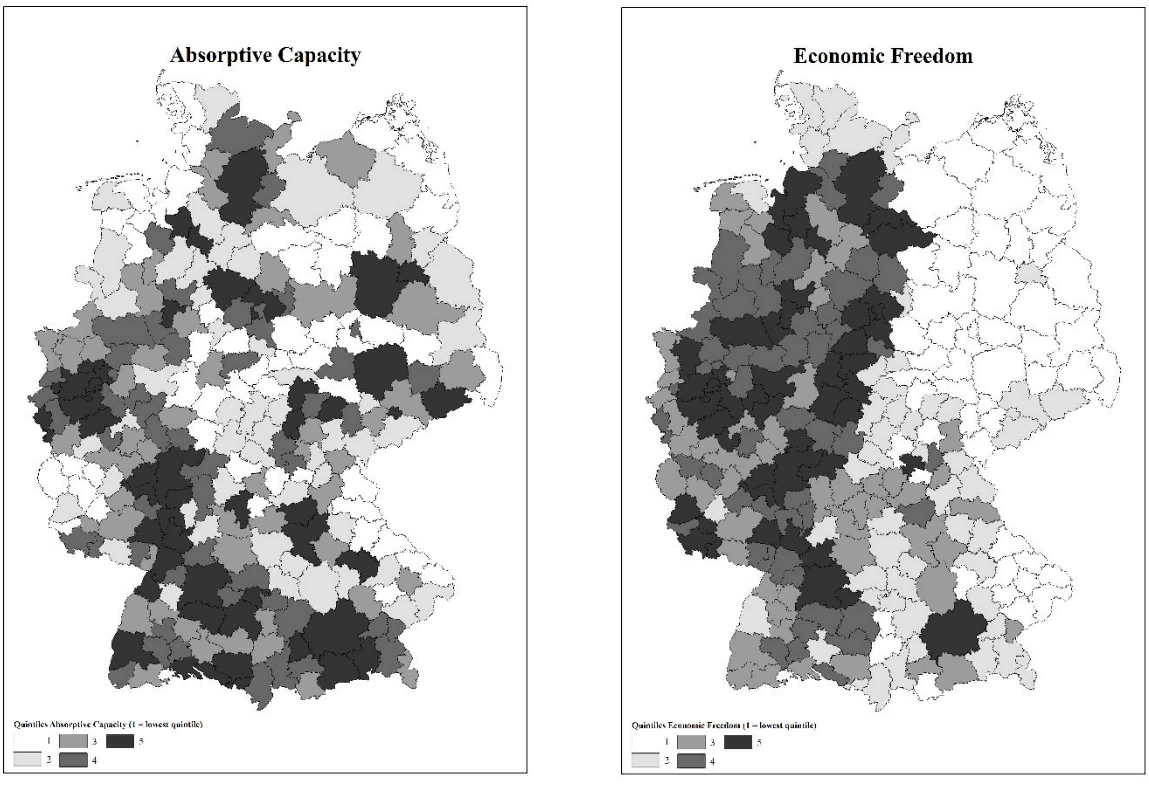
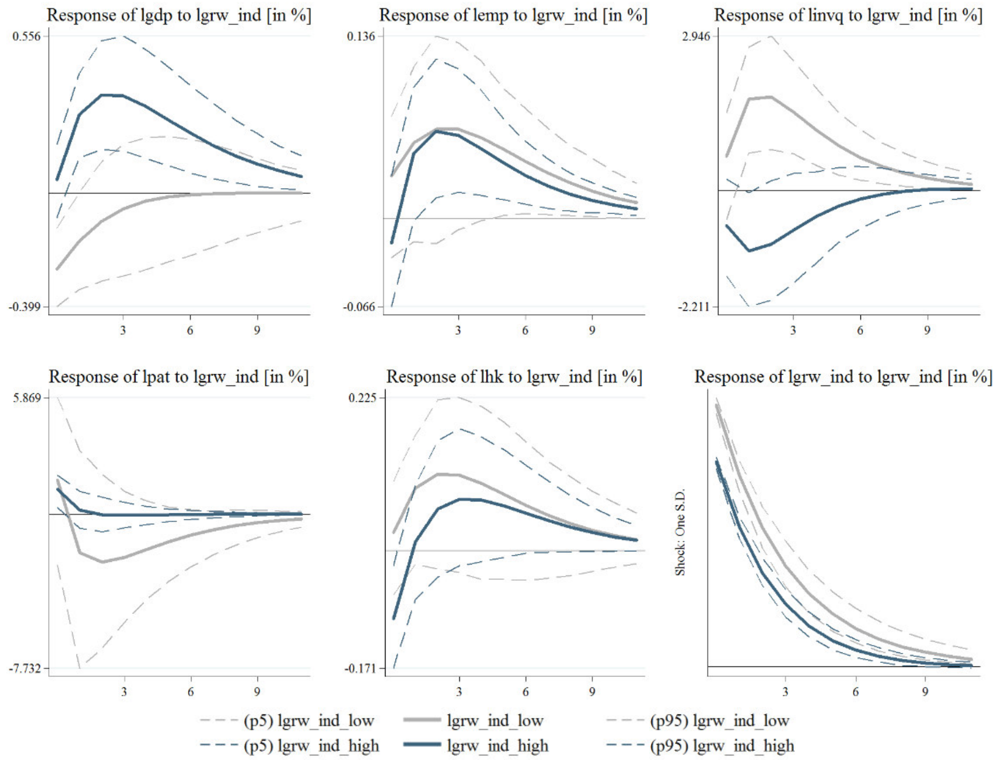
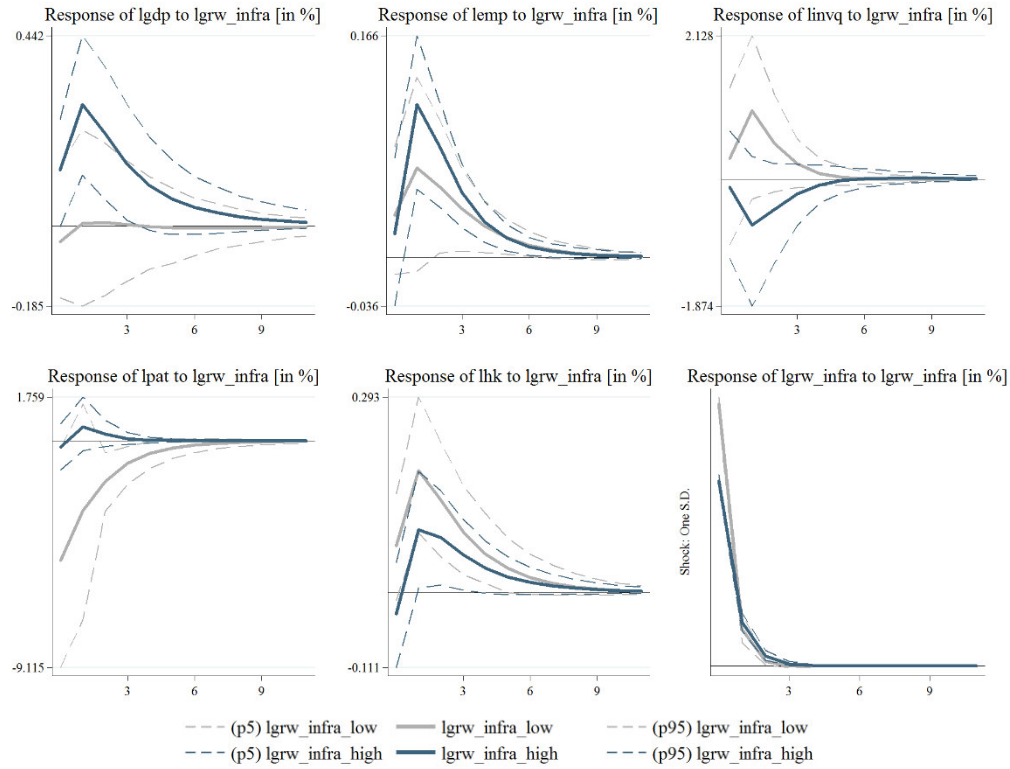


Figure 3: IRFs for the average effects of shocks in the GRW intensity (absorptive capacity classification, median)

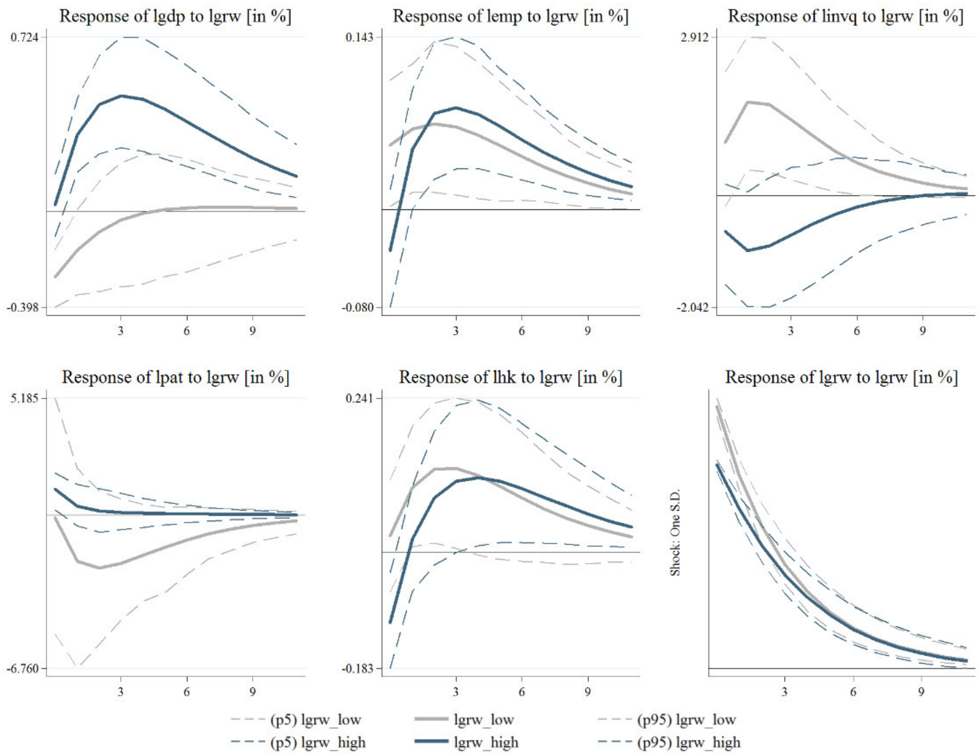
a) GRW industry funding



b) GRW infrastructure funding

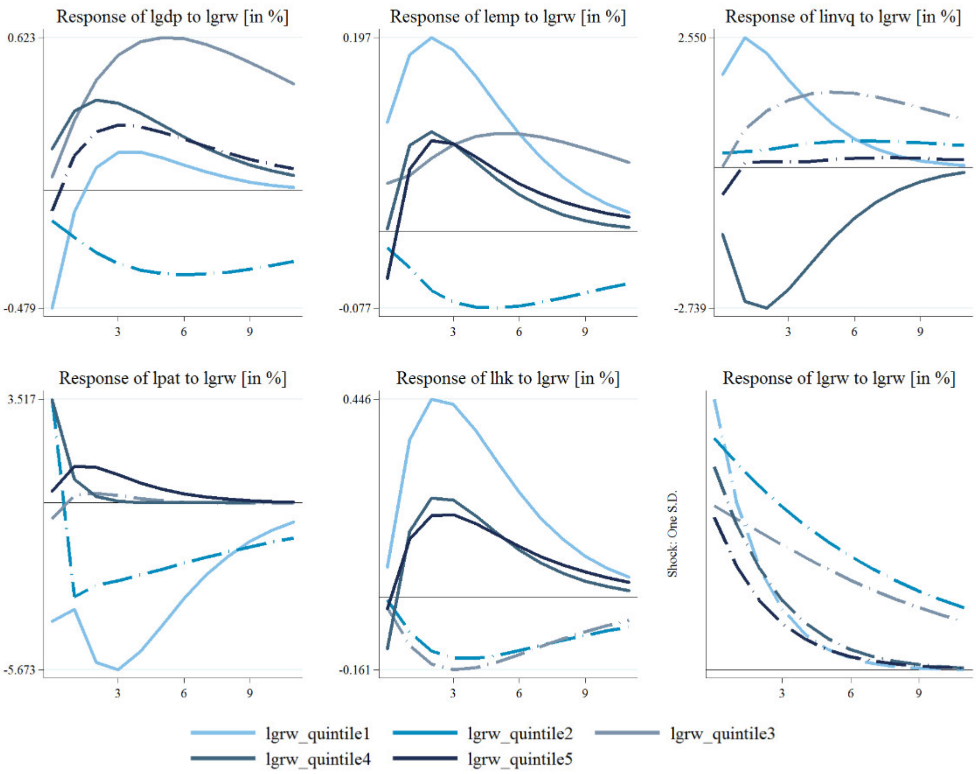


c) Overall GRW funding



Notes: The solid lines illustrate the estimated IRF for each sub-sample and the corresponding dashed lines show the 95% confidence intervals that were calculated by performing Monte Carlo simulations with 200 repetitions.

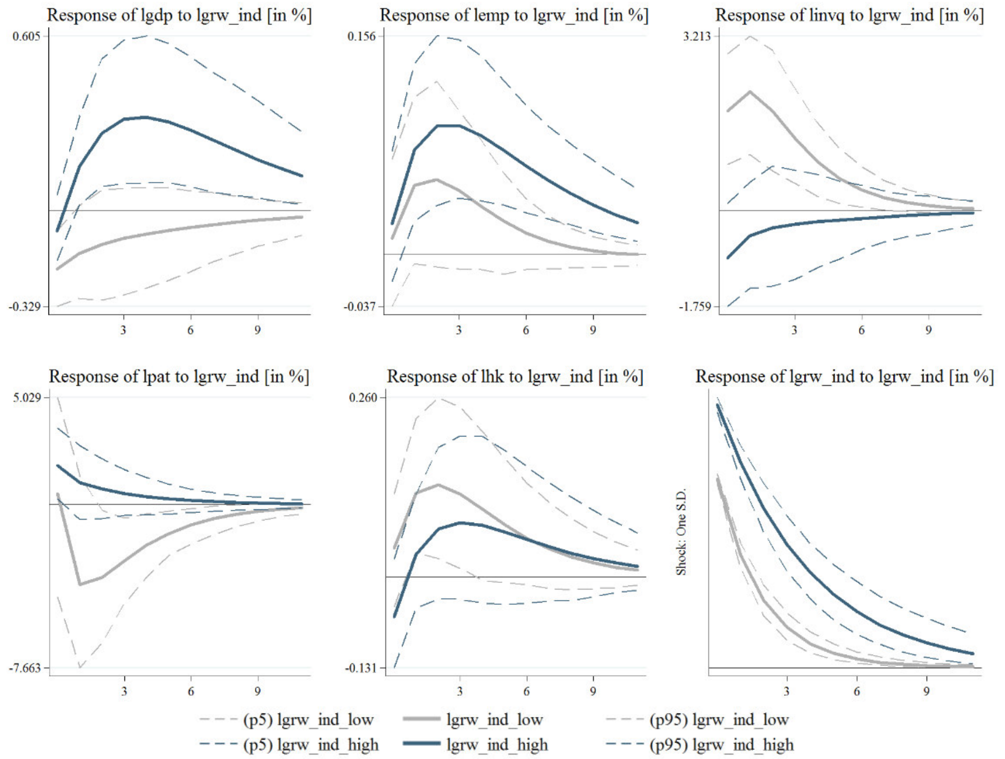
Figure 4: IRFs for the average effects of shocks in the overall GRW intensity (absorptive capacity classification, quintiles)



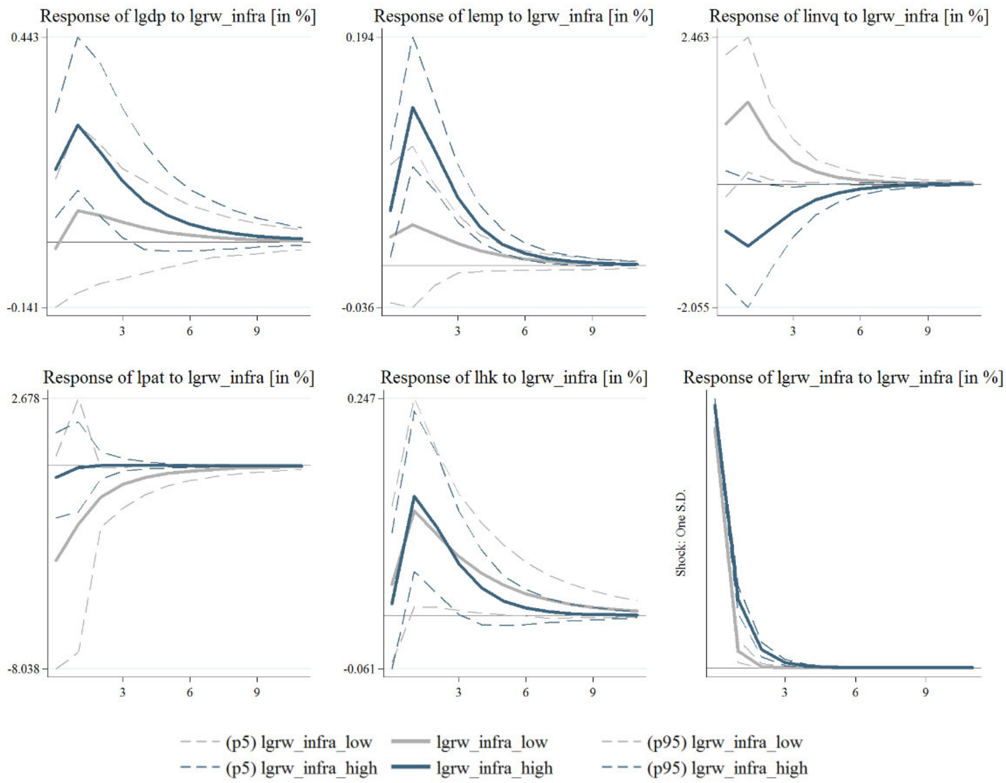
Notes: The solid lines illustrate significant IRFs, while the dashed lines illustrate non-significant IRFs.

Figure 5: IRFs for the average effects of shocks in the GRW intensity (economic freedom classification, median)

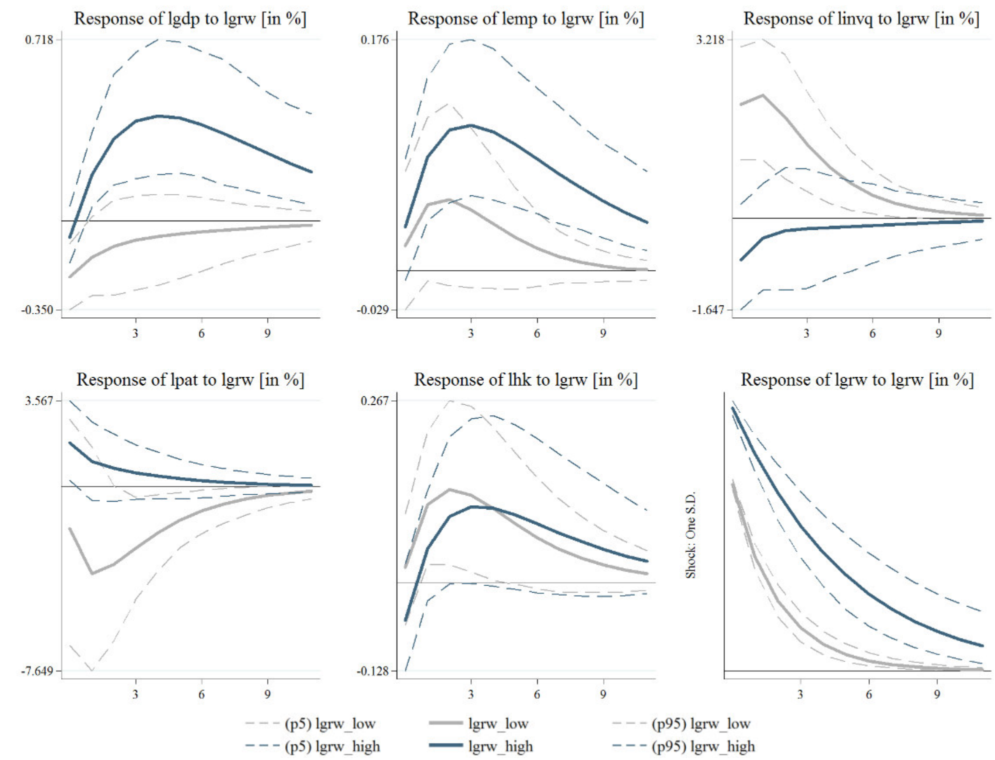
a) GRW industry funding



b) GRW infrastructure funding

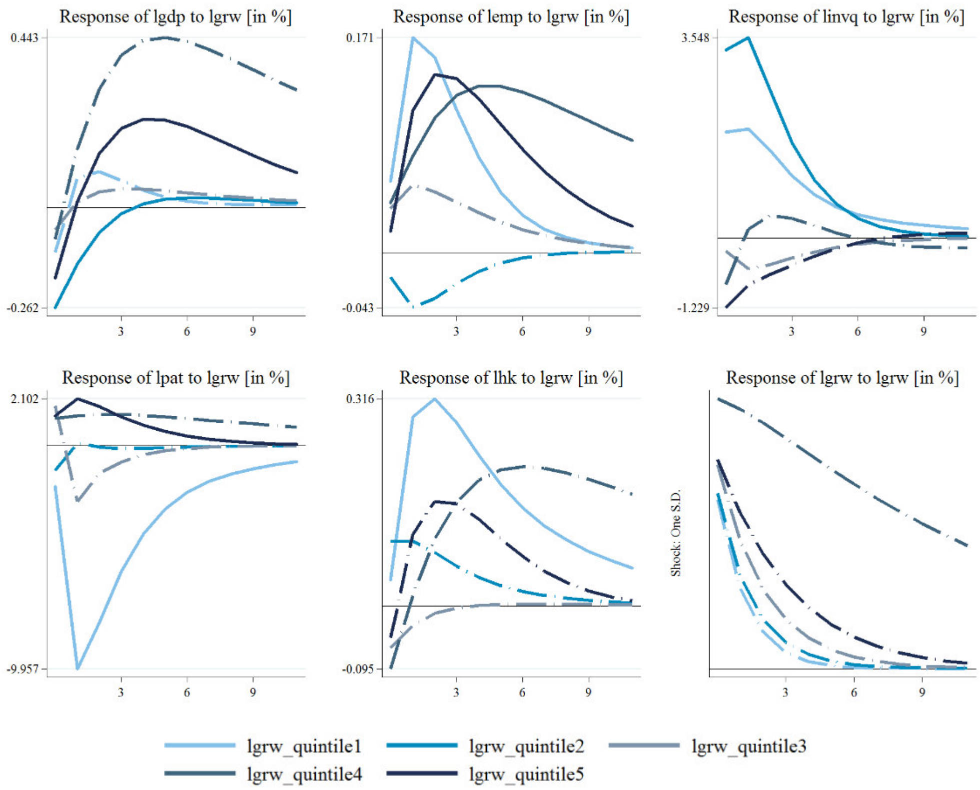


c) Overall GRW funding



Notes: The solid lines illustrate the estimated IRF for each sub-sample and the corresponding dashed lines show the 95% confidence intervals that were calculated by performing Monte Carlo simulations with 200 repetitions.

Figure 6: IRFs for the average effects of shocks in the overall GRW intensity (economic freedom classification, quintiles)



Notes: The solid lines illustrate significant IRFs, while the dashed lines illustrate non-significant IRFs.

Appendix

Table A1: Recent empirical studies on the conditional effects of investment and transfer programs

Authors	Policy	Geographical scale	Conditional effects are measured by	Conditional effects
Röhl and von Speicher (2009)	GRW	Regional (Germany)	Four different types of agglomeration (settlement structure)	Highest effects in agglomerations, followed by rural areas.
Rhoden (2016)	GRW	Regional (Germany)	Four different types of agglomeration (settlement structure)	No different effects in different types of agglomeration.
Cappelen et al. (2003)	EU Structural Funds	Regional (Europe)	Economic environment: less developed regions from Spain, Greece and Portugal are excluded in a reduced sample estimation	Higher effects in economic more advanced regions.
Beugelsdijk and Eijffinger (2005)	EU Structural Funds	National (Europe)	Corruption index	No higher effects in less corrupt countries.
Ederveen et al. (2006)	EU Structural Funds	National (Europe)	Institutional quality index, inflation, trust, openness and corruption	Higher effects in countries with adequate institutions.
Becker et al. (2013)	EU Structural Funds	Regional (Europe)	Absorptive capacity, quality of government	Higher effects in regions with an adequate absorptive capacity (human capital endowment, quality of government)
Fratesi and Perucca (2014)	EU Structural Funds	Regional (Central and Eastern Europe)	Territorial capital	A higher regional territorial capital increases the effectiveness of structural funds regarding GDP growth.

Table A1 (continued)

Authors	Policy	Geographical scale	Conditional effects are measured by	Conditional effects
Rodríguez-Pose and Garcilazo (2015)	EU Structural Funds	Regional (Europe)	Quality of government	Beyond a certain threshold, quality of government increases the efficacy of regional structural funds.
Gagliardi and Percoco (2017)	EU Structural Funds	Regional (Europe)	Settlement structures	The effects of EU objective 1 investments on GDP per capita is higher in intermediate as well as rural regions that are located close to a city.
Breidenbach et al. (2018)	EU Structural Funds	Regional (Europe)	Institutional (government) quality	Positive correlation between the funding effects and government quality.
Burnside and Dollar (2000)	Foreign aid	National (Latin America. Asia and Africa)	Index of Openness, budget surplus and inflation rate	Higher effects in countries with a good policy environment.
Suárez Serrato and Wingender (2016)	Federal spending United States	Counties (Unites States)	Faster- and slower-growing counties	Higher returns to federal spending on income and employment in poorer counties.

Table A2: Variables description and data sources variables VAR model

Variable	Description	Data source
lgdp	Nominal GDP per economically active working population (in ln) defined as: [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) Participation rate: Statistik der Bundesagentur für Arbeit / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR)
linvq	Private-sector physical capital investment rate (in ln) defined as industry investments in the manufacturing, mining and quarrying sector as share of the nominal GDP: [Industry Investments in € / GDP in €] Note: Missing values are interpolated on the basis of an autoregressive process with 3 lags.	Bundesinstitut für Bau-, Stadt-, und Raumforschung (BBSR), laufende Raumbeobachtungen, various issues
lhk	Higher education rate (in ln) defined as: [Employees with university degree / (Population aged 15 to 64 years × Participation rate)]	Institute for Employment Research (IAB), Nuremberg
lemp	Gross employment rate (in ln) defined as: [Employees total / (Population aged 15 to 64 years × Participation rate)]	Institute for Employment Research (IAB), Nuremberg
lpat	Patent rate (in ln) defined as: [Patents / GDP in Mio. €]	Own calculation from the PATSTAT database (Version October 2014, European Patent Office)
lgrw (lgrw_ind, lgrw_infra)	GRW investment intensity (and sub-components for industry and infrastructure investment support) (in ln) are defined as: [GRW funding volumes in € / GDP in €]	Federal Office for Economic Affairs and Export Control (BAFA)
w_X (controls)	Spatial lags for each variable are constructed in absolute values using the STATA command splagvar. Thereupon, all spatial lag variables are normalized and ln-transformed similar to the non-spatial variables above.	

Table A3: Variables description and data sources PCA analysis

Variable	Description	Data source
Higher education rate	Employees with university degree / (Population aged 15 to 64 years × Participation rate)	see Table 1
Patent rate	Patents / GDP in Mio. €	see Table 1
Population density	(Population aged 15 to 64 years × Participation rate) / area (in km^2)	Area in km^2: Bundesinstitut für Bau-, Stadt-, und Raumforschung (BBSR)
Start-up rate high-technology and medium-high-technology sectors	Start-ups high-technology and medium-high-technology sectors / (Population aged 15 to 64 years × Participation rate)	Mannheimer Unternehmenspanel (2015), Centre for European Economic Research (ZEW)
Start-up rate total knowledge intensive activities sectors	Start-ups total knowledge intensive activities sectors / / (Population aged 15 to 64 years × Participation rate)	Mannheimer Unternehmenspanel (2015), Centre for European Economic Research (ZEW)
Overall tax revenues	Overall tax revenue in € / population	Realsteuervergleich des Bundes und der Länder / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR)
Public debts*	Reserve bank credit in € / population	Statistik über Schulden des Bundes und der Länder / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR) Amt für Statistik Berlin-Brandenburg
Public employment*	Employees of the municipality / population (10.000)	Personalstandsstatistik der Länder, Gemeinden und Gemeindeverbände / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR) Statistische Ämter des Bundes und der Länder
Voter turnout	Second votes / people eligible to vote (in %)	Allgemeine Bundestagswahlstatistik des Bundes und der Länder / Indikatoren und Karten zur Raum und Stadtentwicklung (INKAR)

* No data is available for the districts of the city states Hamburg, Bremen and Berlin. However, the labor market regions Hamburg, Bremen and Bremerhaven comprise more administrative districts than the particular city district itself, for which reason interpretable values exist for these labor market regions (underestimation is possible). To approximate values for Berlin, pubic employment includes employees of municipalities and of the federal state, while the public debts are measured for the federal state Berlin. Please note that the labor markets regions comprising city states are excluded for the calculation of the factor loadings.

Table A4: T-tests using estimated average responses in subsamples at time *t* (absorptive capacity, initial changes in the GRW intensity are equal in absolute terms)

		GRW industry funding				GRW infrastructure funding				Overall GRW funding			
Time	**Response variable**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**
0	lhk	2.0012	**0.0230**	0.9770	**0.0461**	1.3896	0.0827	0.9173	0.1654	2.1182	**0.0174**	0.9826	**0.0348**
1	lhk	0.8598	0.1952	0.8048	0.3904	0.5164	0.3029	0.6971	0.6059	0.8759	0.1908	0.8092	0.3816
2	lhk	0.3231	0.3734	0.6266	0.7468	0.2661	0.3952	0.6048	0.7903	0.2006	0.4205	0.5795	0.8411
3	lhk	0.1315	0.4477	0.5523	0.8954	0.1831	0.4274	0.5726	0.8549	-0.0977	0.5389	0.4611	0.9222
4	lhk	0.0377	0.4850	0.5150	0.9700	0.1355	0.4462	0.5538	0.8923	-0.2599	0.6025	0.3975	0.7951
5	lhk	-0.0155	0.5062	0.4938	0.9877	0.0876	0.4651	0.5349	0.9302	-0.3677	0.6434	0.3566	0.7133
6	lhk	-0.0498	0.5199	0.4801	0.9603	0.0344	0.4863	0.5137	0.9726	-0.4506	0.6738	0.3262	0.6525
7	lhk	-0.0735	0.5293	0.4707	0.9414	-0.0237	0.5095	0.4905	0.9811	-0.5145	0.6964	0.3036	0.6072
8	lhk	-0.0891	0.5355	0.4645	0.9290	-0.0816	0.5325	0.4675	0.9350	-0.5593	0.7118	0.2882	0.5763
9	lhk	-0.1011	0.5402	0.4598	0.9195	-0.1369	0.5544	0.4456	0.8912	-0.5849	0.7205	0.2795	0.5589
10	lhk	-0.1088	0.5433	0.4567	0.9134	-0.1906	0.5755	0.4245	0.8490	-0.6193	0.7320	0.2680	0.5360
11	lhk	-0.1133	0.5451	0.4549	0.9099	-0.2293	0.5906	0.4094	0.8188	-0.6400	0.7387	0.2613	0.5225
12	lhk	-0.1163	0.5463	0.4537	0.9075	-0.2600	0.6025	0.3975	0.7950	-0.6341	0.7368	0.2632	0.5264
0	lpat	0.0563	0.4776	0.5224	0.9551	-1.6036	0.9452	0.0548	0.1096	-0.4915	0.6883	0.3117	0.6233
1	lpat	-0.6485	0.7415	0.2585	0.5170	-1.2878	0.9007	0.0993	0.1986	-0.9231	0.8217	0.1783	0.3565
2	lpat	-0.8677	0.8070	0.1930	0.3861	-2.3824	0.9912	**0.0088**	**0.0177**	-1.1850	0.8816	0.1184	0.2367
3	lpat	-1.0218	0.8463	0.1537	0.3075	-2.0700	0.9805	**0.0195**	**0.0391**	-1.3195	0.9061	0.0939	0.1877
4	lpat	-1.1134	0.8669	0.1331	0.2662	-1.6064	0.9455	0.0545	0.1090	-1.3576	0.9123	0.0877	0.1753
5	lpat	-1.1546	0.8755	0.1245	0.2490	-1.2850	0.9002	0.0998	0.1995	-1.2466	0.8934	0.1066	0.2133
6	lpat	-1.1484	0.8742	0.1258	0.2515	-1.0697	0.8573	0.1427	0.2854	-1.2260	0.8895	0.1105	0.2209
7	lpat	-1.1201	0.8683	0.1317	0.2633	-0.9207	0.8211	0.1789	0.3578	-1.2282	0.8899	0.1101	0.2201
8	lpat	-1.0452	0.8517	0.1483	0.2966	-0.8145	0.7921	0.2079	0.4159	-1.1379	0.8721	0.1279	0.2559
9	lpat	-1.0086	0.8431	0.1569	0.3138	-0.6949	0.7562	0.2438	0.4875	-1.0772	0.8590	0.1410	0.2820
10	lpat	-0.9805	0.8363	0.1637	0.3274	-0.6043	0.7270	0.2730	0.5460	-0.9742	0.8347	0.1653	0.3305
11	lpat	-0.9404	0.8262	0.1738	0.3476	-0.5437	0.7065	0.2935	0.5869	-0.8813	0.8107	0.1893	0.3787
12	lpat	-0.8465	0.8011	0.1989	0.3978	-0.5170	0.6973	0.3027	0.6055	-0.7909	0.7853	0.2147	0.4295
0	linvq	1.5876	0.0566	0.9434	0.1132	0.4392	0.3304	0.6696	0.6608	1.7584	**0.0397**	0.9603	**0.0794**
1	linvq	3.1017	**0.0010**	0.9990	**0.0021**	1.6431	0.0506	0.9494	0.1012	2.7328	**0.0033**	0.9967	**0.0066**
2	linvq	2.8202	**0.0025**	0.9975	**0.0050**	1.5275	0.0637	0.9363	0.1274	2.4189	**0.0080**	0.9920	**0.0160**
3	linvq	2.5439	**0.0057**	0.9943	**0.0113**	1.2007	0.1153	0.8847	0.2306	2.0208	**0.0220**	0.9780	**0.0440**
4	linvq	2.2164	**0.0136**	0.9864	**0.0272**	0.7484	0.2273	0.7727	0.4546	1.6978	**0.0452**	0.9548	0.0903
5	linvq	1.8853	**0.0301**	0.9699	0.0601	0.3007	0.3819	0.6181	0.7638	1.3543	0.0882	0.9118	0.1764
6	linvq	1.5390	0.0623	0.9377	0.1246	-0.0295	0.5118	0.4882	0.9765	1.0959	0.1369	0.8631	0.2738
7	linvq	1.2610	0.1040	0.8960	0.2080	-0.2450	0.5967	0.4033	0.8066	0.8869	0.1878	0.8122	0.3757
8	linvq	1.0328	0.1512	0.8488	0.3023	-0.3541	0.6383	0.3617	0.7234	0.6776	0.2492	0.7508	0.4984
9	linvq	0.8193	0.2066	0.7934	0.4131	-0.4281	0.6656	0.3344	0.6688	0.5104	0.3050	0.6950	0.6100
10	linvq	0.6280	0.2652	0.7348	0.5303	-0.4727	0.6817	0.3183	0.6367	0.3669	0.3570	0.6430	0.7139
11	linvq	0.4684	0.3199	0.6801	0.6397	-0.4799	0.6842	0.3158	0.6316	0.2361	0.4067	0.5933	0.8135
12	linvq	0.3281	0.3715	0.6285	0.7430	-0.4836	0.6855	0.3145	0.6290	0.1277	0.4492	0.5508	0.8985
0	lemp	1.1141	0.1330	0.8670	0.2659	0.1228	0.4512	0.5488	0.9023	1.9645	**0.0251**	0.9749	0.0502
1	lemp	-0.1058	0.5421	0.4579	0.9158	-1.4342	0.9239	0.0761	0.1523	0.0418	0.4833	0.5167	0.9667
2	lemp	-0.2689	0.6059	0.3941	0.7881	-1.4210	0.9220	0.0780	0.1561	-0.5407	0.7055	0.2945	0.5890
3	lemp	-0.2261	0.5894	0.4106	0.8213	-1.1665	0.8779	0.1221	0.2441	-0.7097	0.7609	0.2391	0.4783
4	lemp	-0.1304	0.5518	0.4482	0.8963	-0.7868	0.7841	0.2159	0.4319	-0.7550	0.7746	0.2254	0.4507
5	lemp	-0.0348	0.5139	0.4861	0.9723	-0.4581	0.6764	0.3236	0.6471	-0.7820	0.7827	0.2173	0.4347
6	lemp	0.0550	0.4781	0.5219	0.9562	-0.2477	0.5977	0.4023	0.8045	-0.7855	0.7837	0.2163	0.4326
7	lemp	0.1270	0.4495	0.5505	0.8990	-0.1436	0.5570	0.4430	0.8859	-0.7898	0.7849	0.2151	0.4301
8	lemp	0.1809	0.4283	0.5717	0.8566	-0.1250	0.5497	0.4503	0.9006	-0.7884	0.7845	0.2155	0.4309
9	lemp	0.2129	0.4157	0.5843	0.8315	-0.1549	0.5615	0.4385	0.8770	-0.7701	0.7792	0.2208	0.4417
10	lemp	0.2443	0.4036	0.5964	0.8071	-0.2028	0.5803	0.4197	0.8394	-0.7556	0.7748	0.2252	0.4503
11	lemp	0.2634	0.3962	0.6038	0.7924	-0.2530	0.5998	0.4002	0.8004	-0.7286	0.7667	0.2333	0.4666
12	lemp	0.2744	0.3920	0.6080	0.7839	-0.2952	0.6160	0.3840	0.7680	-0.7194	0.7638	0.2362	0.4723
0	lgdp	-2.5242	0.9940	**0.0060**	**0.0120**	-1.5646	0.9408	0.0592	0.1185	-2.4891	0.9934	**0.0066**	**0.0132**
1	lgdp	-3.3716	0.9996	**0.0004**	**0.0008**	-2.1075	0.9822	**0.0178**	**0.0357**	-3.5813	0.9998	**0.0002**	**0.0004**
2	lgdp	-2.7807	0.9972	**0.0028**	**0.0057**	-1.7465	0.9593	**0.0407**	0.0815	-3.1135	0.9990	**0.0010**	**0.0020**
3	lgdp	-2.3357	0.9900	**0.0100**	**0.0200**	-1.4026	0.9192	0.0808	0.1615	-2.7466	0.9969	**0.0031**	**0.0063**
4	lgdp	-2.0519	0.9796	**0.0204**	**0.0408**	-1.1855	0.8817	0.1183	0.2365	-2.4607	0.9929	**0.0071**	**0.0143**
5	lgdp	-1.8140	0.9648	**0.0352**	0.0704	-1.0176	0.8452	0.1548	0.3095	-2.3131	0.9894	**0.0106**	**0.0212**
6	lgdp	-1.6074	0.9456	0.0544	0.1088	-0.9392	0.8259	0.1741	0.3482	-2.1468	0.9838	**0.0162**	**0.0324**
7	lgdp	-1.4463	0.9256	0.0744	0.1489	-0.8605	0.8050	0.1950	0.3900	-2.0402	0.9790	**0.0210**	**0.0420**
8	lgdp	-1.3265	0.9073	0.0927	0.1854	-0.8215	0.7941	0.2059	0.4119	-1.9223	0.9724	**0.0276**	0.0553
9	lgdp	-1.2207	0.8885	0.1115	0.2229	-0.7792	0.7818	0.2182	0.4363	-1.8086	0.9644	**0.0356**	0.0713
10	lgdp	-1.1471	0.8740	0.1260	0.2520	-0.7352	0.7687	0.2313	0.4626	-1.7057	0.9556	**0.0444**	0.0888
11	lgdp	-1.0604	0.8552	0.1448	0.2896	-0.6953	0.7564	0.2436	0.4873	-1.6201	0.9470	0.0530	0.1060
12	lgdp	-0.9634	0.8320	0.1680	0.3360	-0.6676	0.7476	0.2524	0.5048	-1.5232	0.9357	0.0643	0.1285

Notes: diff = mean(low_regions) - mean(high_regions); H_0: diff = 0; degrees of freedom = 398

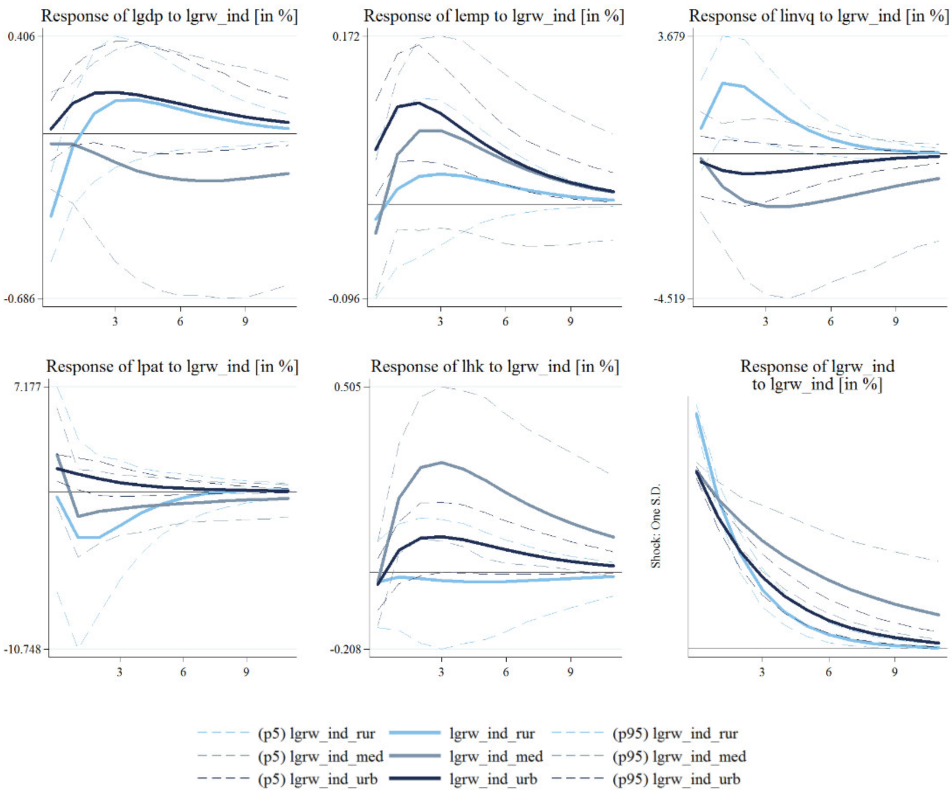
Table A5: T-tests using estimated average responses in subsamples at time *t* (economic freedom, initial changes in the GRW intensity are equal in absolute terms)

		GRW industry funding				GRW infrastructure funding				Overall GRW funding			
Time	**Response variable**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**	**t-value**	**Ha: diff > 0, Pr(T > t)**	**Ha: diff < 0, Pr(T < t)**	**Ha: diff != 0, (|T| > |t|)**
0	lhk	1.3847	0.0835	0.9165	0.1669	0.3377	0.3679	0.6321	0.7358	1.0392	0.1497	0.8503	0.2994
1	lhk	1.4325	0.0764	0.9236	0.1528	-0.0590	0.5235	0.4765	0.9530	1.1645	0.1225	0.8775	0.2449
2	lhk	0.9860	0.1624	0.8376	0.3247	0.0037	0.4985	0.5015	0.9970	0.7918	0.2145	0.7855	0.4290
3	lhk	0.7297	0.2330	0.7670	0.4660	0.2539	0.3999	0.6001	0.7997	0.5510	0.2910	0.7090	0.5819
4	lhk	0.5315	0.2977	0.7023	0.5954	0.4894	0.3124	0.6876	0.6248	0.3583	0.3601	0.6399	0.7203
5	lhk	0.3952	0.3464	0.6536	0.6929	0.6760	0.2497	0.7503	0.4994	0.2038	0.4193	0.5807	0.8386
6	lhk	0.2803	0.3897	0.6103	0.7794	0.7926	0.2142	0.7858	0.4285	0.0715	0.4715	0.5285	0.9431
7	lhk	0.1785	0.4292	0.5708	0.8584	0.8256	0.2048	0.7952	0.4095	-0.0374	0.5149	0.4851	0.9702
8	lhk	0.0969	0.4614	0.5386	0.9229	0.8490	0.1982	0.8018	0.3964	-0.1239	0.5493	0.4507	0.9015
9	lhk	0.0352	0.4859	0.5141	0.9719	0.8215	0.2059	0.7941	0.4119	-0.1904	0.5754	0.4246	0.8491
10	lhk	-0.0133	0.5053	0.4947	0.9894	0.7975	0.2128	0.7872	0.4257	-0.2424	0.5957	0.4043	0.8086
11	lhk	-0.0518	0.5206	0.4794	0.9587	0.7642	0.2226	0.7774	0.4452	-0.2854	0.6123	0.3877	0.7755
12	lhk	-0.0783	0.5312	0.4688	0.9376	0.7071	0.2400	0.7600	0.4799	-0.3115	0.6222	0.3778	0.7555
0	lpat	-0.2730	0.6075	0.3925	0.7850	-1.2312	0.8905	0.1095	0.2190	-1.0345	0.8492	0.1508	0.3015
1	lpat	-1.5982	0.9446	0.0554	0.1108	-0.7036	0.7590	0.2410	0.4821	-1.5075	0.9338	0.0662	0.1325
2	lpat	-1.9964	0.9767	**0.0233**	**0.0466**	-1.6386	0.9490	0.0510	0.1021	-1.8563	0.9679	**0.0321**	0.0642
3	lpat	-2.3131	0.9894	**0.0106**	**0.0212**	-1.5100	0.9341	0.0659	0.1318	-2.1597	0.9843	**0.0157**	**0.0314**
4	lpat	-2.2413	0.9872	**0.0128**	**0.0256**	-1.2941	0.9018	0.0982	0.1964	-2.1196	0.9827	**0.0173**	**0.0347**
5	lpat	-2.2271	0.9867	**0.0133**	**0.0265**	-1.1835	0.8813	0.1187	0.2373	-2.1030	0.9820	**0.0180**	**0.0361**
6	lpat	-1.9745	0.9755	**0.0245**	**0.0490**	-1.0251	0.8470	0.1530	0.3060	-1.9183	0.9721	**0.0279**	0.0558
7	lpat	-1.7242	0.9573	**0.0427**	0.0854	-0.9268	0.8227	0.1773	0.3546	-1.7124	0.9562	**0.0438**	0.0876
8	lpat	-1.5486	0.9389	0.0611	0.1223	-0.8673	0.8069	0.1931	0.3863	-1.5292	0.9365	0.0635	0.1270
9	lpat	-1.4086	0.9201	0.0799	0.1597	-0.7933	0.7860	0.2140	0.4281	-1.3945	0.9180	0.0820	0.1639
10	lpat	-1.2702	0.8976	0.1024	0.2048	-0.7624	0.7769	0.2231	0.4463	-1.2585	0.8955	0.1045	0.2090
11	lpat	-1.0869	0.8611	0.1389	0.2778	-0.7519	0.7737	0.2263	0.4526	-1.1197	0.8682	0.1318	0.2635
12	lpat	-0.9578	0.8306	0.1694	0.3388	-0.7187	0.7636	0.2364	0.4727	-0.9835	0.8370	0.1630	0.3260
0	linvq	3.3278	**0.0005**	0.9995	**0.0010**	1.9404	**0.0265**	0.9735	0.0530	3.4894	**0.0003**	0.9997	**0.0005**
1	linvq	3.2160	**0.0007**	0.9993	**0.0014**	2.5492	**0.0056**	0.9944	**0.0112**	3.1882	**0.0008**	0.9992	**0.0015**
2	linvq	2.4938	**0.0065**	0.9935	**0.0130**	2.5810	**0.0051**	0.9949	**0.0102**	2.4028	**0.0084**	0.9916	**0.0167**
3	linvq	2.2048	**0.0140**	0.9860	**0.0280**	2.5713	**0.0052**	0.9948	**0.0105**	2.0586	**0.0201**	0.9799	**0.0402**
4	linvq	1.9080	**0.0286**	0.9714	0.0571	2.4439	**0.0075**	0.9925	**0.0150**	1.7982	**0.0365**	0.9635	0.0729
5	linvq	1.6354	0.0514	0.9486	0.1028	2.0473	**0.0206**	0.9794	**0.0413**	1.5428	0.0618	0.9382	0.1237
6	linvq	1.4077	0.0800	0.9200	0.1600	1.7481	**0.0406**	0.9594	0.0812	1.3097	0.0955	0.9045	0.1911
7	linvq	1.2198	0.1116	0.8884	0.2233	1.3527	0.0885	0.9115	0.1769	1.1369	0.1281	0.8719	0.2563
8	linvq	1.0219	0.1537	0.8463	0.3074	1.0756	0.1414	0.8586	0.2828	0.9449	0.1726	0.8274	0.3453
9	linvq	0.8028	0.2113	0.7887	0.4226	0.8881	0.1875	0.8125	0.3750	0.7708	0.2207	0.7793	0.4413
10	linvq	0.6839	0.2472	0.7528	0.4944	0.7215	0.2355	0.7645	0.4710	0.6522	0.2573	0.7427	0.5147
11	linvq	0.5844	0.2796	0.7204	0.5593	0.6243	0.2664	0.7336	0.5328	0.5599	0.2879	0.7121	0.5759
12	linvq	0.5112	0.3048	0.6952	0.6095	0.5514	0.2908	0.7092	0.5816	0.4840	0.3143	0.6857	0.6286
0	lemp	-0.1116	0.5444	0.4556	0.9112	-0.4200	0.6626	0.3374	0.6747	-0.1277	0.5508	0.4492	0.8985
1	lemp	-0.0975	0.5388	0.4612	0.9224	-1.7204	0.9569	**0.0431**	0.0861	-0.2495	0.5984	0.4016	0.8031
2	lemp	-0.2590	0.6021	0.3979	0.7958	-1.8664	0.9686	**0.0314**	0.0627	-0.4458	0.6720	0.3280	0.6560
3	lemp	-0.4885	0.6872	0.3128	0.6255	-1.6820	0.9533	**0.0467**	0.0934	-0.7190	0.7637	0.2363	0.4726
4	lemp	-0.7390	0.7698	0.2302	0.4604	-1.3318	0.9082	0.0918	0.1837	-1.0055	0.8424	0.1576	0.3153
5	lemp	-1.0134	0.8442	0.1558	0.3115	-0.9340	0.8246	0.1754	0.3509	-1.3208	0.9063	0.0937	0.1873
6	lemp	-1.3256	0.9071	0.0929	0.1857	-0.5971	0.7246	0.2754	0.5508	-1.6156	0.9465	0.0535	0.1070
7	lemp	-1.5540	0.9395	0.0605	0.1210	-0.3722	0.6450	0.3550	0.7099	-1.8299	0.9660	**0.0340**	0.0680
8	lemp	-1.7134	0.9563	**0.0437**	0.0874	-0.2288	0.5904	0.4096	0.8191	-1.9645	0.9749	**0.0251**	0.0502
9	lemp	-1.7842	0.9624	**0.0376**	0.0752	-0.1592	0.5632	0.4368	0.8736	-2.0061	0.9772	**0.0228**	**0.0455**
10	lemp	-1.7864	0.9626	**0.0374**	0.0748	-0.1225	0.5487	0.4513	0.9026	-1.9091	0.9715	**0.0285**	0.0570
11	lemp	-1.7799	0.9621	**0.0379**	0.0759	-0.1073	0.5427	0.4573	0.9146	-1.8580	0.9680	**0.0320**	0.0639
12	lemp	-1.7471	0.9593	**0.0407**	0.0814	-0.1005	0.5400	0.4600	0.9200	-1.7178	0.9567	**0.0433**	0.0866
0	lgdp	-1.6248	0.9475	0.0525	0.1050	-1.5057	0.9335	0.0665	0.1329	-1.8937	0.9705	**0.0295**	0.0590
1	lgdp	-2.1841	0.9852	**0.0148**	**0.0295**	-1.1483	0.8742	0.1258	0.2515	-2.4080	0.9918	**0.0082**	**0.0165**
2	lgdp	-2.0600	0.9800	**0.0200**	**0.0400**	-0.9294	0.8234	0.1766	0.3533	-2.2438	0.9873	**0.0127**	**0.0254**
3	lgdp	-2.0745	0.9807	**0.0193**	**0.0387**	-0.7336	0.7682	0.2318	0.4636	-2.2866	0.9886	**0.0114**	**0.0227**
4	lgdp	-2.0506	0.9795	**0.0205**	**0.0410**	-0.5610	0.7124	0.2876	0.5751	-2.2473	0.9874	**0.0126**	**0.0252**
5	lgdp	-2.0261	0.9783	**0.0217**	**0.0434**	-0.4640	0.6785	0.3215	0.6429	-2.2742	0.9883	**0.0117**	**0.0235**
6	lgdp	-2.0007	0.9770	**0.0230**	**0.0461**	-0.3959	0.6538	0.3462	0.6924	-2.2627	0.9879	**0.0121**	**0.0242**
7	lgdp	-1.9473	0.9739	**0.0261**	**0.0522**	-0.3402	0.6330	0.3670	0.7339	-2.1567	0.9842	**0.0158**	**0.0316**
8	lgdp	-1.8677	0.9687	**0.0313**	0.0625	-0.3026	0.6188	0.3812	0.7624	-2.1528	0.9840	**0.0160**	**0.0319**
9	lgdp	-1.8103	0.9645	**0.0355**	0.0710	-0.2657	0.6047	0.3953	0.7906	-2.0966	0.9817	**0.0183**	**0.0367**
10	lgdp	-1.7378	0.9585	**0.0415**	0.0830	-0.2418	0.5955	0.4045	0.8090	-1.9806	0.9758	**0.0242**	**0.0483**
11	lgdp	-1.6804	0.9532	**0.0468**	0.0937	-0.2221	0.5878	0.4122	0.8243	-1.8135	0.9647	**0.0353**	0.0705
12	lgdp	-1.5613	0.9404	0.0596	0.1193	-0.2081	0.5824	0.4176	0.8352	-1.7258	0.9574	**0.0426**	0.0852

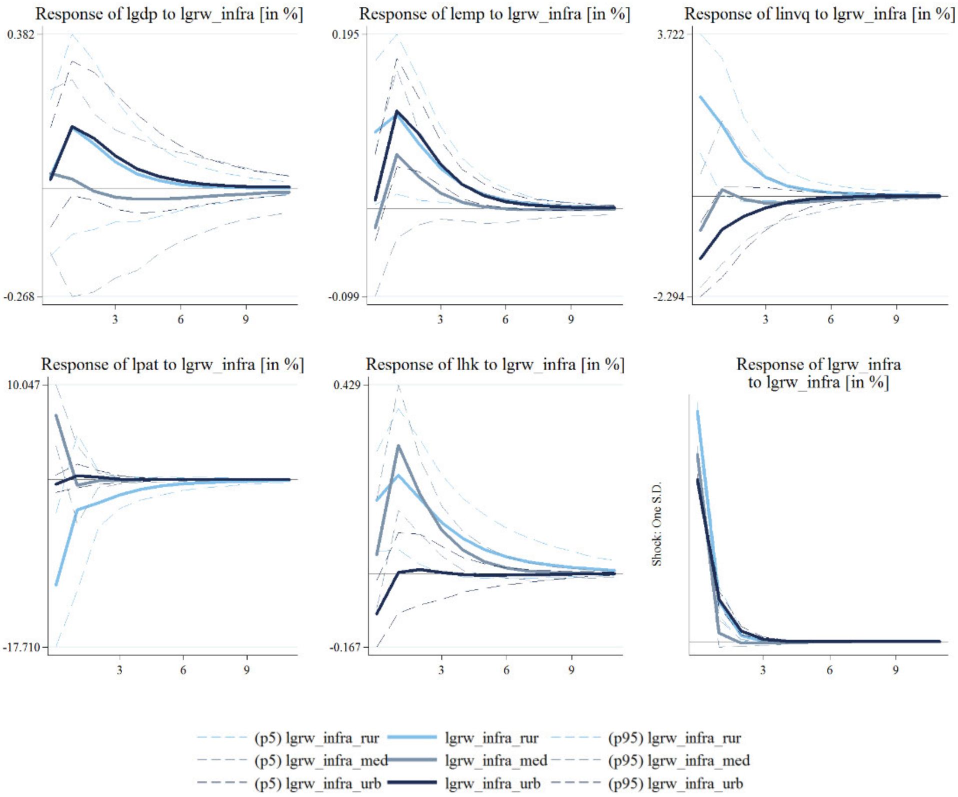
Notes: diff = mean(low_regions) - mean(high_regions); H_0: diff = 0; degrees of freedom = 398

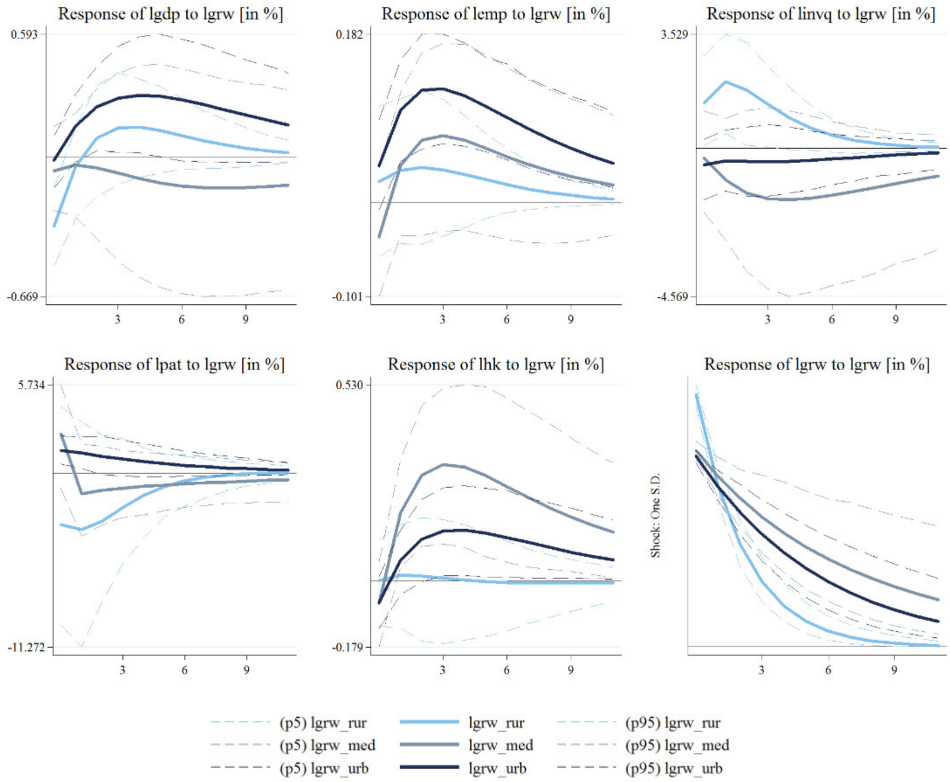
Figure A6: IRFs for the average effects of shocks in the GRW intensity (BBSR classification)

a) GRW industry funding



b) GRW infrastructure funding





Notes: The solid lines illustrate the estimated IRF for each sub-sample and the corresponding dashed lines show the 95% confidence intervals that were calculated by performing Monte Carlo simulations with 200 repetitions.