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No gains of federalism in innovation support? - The case of Germany

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Abstract

Expanding the view on innovation policy within federal structures, this paper examines the characteristics of companies receiving public innovation support, as well as its efficiency from different levels. The question concerns whether there are any gains of federalism regarding a federal support framework, with earlier studies having assumed a homogeneous innovation policy within a country. The new focus for Germany lies at either the state, national or European level, since each of them offers forms of innovation support. Analysed with logistic regressions, firm characteristics differ between the state, federal and European level, while some characteristics are closely linked at all levels. Furthermore, regional differences between German states ("Bundeslaender") become visible: companies in Eastern Germany more frequently receive innovation support at all levels. Small companies receive less support at the federal and European level, while regional programmes do not face such problems. Moreover, lock-in-effects also influence the likelihood of being supported. Testing for an increase in turnover and return on sales, efficiency of innovation subsidies with regard to an increase in competitiveness can only be confirmed for the federal level. Therefore, federal structures have a positive influence on opening the public innovation framework to a broader variety of companies; nonetheless, problems have to be faced and reduced. Testing for efficiency, the gains of federal structures are deniable.

Jelcodes:O31,O38

1 Introduction

Governments at all levels claim the importance of innovativeness for regional economic growth and competitiveness, using different measures of innovation support to foster innovativeness within their respective jurisdiction. The importance of innovativeness for economic development and growth is based on theories starting with Schumpeter (1942), whose *"creative destruction"* is an engine of development and growth. More recent authors such as Brouwer (2000, p. 149) have proclaimed the importance of innovation towards economic growth based on Schumpeter's theories.

Enhancing private companies' innovation activities, the government offers innovation support via subsidies, tax-cuts, protective legislation or supportive infrastructure. With very few exceptions (essentially Fernández-Ribas 2009 for Spain), the literature considers innovation and R&D policy to be homogeneous within a country (Fier, Czarnitzki 2005 for Germany, Duguet 2004 for France, or Aerts and Czarnitzki 2004 for Belgium).

However, this assumption is questionable given that several countries are based on a federal system like Germany or are closely linked to multi-level government structures like the European Union. Federal countries within the European Union include Belgium, Germany and Austria, while centralist countries include Portugal, France and Ireland (compare Lijphart 2012, p. 178). Owing to a lack of empirical studies describing the impact of federalism on the field of innovation, this study attempts to reduce this gap by evaluating both the characteristics of publicly supported companies and the economic impact and efficiency of public innovation support on firm competitiveness.

In the Federal Republic of Germany, it is necessary to address the influence of three different political levels connected to innovation policy: according to Kulicke et al. (2010, p. 79), fifteen of the sixteen German states (*"Bundeslaender"*) offer general innovation subsidies in addition to those offered by the federal government and the supranational European structures. By offering more than 500 million Euros of innovation support, the federal *"Zentrale Innovationsprogramm Mittelstand (ZIM)"* is the largest support programme, while state programmes vary widely between the states. Focusing on innovation support, the consequences of different levels of support are to be assessed: the scope of this paper concerns whether the different state innovation policies solely create additional bureaucracy to two existing levels of bureaucracy or alternatively offer the possibility to reach out to a larger variety of supported companies, thus increasing the impact of government spending. While the general additionality of innovation subsidies creates the opportunity to test, this is insufficient to conclude that public spending is placed in the most efficient way and reaches its goals. Goals of innovation policy in theory should be interlinked with firm characteristics of recipients of innovation grants in practice.

After reviewing the literature on innovation support in the 2nd part of this paper and linking the fields of innovation, federalism and public spending, hypotheses are built in part 3 to concentrate on the core

questions mentioned above. Describing the dataset and the variables chosen reflects the backbone of the 4th part, while the results of both the firm characteristics of recipients and the impact of public support on output variables are analysed in part 5. Within the conclusion in part 6, the results are put into the context with the public innovation policy for policy implications and with the current scientific situation for further research.

2 Literature Review

2.1 Justification of public innovation support

If individuals and private companies create new ideas and innovations, this prompts the question of why government intervention to support private investment can be necessary and justified. Considering this question, empiric literature examines the socially optimal level of innovation and its allocation in reality.

Czarnitzki et al. (2011, p. 217) justify public support for innovation through either the government's demand for new technologies or market failures resulting from under-investment, which can already be found in Arrow (1962). Particularly relevant for this paper is the second effect of private under-investment owing to market failures: *"So R&D expenditures will be either too large or too small, which in both cases calls for government interference"* (Grossman and Helpman 1991, p. 106, compare also Brouwer 2000, p. 150).

Görg and Strobl (2005, p. 1) stresses that the social return of R&D activity is larger than the private return, despite being hard to measure (see Griliches 1992, pp. S31). Although studies such as Wallsten (2000, p. 83) criticise the manner of innovation support and question its additionality (see part 2.3, p. 4), they agree that *"the social returns to private R&D are often higher than the private returns, some research projects would benefit society but would be privately unprofitable"*.

While companies start their investment if it is profitable (see Grossman et al. 1994, p. 27), there are different aspects that reduce the profitability of investment in innovation:

Either externalities (see Nelson 1959, pp. 305–306) or uncertainty (see Grossman et al. 1994, pp. 37–38 or Brouwer 2000, p. 150) combined with the special attributes of the good 'innovation' might reduce private profits and consequently the incentive to innovative activities:

External effects regarding innovation activities include the classical problems of public goods. Griliches (1992, pp. S31) refers to innovation as *"a non-rivalrous good"*, suggesting *"it is usually very hard to appropriate more than a tiny fraction of its social returns. Even if it were possible to establish some property rights in the idea (e.g. via patents), the resulting second-best prices would be nonlinear and would not provide us with appropriate measures of either marginal or total social returns."*

Dealing with uncertainty, private actors are unable to know whether an innovation will be a success or failure, with this uncertainty reducing the likelihood to innovate. Without uncertainty, more competition would foster innovation (compare Loury 1979, p. 396). In fact, a more diverse structure of innovation activities would reduce the effects of uncertainty, as Levine (1997, p. 694) shows:

"The ability to hold a diversified portfolio of innovative projects reduces risk and promotes investment in growth-enhancing innovative activities (with sufficiently risk averse agents)."

In particular, small and medium sized enterprises are unable to diversify their innovation portfolios owing to their limited capacities, which is one justification for a special focus on such companies. Furthermore, there are not only different concepts regarding protection regime in SMEs but also employment policies and tacit knowledge (compare Thomä and Bizer 2013).

Authors generally agree that public support for private innovative activities is justifiable, although its effects and the influence of federalism on this field have to be evaluated.

2.2 Theory of federalism and its relation to innovation

Federalism exists in a variety of forms all around the globe. In several federal countries such as the United States of America or Germany, federal structures mainly influence the system of innovation policy with either the regional jurisdictions or a combination of national and regional jurisdictions granting innovation support. Oates (1972, p. 14) highlights: *"The optimal form of government: a federal system"*; however, whether this is also the case regarding innovation policy requires analysis. While Switzerland is considered one of the most federal countries in Europe, the Swiss innovation framework marks innovation support as a topic solely handled by the federal government and seldom by regional authorities.

The implementation of federalism generally depends on the level of decentralisation (compare Oates 1972, p. 19 but also more generally Tiebout 1956, p. 424) and its internal organisation (compare Lijphart 2012, pp. 174–186).

The advantages of a federal structure in economic theories include a smaller state and the reduction of the *"leviathan"* (see Oates 2005, p. 355, Pitlik 1997, Feld 2007), a stronger influence of the preferences within a jurisdiction (Oates 1972, pp. 11–12, Hausner 2005, p. 56, Neumann 1971, p. 500, Erlei et al. 2007, pp. 440–441) and consequently fewer *"frustration costs"* (Hausner 2005, p. 57, Blankart 2006, pp. 597–598), a higher openness to establishing new and innovative programmes (Blankart 2006, p. 598), and a higher accountability of the political actors at the regional level (Oates 2005, p. 358). Transferring these theoretical advantages to a federal framework on innovation would render more efficient innovation support, a clear focus on the regional innovative system and its uniqueness. Less innovative actors would be theoretically unable to gain or reject public support, if wanted, and there would be greater transparency of regional actors offering innovation support.

In contrast, higher coordination might be necessary (Wilson and Souitaris 2002, pp. 1135–1136), economies of scale might not be used in a decentralised manner (Blankart 2006, pp. 600–602), and the externalities of pure public goods might still fail to result in socially optimal levels of a good's supply (Oates 1972, p. 9). Focusing on innovation policy, the theoretical disadvantages would mean higher transaction costs for policy makers to coordinate their innovation framework, higher bureaucracy costs and less accessibility for bigger projects, and – due to externalities across jurisdictions – still a not socially optimal level of innovative

activities. In particular, economies of scale represent a relevant factor in seeking the regional agglomeration of innovative partners such as companies, laboratories or other research facilities, caused by knowledge spillovers and the attributes of non-codified knowledge (compare Ács and Varga 2005, p. 326).

Furthermore, according to empirical literature, regional innovation programmes have become increasingly important in Europe due to the knowledge of regional characteristics opening greater possibilities to focus on the unique necessities in each jurisdiction (see Fernández-Ribas 2009, pp. 458–459). Many different levels and systems of regionalisation and innovation support programmes can be found worldwide (see OECD 2002, pp. 98–99) or in Germany (see Kulicke et al. 2010, pp. 212–221). In Europe, the influence of regional programmes and regional governments has grown, as mentioned by Fernández-Ribas (2009, p. 457). Considering the situation in Germany, there is a broad regional autonomy (see OECD 2002, p. 71), yet a wide range of different approaches regarding states' innovation policy (compare OECD 2002, p. 44) can also be described. Nevertheless, Schmalholz (2005, p. 19) concludes that many innovation programmes in German states focus on similar targets to other states, which makes a closer focus on regional preferences and fields of regional comparative advantages at least partially questionable and worth investigating in further detail.

Federalism has its impact on the innovation policy framework – especially in Germany –, but the decision whether this influence is either positive or negative is unclear.

2.3 Innovation support and its empirical impact

The focus of several studies remains on the impact of innovation support, by either innovation subsidies or tax reduction. However, as shown in Becker (2012), with few exceptions such as Fernández-Ribas (2009), most claim the structure of innovation support within a country to be homogenous, despite some studies such as Belitz et al. (2010, p. 6) or Busom and Fernández-Ribas (2007) stressing that subsidies are offered at different levels in Europe. Nonetheless, these studies offer the possibility to observe important facts about the nature of innovation support and R&D support, which are both the subject of many studies.

Considering innovation and R&D support in general, most of the studies show additionality (at least partially) of public money spent (see Duguet 2004, p. 272 for France, Aerts and Czarnitzki 2004, p. 16 for Belgium, Czarnitzki and Fier 2002, pp. 17–18 for Germany).

Busom (2000, p. 133) shows the positive effect of support programmes whilst also stressing that the possibility of a crowding out cannot be entirely ruled out in Spain. For Ireland, Görg and Strobl (2005, p. 17) note that public support will not crowd out private investment for domestic small and medium sized enterprises, but that the effect is unclear regarding large multinational companies. Similar results are found in Lach (2002, p. 389), which does not completely reject a crowding-out yet shows that less substitution of private spending by public support is found in smaller companies in Israel.

Whereas Wallsten (2000, pp. 97–98) claims that significant and high crowding-out-effects are related to public funding on R&D in North America, Levy (1990, p. 172) previously analysed that innovation support is complementary in several states of the US, and substitutionary to private investments in others.

In contrast, Hall and van Reenen (2000, p. 462) show that a dollar of public innovation support induces a further dollar of private investment in North America, although the effect claimed by Fier, Czarnitzki (2005, p. 4) appears to be smaller in Germany (with 0.28 Euro private investment induced by one Euro of public spending).

The additionality is generally also supported by Krohmer (2010, p. 51), who, having analysed 57 studies focused on R&D support, emphasises that crowding-out of private investments is not to be found. The structure of supported companies shows that larger companies generally have an easier access to innovation support in both France (Duguet 2004, p. 245) and Spain (Busom and Fernández-Ribas 2007, p. 4).

Regarding the structure of innovation support in Germany, Kulicke et al. (2010, p. 79) emphasise that all German states apart from Baden-Wuerttemberg offer general[1] innovation support programmes. Grenzmann et al. (2010, p. 387) highlight the importance of private spending on R&D, which accounts for approximately 90% of the R&D spending in Germany, while Belitz et al. (2010, p. 6) add that regional programmes in Germany tend to focus on selective fields of technology rather than general support.

Taking federal structures into account, the findings of Fernández-Ribas (2009, pp. 463–465) show that regional innovation programmes in Spain tend to support companies with higher barriers to innovate and less knowledge to innovation programmes.

Besides Wallsten (2000), most of the empiric literature at least partially confirms additionality, which can be seen as a general hint against the complete inefficiency (or in favour of efficiency) of innovation grants. However, there is only little literature on the special federal innovative framework at present.

3 Hypotheses

It is the scope of this paper to test the effect of federal structures. The innovation framework in Germany and impact of federalism will be analysed.

Hypothesis 1: Small- and medium-sized enterprises (SME) have greater difficulties in gaining national and supranational innovation support than regional innovation support.

Based on the assumption of lower frustration costs and a closer link to regionally homogenous preferences, regional programmes should present the opportunity to reduce barriers, particularly for small- and medium-sized enterprises, as well as reducing the barriers for firms that have problems innovating. This hypothesis is in line with the findings of Fernández-Ribas (2009, p. 463): *"Interestingly, firms with major limitations to innovate are more likely to participate in regional and local programmes".*

Hypothesis 2: Regional influences and differences between state level and federal level exist within Germany.

[1] In contrast to specific innovation programs for instance supporting energy efficiency or special technologies.

Otherwise, the general assumption of a homogenous structure of innovation support suggested in other papers would be preferable and federal structures would not support companies with different firm characteristics. Different influences for regions are also included to test for regional specificities and their effects on innovation support.

Hypothesis 3: Regional programmes focus more intensely on companies with a regional focus.

Hypothesis 3 is considered the consequence of Hypothesis 1, and adopts a focus on regional preferences and regional circumstances as mentioned above, as well as in Oates (1972, pp. 11–12) and Blankart (2006, pp. 597–598). A regional focus would reduce frustration costs of regional innovators and enhance a closer focus on the situation of the jurisdiction.

Hypothesis 4: Companies that regularly spend money on innovation will have an easier access to innovation support than other companies.

This hypothesis might be relevant for further research and forms a basis for characterising companies gaining innovation support. It is a first test for possible lock-in-effects and is supposed to be an influencing factor at all levels of the innovation policy framework.

Hypothesis 5: Supported companies are more competitive than companies without innovation support.

In addition to the hypotheses focused on company and market characteristics, Hypothesis 5 offers the possibility to examine at least some aspects of the efficiency concerning an increase in the competitiveness of a company and in general. As mentioned by the OECD (2002, p. 31) and Atkinson (1991, p. 563), the effectiveness and efficiency of support programmes is important.

4 Data and methods

4.1 Data

In order to examine the effects and target groups of regional, national or supranational innovation support, an econometric approach regarding the empirical backgrounds of companies that receive innovation subsidies represents an adequate approach. Given that most of the programmes supporting innovative activity tend to focus on small- and medium-sized companies, the company size and other characteristics that might influence the reception of innovation support are observed.

Focusing on innovation support in Germany, the existing panel data of the Mannheim Innovation Panel (MIP) of the Centre for European Economic Research (ZEW) builds a solid base for an analysis of the economic framework, with approximately 6,000 companies annually participating in the written questionnaire. Every second year, the questionnaire includes questions referring to the political level that grants innovation support. Given that a combination of different waves of the MIP as an unbalanced panel would dramatically

reduce the number of observations, the data collection wave of the MIP from 2007[2] forms the general dataset for this paper. Apart from the support variables (see page 8), only companies that answered all questions examined in this papers are taken into the regression, thus reducing the sample to 1,259 observations. For the second set of regressions, which examines the effects of public innovation support on output variables such as turnover and return on sales, a larger sample with 6,069 observations is used.

Compared with other datasets for Germany, such as the Kreditanstalt für Wiederaufbau (KfW), the data of the MIP is more strongly focused on innovative companies, and on average reaches more companies (compare Rothgang and Dürig 2009, p. 269).

4.2 Method

Using the data of the MIP, all three different political levels that offer innovation support in Germany, namely the regional state-level ("Bundeslaender"), federal level ("Bund") and supranational European level ("EU") are compared. This study examines the reception of public innovation support as a dependent variable in an econometric model. This dependent variable is binary coded, and consequently a binary model – in this case a Logit-regression – is chosen to evaluate which characteristics of a company influence the reception of innovation support. Post-estimation tests for the three estimations are included in Tables 3, 4 and 5 in the appendix. In order to render the interpretation easier, the odds ratio is included, which enables comparing the effects of the different variables.

Furthermore, the efficiency of the public support is tested by evaluating the influence of the subsidies on the changes in turnover and return on sales with a second set of logistic regressions.

A second version of all logistic regressions with robust errors in order to prevent dependency of error terms or heteroscedasticity, included in the appendix, comes to the same results as the regression shown in Table 2. Additionally, tests for collinearity can be found in the appendix.

Table 1: Descriptive statistics on the usage of innovation support measures by support level

	N	**%**	**Mean**	**Std. Dev.**
State Level Support	235	18.7	0.1867	0.3898
Federal Level Support	341	27.1	0.2708	0.4446
European Level Support	137	11.0	0.1096	0.3125

Notes: Calculated with STATA; N = number of firms, % = share of sample; total number of observation amounts to 1,259.

[2] The data on public support is included every second year in the MIP. The results are very similar with other earlier data waves or combined data of different data waves. Compare for combined data of the data waves 2005 and 2007 Appendix (see p.15).

4.3 Variables

Based on similar studies such as Busom and Fernández-Ribas (2007) and Fernández-Ribas (2009) for Spain, a general setting of variables is chosen and expanded. Busom and Fernández-Ribas (2007) focused on the overlap between different levels with general independent variables, including the wage-level for researchers or the share of high-skilled employees. By adding other explanatory variables such as the SME-definition of the European Union as a dummy, or dummy variables for German regions, the analysed influences are thus broadened.

The dependent variables *suppst* (public innovation support granted by the state level), *suppfe* (public innovation support granted by the federal level) and *suppeu* (public innovation support granted by the European level)[3] are explained by 12 independent variables.[4]

To check for interactions between the different support levels, the two support dummy variables that are not used as a dependent variable are included as explanatory variables (*suppst*, *suppfe* or *suppeu*). Given that there are common goals between different support programmes, a positive influence is expected.

In terms of the importance of company size and the aforementioned problems of smaller companies innovating, the first explanatory variable is *sme*, which is a dummy-variable for companies covered by the SME-definition of the European Union[5] and is used to test for Hypothesis 1. A negative influence is expected, which would suggest that smaller companies face barriers accessing public innovation.

As regional dummy-variables *east* shows whether the unit is in eastern Germany, this might indicate easier access to public transfers due to the transition process. Indeed, more funds supporting private companies are available at all levels in an attempt to raise the innovativeness in eastern Germany. By contrast, *donor* indicates whether a firm is active in a state that is net payer in the German federal fiscal relations between states. According to the federal fiscal relations, wealthier donor states have to transfer money to the poorer German states. During the evaluated period, five states were donor states while eleven were recipients. These two variables allow the regional focus for Hypothesis 2. The database of the MIP does not allow adding further state level data for single states, given that the number of observations would be too small. [6] The access for companies in eastern Germany should generally be easier; therefore, the coefficient is supposed to be positive, while the access for companies in donor states is supposed to be more difficult, given that most of the programmes tend to focus on regions with problems regarding competitiveness.

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[3] The variables of *suppst* and *suppeu* might be closely linked because the administration of European funds is often transferred to the state level in Germany.

[4] For all three support variables, missing variables due to the questionnaire have been added: companies often only complete the questionnaire for the support level received. Therefore, if one level is completed, missing values for these companies at other levels are set to 0.

[5] The data of the MIP only allows using the number of employees and turnover. Data on the balance sheet is not available.

[6] Attempts to add state level data for five states that had the largest number of observations showed similar results at an earlier stage of this paper, but also with large statistical problems.

In order to test for the market surroundings and market focus of Hypothesis 3, the market share *mshare* is also included as a dummy for *national* and *international* market focus (compared to the regional market focus). The dummy-variable *qualcomp* explains whether there is strong or very strong competition regarding quality. It is expected that all market share and qualitative competition have a positive value at all three levels, while the effects of national or international market focus are supposedly positive at the federal and European level.

Several variables are chosen to examine Hypothesis 4: the variable *lnrdexp* combines the relative impact on expenditures spent on R&D with the number of R&D employees (in logs) in order to show the amount of money spent on R&D per capita within the unit, which is similar to both studies from Spain. A more general indicator concerning the question of whether the unit is part of a white or blue collar company is explained by *hiedu*, which indicates the share of employees with higher degrees of education. Given that lock-in effects might be at a closer focus, the dummy-variable *regularly* indicates whether the company was already active in innovation processes during the previous two years (in this case before 2007). All variables are supposed to show positive coefficients in all regressions as these surroundings will increase the likelihood of innovation and consequently the likelihood of receiving innovation support.

Together, all these variables provide a broad view of factors influencing the reception of public innovation support. Furthermore, lagged variables *suppst05*, *suppfe05* and *suppeu05*, which show whether a firm received public support one year earlier, are also included in the appendix. An expected positive influence would provide evidence for existing lock-in-effects.

Additional variables such as companies' investments in trainings, being part of a multinational company or the export share, which were included in Busom and Fernández-Ribas (2007) and Becker (2012) are omitted due to a reduction of the variable set, as well as having no influence.

Three different models – one for each level of innovation support – are selected in order to show the different influences. Within the preparations, other variables were also tested – particularly considering company size – yet most of them were rejected.

The test on the efficiency regarding an increase in competitiveness of public innovation subsidies is based on two newly-created dummy variables, which changes its value if the turnover and the return on sales rose or fell between 2005 and 2006. These output variables are chosen as they are available in the existing data and can be seen as indicators for the change of a company's competitiveness. Hereby the turnover is a cardinally scaled variable, while the return on sales is an ordinally scaled variable. Nonetheless, rises and falls in both scales can be subscribed by the respective dummy variables *turnup* and *turndown* or *rosup* and *rosdown* as dependent variables.

As independent variables in the efficiency test, the reception of public innovation subsidies of the three aforementioned levels (*suppst*, *suppfe*, *suppeu*) is used. Therefore, a test for the impact of receiving public innovation subsidies on turnover and return on sales is included with a logistic regression. If public support programmes are working effectively, all coefficients should be positive.

5 Results

5.1 Firm characteristics and its impact on the reception of public innovation support

Whether different attributes of companies have different influences on the likelihood of receiving public support from different political levels is at the core of an empirical approach regarding federalism and innovation policy.

Table 2 shows the empirical findings of the three logistic regressions. All three levels commonly suggest that interaction with other levels of support is one of the strongest positive factors influencing another support level: all interaction terms with other support levels are highly significant and have a high odds ratio. However, other factors such as the regional location in Eastern Germany *east* also influence all levels of support. The regional position in Eastern Germany positively influences the likelihood of state and federal programmes, in contrast to a negative (albeit smaller and less significant) influence at the European level. This last finding is particularly surprising, given that the former target one regions in Germany are mostly in Eastern Germany.

At the state level, both regional factors *east* and *donor* are significant. The location of a firm in a region that is a net payer to the German federal fiscal system reduces the likelihood of being supported by the regional level. Regarding company size, the dummy variable *sme* is not significant at the state level, but its coefficient is only positive with a higher odds ratio at the state level than other levels. The expenditure on research and development *lnrdexp* has a positive (and significant) influence at the state and European level.

At the federal level, the degree of quality competition is particularly important: *qualcomp* is only significant at the federal level and shows a higher odds ratio than at the other levels.

The continuity of innovative activities *regularly* and the share of higher educated employees *highedu* influence both the federal and European level with high significance, while being insignificant at the state level.

Company size has a negative impact on the likelihood of being a supported company at the federal and European level; however, this negative impact is only statistically significant at the European level, at a 10 percent level. Additionally, market characteristics tend to have a stronger and different influence at the European level than the state and federal level: a higher market share *mshare* increases the likelihood of being a supported company, whereas European support levels appear to focus on regional companies, given that the coefficients for companies with *national* and *international* market focus are only negative at the European levels, and in terms of *national* also significant at a 5 percent level.

Caution is necessary when evaluating possible lock-in effects. Owing to the reduced database in Table A1, some other variables changed their coefficients, although the high significance of all lagged support variables *suppst05*, *suppfe05* and *suppeu05* shows lock-in effects and path dependency, at least for the reduced database.[7]

[7] Further post-estimation tests can be found in the appendix.

The findings generally show that different political levels supporting innovation interact, whilst, also highlighting that all three levels of the innovation policy framework in Germany reach companies with different firm characteristics. However this does not clarify the question of both the efficiency and goals of the programmes.

5.2 Public innovation support and its effect on firm competitiveness

In terms of the efficiency of innovation support, it is necessary to consider output oriented measures. Support programmes – especially regional programmes – are often implemented in order to increase competitiveness, with the OECD (2002, p. 31) emphasising that *"many OECD regions are formulating regional innovation strategies to increase their economic competitiveness"*.

Output variables such as the turnover and return on sales offer the possibility to compare the change in the economic competitiveness and position in market during the last year, given that dummy variables for a rise (*turnup* or *rosup*) or fall (*turndown* or *rosdown*) are evaluated with their connection to public innovation subsidies of the different levels.

The effect on turnover changes indicates that only federal support creates a significant and positive influence on higher turnover at the end of the year and reduces the highly significant risk of sinking turnovers. This is also in line with an emerging return on sales, which is significant.

State level support has no significant influence on a turnover rise (but nonetheless has a negative coefficient), yet a significant and positive influence on the likelihood of being a company with reduced turnover at the end of the year.

At the European level, significance is only reached regarding a rise in the return on sales, although the coefficient is negative. Accordingly, firms supported by the European Union are more likely to have a decline in the return on sales. However, it is necessary to point out that the coefficient in the logistic regression for a turnover rise for the European level is positive yet not significant.

Given that the effects at the state and European level are different and incoherent between turnover and return on sales, no clear result can be observed.

As an important constraint to these results, the very low Pseudo-R^2 warrants mention[8]: Other factors seem to influence turnover and return on sales more than the reception of public support. Nonetheless, the unclear direction of the coefficients at the state and European level provide a hint concerning efficiency problems.

Summarising these basic efficiency tests, a positive impact regarding output measures can only be clearly found at the federal level in Germany, while the results are unclear or partially negative for the state and European level.

[8] In order to clarify results, the sample for the second set of regressions was enlarged to almost the entire data collection wave from 2007.

Table 2: Attributes of supported companies (logistic regressions, LOGIT)

	State Level Support (suppst)			*Federal Level Support (supppfe)*			*European Level Support (suppeu)*		
	Coef.	*Std. Error*	*Odds Ratio*	*Coef.*	*Std. Error*	*Odds Ratio*	*Coef.*	*Std. Error*	*Odds Ratio*
Other support levels									
suppst				1.3399***	0.1817	3.8187***	1.2281***	0.2345	3.4147***
suppfe	1.3413***	0.1820	3.8240***				1.5767***	0.2303	4.8389***
suppeu	1.1995***	0.2313	3.3185***	1.5691***	0.2302	4.8022***			
Firm characteristics									
sme	0.0231	0.2120	1.0233	-0.1782	0.1861	0.8368	-0.5227*	0.2761	0.5929*
lnrdexp	0.1501*	0.0801	1.1620*	0.0511	0.0676	1.0525	0.3548***	0.1061	1.4260***
highedu	0.0036	0.0033	1.0036	0.0164***	0.0028	1.0165***	0.0148***	0.0037	1.0149***
regularly	0.1953	0.2088	1.2157	0.6695***	0.1845	1.9533***	0.5823**	0.2929	1.7901**
Market characteristics									
mshare	-0.0023	0.0035	0.9977	-0.0007	0.0030	0.9993	0.0085**	0.0038	1.0085**
national	0.1305	0.3128	1.1394	0.2315	0.2830	1.2605	-0.8773**	0.3495	0.4159**
international	0.4546	0.3347	1.5756	0.3239	0.3009	1.3825	-0.5872	0.3690	0.5559
qualcomp	0.2247	0.2186	1.2519	0.4674**	0.1914	1.5958**	-0.2083	0.2536	0.8120
Regional characteristics									
east	1.3127 ***	0.2535	3.7162***	1.1255***	0.2388	3.0817***	-0.7736**	0.3196	0.4613**
donor	-0.5032*	0.2609	0.6046*	0.3086	0.2264	1.3615	-0.4855*	0.2864	0.6154*
_cons	-2.7018	0.5146	0.0671	-3.4385	0.4708	0.0321	-2.0787	0.6025	0.1251
LR chi^2 (12)	298.38			335.58			209.64		
Prob > chi^2	0.0000			0.0000			0.0000		
McFadden's Pseudo R^2	0.2462			0.2282			0.2408		

Notes: Calculated with STATA; *** denotes significance at 1% level; ** at 5% level; * at 10% level, number of observations amounts to 1,259.

Table 3: Effects of public support on turnover and return on sales (logistic regressions, LOGIT), full sample

	Turnover Rise (turnup)			*Turnover Fall (turndown)*			*Return on sales Rise (rosup)*			*Return on sales Fall (rosdown)*		
	Coef.	*Std. Error*	*Odds Ratio*	*Coef.*	*Std. Error*	*Odds Ratio*	*Coef.*	*Std. Error*	*Odds Ratio*	*Coef.*	*Std. Error*	*Odds Ratio*
Level of support												
suppst	-0.1640	0.1139	0.8487	0.2316**	0.1156	0.5445	0.0015	0.1304	1.0015	0.0758	0.1796	1.1599
suppfe	0.6039***	0.1116	1.8292	-0.6078***	0.1152	1.2606	0.5279***	0.1158	1.6954	0.1483	0.1661	1.0787
suppeu	0.2172	0.1499	1.2426	-0.2123	0.1539	0.8087	-0.2907*	0.1696	0.7477	-0.2406	0.2417	0.7861
_cons	0.3614	0.0278	1.4354	-0.5254	0.0283	0.5913	-1.3857	0.0341	0.2501	-2.2453	0.0464	0.1059
LR chi^2 (12)	43.87			40.13			22.44			1.67		
Prob > chi^2	0.0000			0.0000			0.0001			0.6442		
McFadden's Pseudo R^2	0.0054			0.0050			0.0036			0.0004		

Notes: Calculated with STATA; *** denotes significance at 1% level; ** at 5% level; * at 10% level, number of observations amounts to 6,069.

6 Conclusion

Complying with theory (see part 2.2, p.3), federal structures influence the likelihood of receiving innovation support in Germany, with different support levels focusing on different firm characteristics. Nonetheless, the different political levels are closely linked: the interpretation of the high effect of other support levels clearly allows the interpretation that all innovation programmes have a common core. Compared with Becker (2012, p. 62), the loss in significance for the continuity of innovation activities, higher educated workers and research and development expenditure illustrates possible common characteristics.

Despite the results not being as clear as Fernández-Ribas (2009, pp. 464–465), the barriers for smaller companies and those with other limitations appear to be lower at the state level. European level programmes show a clear disadvantage for small- and medium-sized enterprises, while a negative impact (albeit not being significant) is also shown for federal programmes. On the other hand, regional programmes show a positive effect, although this is also not significant. For this reason, Hypothesis 1 cannot be entirely rejected.

Furthermore, Hypothesis 2 can also not be rejected. In particular, the spatial effect of a firm of being located in Eastern Germany has a strong and significant influence on the likelihood of being a recipient of innovation subsidies at all levels. At present, the former GDR states have a different innovative framework with much larger governmental activities, owing to the absence of larger private innovative actors. Furthermore, most of the areas supported by the European *"convergence"* targets lie in Eastern Germany, which also influences the other levels given that their programmes are often used to co-finance. Moreover, this can also explain why companies in states that pay money into the German federal fiscal system are less likely to be supported companies at the state and European level: these five states hardly had any convergence areas in 2005-2007,[9] apart from North Rhine-Westphalia.

An easier access to innovation support for firms with a regional market focus has to be negated at the state and federal level, with only the regressions for the European level showing a stronger support for regionally focused companies. Therefore, Hypothesis 3 can be rejected, which is somewhat surprising. Possible reasons can be found in the selection process and its consequences. *"Cream skimming"* (Radicic and Pugh 2013, p. 1) and *"cherry picking to identify success stories"* (Radicic and Pugh 2013, p. 20) created by the selection process might influence the regional and national level more strongly: the pressure to produce success stories is higher within Germany, where the results can be observed more easily by the public community, than at the European level. This also be considered an explanation for the high odds ratio and significance of the dependency of other levels of support: successful companies tend to have easier access to the other levels having been successful at one level.

[9] The *donor* states were Bavaria, Baden-Wuerttemberg, Hamburg, Hesse, and North Rhine-Westphalia.

The fourth hypothesis cannot be rejected, particularly if all three finance variables are considered together: while the effect of a single variable might differ at the three levels, evidence shows that expenditure on R&D, regular innovation activities and higher educated employees have a positive influence, despite the continuity of innovative activities not being significant at the state level. Furthermore, the additional regression on path dependency clearly shows a high influence of past access to innovation subsidies of the same support level for all three levels. For this reason, path dependency and lock-in effects should be considered influences on the reception of public innovation subsidies.

Supported companies are not significantly more competitive if they are supported by the state or European level, and thus Hypothesis 5 has to be partially rejected. At the federal level in Germany, public support reaches companies that subsequently increase their turnover and return on sales; however, both indicators do not show any clear results for the other two levels. The effectiveness of innovation support at the state and European level can consequently be questioned, while results for turnover and return on sales at both levels are different and incoherent. On the one hand, a more detailed approach such as Atkinson (1991) is hardly possible for Germany owing to the lack of state level data, while on the other hand, a comparative approach between European countries is possible. As previously mentioned, the question of causality also has to be posed for the federal level: it is possible that only the companies with a higher probability of turnover and return on sales increases are selected for federal programmes.

With hypotheses regarding SME support, regional influences and regular innovative measures, the scope of this paper is outlined as identifying the influence of federal structures in the German innovation framework. With innovation policy framework at the state, federal, and European levels, the broader German approach reaches a larger variety of supported companies, which is in line with the general findings of Fernández-Ribas (2009) for Spain. Furthermore, similar companies with higher innovation barriers seem to have less difficult access to regional programmes compared with other levels.

However, with strong lock-in effects, the partially proven danger of *"cream skimming"*, less regional focus of regional programmes, regionally different frameworks and little positive impact on the competitiveness of companies, further research and policy changes are necessary.

A comparative study on different federal and non-federal countries and their respective innovation framework would be fruitful, particularly because evidence for the efficiency of European level programmes and decentralised structures is currently lacking. Moreover, further output oriented analysis of the innovative support measures in Germany or other European countries, as well as a matching between participating and non-participating companies would also reduce the gap of empirical findings regarding the innovation framework in Europe.

Policy makers in Germany should be concerned about the unclear results regarding efficiency of innovative support at the state and European level. Like Atkinson (1991) has shown for the USA, a better evaluation of targets, effectiveness and efficiency of the innovation support framework is necessary. The findings in this paper show that only the federal level in Germany reaches these standards regarding turnover and return on

sales as indicators for efficiency. This finding supports countries such as Switzerland, which concentrate innovation support at the federal level, and at least raises doubts about the efficiency gains from federalism. Before reacting at the other two levels, other output indicators for efficiency of innovation support have to be analysed, and thus further research is warranted.

Concerning the support of small- and medium-sized companies, none of the different political levels support such companies as planned,[10] while only the state level at least manages not to cause disadvantages for SMEs. It is necessary to admit that the likelihood of being supported is naturally higher with a higher number of innovation projects within a company. Therefore, an underestimation of the likelihood of SME support might cause stronger effects; nonetheless, the difference between the three support levels clearly marks the necessity of reaction by policy makers.

Additionally, the partial rejection of a regional market focus further emphasises the importance of evaluating the selection process of supported companies. When selection processes become *"perverse"* regarding their impact and subsidies for randomly chosen companies have a higher impact than those actually chosen, as Radicic and Pugh (2013, p. 18) point out, policy makers have to change the selection processes.

Other critical points are path dependency and lock-in effects. Companies have previously been supported are much more likely to be supported in the future. If this is only the case due to regular innovative activities, criticism might not be relevant. However, this effect possibly shows that new companies are excluded and face higher barriers to access innovation support. Given that this problem is also mentioned by Fernández-Ribas (2009), German politicians should engage with this problem urgently.

The evidence concerning whether federal structures in Germany foster or reduce innovations has two faces. First, all three levels of the German public innovation support framework reach firms with different characteristics; therefore, federalism fosters innovation. Regional programmes create lower barriers for innovative companies to gain innovation subsidies. However, by contrast, efficiency is higher at the federal level, which might indicate problems of a federal innovation policy framework. Measures to increase efficiency should be introduced in order to reduce this effect. Moreover, innovation support at all three levels faces other problems involving lock-in-effects or the selection process.

Therefore, the favourability of a federal system depends on the preferences. German society tends to focus on reducing barriers to access innovation support, because this is a main goal for all innovation programmes.

Nonetheless, while gains for smaller companies in a federal system might exist, no such gains exist regarding the efficiency of innovation support.

[10] All political levels claim to support mainly small and medium sized enterprises in Germany. Compare for instance Kulicke et al. 2010.

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Appendix

Table A1: Attributes of supported companies with time lags for earlier support (logistic regressions, LOGIT)

	State Level Support (suppst)		*Federal Level Support (suppfe)*		*European Level Support (suppeu)*	
	Coef.	*Std. Error*	*Coef.*	*Std. Error*	*Coef.*	*Std. Error*
Other support levels						
suppst			0.4911	0.3470	1.3640***	0.4933
suppfe	0.8624***	0.3252			1.3545***	0.4580
suppeu	1.4223***	0.4057	1.5936***	0.4461		
Firm characteristics						
sme	-0.4262	0.4105	0.4465	0.3378	0.0081	0.5282
lnrdexp	0.3774**	0.1747	-0.0104	0.1349	0.2157	0.2727
highedu	0.0004	0.0059	0.0113**	0.0054	0.0199***	0.0078
regularly	-0.2845	0.3527	0.2943	0.3367	1.8204**	0.7255
Market characteristics						
mshare	-0.0016	0.0059	-0.0010	0.0052	-0.0155*	0.0090
national	1.0964*	0.6304	0.1265	0.5213	-1.3682	0.8360
international	1.3491**	0.6699	0.1609	0.5548	-0.8684	0.8699
qualcomp	-0.1785	0.3551	0.3661	0.3345	-0.9800*	0.5353
Regional characteristics						
east	1.1561***	0.4453	0.7253	0.4464	-0.8051	0.6457
donor	-0.5114	0.4432	-0.1079	0.4219	0.1652	0.6062
Time dependency						
suppst05	1.7346***	0.3035				
suppfe05			2.5687***	0.2854		
suppeu05					3.6153***	0.4889
_cons	-2.7027	0.9618	-3.4829	0.8693	-3.7010	1.5108
LR chi^2 (12)	155.27		233.37		180.48	
Prob > chi^2	0.0000		0.0000		0.0000	
McFadden's Pseudo R^2	0.3244		0.3874		0.5136	

Notes: Calculated with STATA; *** denotes significance at 1% level; ** at 5% level; * at 10% level, number of observations amount to 503

Table A2: Attributes of supported companies with robust standard errors (logistic regressions, LOGIT)

	State Level Support (suppst)		*Federal Level Support (suppfe)*		*European Level Support (suppeu)*	
	Coef.	*Std. Error*	*Coef.*	*Std. Error*	*Coef.*	*Std. Error*
Other support levels						
suppst			1.3399***	0.1795	1.2281***	0.2356
suppfe	1.3413***	0.1790			1.5767***	0.2352
suppeu	1.1995***	0.2324	1.5691***	0.2384		
Firm characteristics						
sme	0.0231	0.2105	-0.1782	0.1955	-0.5227*	0.2827
lnrdexp	0.1501*	0.0790	0.0511	0.0720	0.3548***	0.1278
highedu	0.0036	0.0034	0.0164***	0.0028	0.0148***	0.0038
regularly	0.1953	0.2070	0.6695***	0.1893	0.5823**	0.2962
Market characteristics						
mshare	-0.0023	0.0037	-0.0007	0.0030	0.0085**	0.0036
national	0.1305	0.3235	0.2315	0.2939	-0.8773**	0.3728
international	0.4546	0.3454	0.3239	0.3130	-0.5872	0.3858
qualcomp	0.2247	0.2279	0.4674**	0.1951	-0.2083	0.2560
Regional characteristics						
east	1.3127***	0.2568	1.1255***	0.2445	-0.7736**	0.3308
donor	-0.5032*	0.2667	0.3086	0.2312	-0.4855*	0.2813
_cons	-2.7018	0.4858	-3.4385	0.5126	-2.0787	0.6297
LR chi^2 (12)	226.41		229.14		171.74	
Prob > chi^2	0.0000		0.0000		0.0000	
McFadden's Pseudo R^2	0.2462		0.2282		0.2408	

Notes: Calculated with STATA; *** denotes significance at 1% level; ** at 5% level; * at 10% level, number of observations amount to 1,259

Table A3: Post-estimation (goodness of fit), LOGIT for suppst

number of observations	1259
number of covariate patterns	1257
Pearson chi²(1244)	1282.96
Prob > chi²	0.2158

	True		
Classified	*D*	*~D*	*Total*
+	99	56	155
-	136	968	1104
Total	235	1024	1259

Sensitivity	Pr(+ | D)	42.13%
Specificity	Pr(- | ~D)	94.53%
Positive predictive value	Pr(D | +)	63.87%
Negative predictive value	Pr(~D | -)	87.68%
False + rate for true ~D	Pr(+ | ~D)	5.47%
False - rate for true D	Pr(- | D)	57.87%
False + rate for classified +	Pr(~D | +)	36.13%
False - rate for classified -	Pr(D | -)	12.32%
Correctly classified		84.75%

Notes: Calculated with STATA; Classified + if predicted Pr(D) ≥ 0.5; True D defined as *suppst* ≠ 0

Table A4: Post-estimation (goodness of fit), LOGIT for suppfe

number of observations			1259
number of covariate patterns			1254
Pearson chi²(1244)			1239.61
Prob > chi²			0.5058
	True		
Classified	*D*	*~D*	*Total*
+	148	56	204
-	193	862	1055
Total	341	918	1259
Sensitivity	Pr(+| D)		43.40%
Specificity	Pr(-|~D)		93.90%
Positive predictive value	Pr(D| +)		72.55%
Negative predictive value	Pr(~D| -)		81.71%
False + rate for true ~D	Pr(+|~D)		6.10%
False - rate for true D	Pr(-| D)		56.60%
False + rate for classified +	Pr(~D| +)		27.45%
False - rate for classified -	Pr(D| -)		18.29%
Correctly classified			80.22%

Notes: Calculated with STATA; Classified + if predicted Pr(D) ≥ 0.5; True D defined as *suppfe* ≠ 0

Table A5: Post-estimation (goodness of fit), LOGIT for suppeu

number of observations			1259
number of covariate patterns			1257
Pearson chi²(1244)			1191.8
Prob > chi²			0.8

	True		
Classified	*D*	*~D*	*Total*
+	25	22	47
-	113	1099	1212
Total	138	1121	1259

Sensitivity	Pr(+ | D)	18.12%
Specificity	Pr(- | ~D)	98.04%
Positive predictive value	Pr(D | +)	53.19%
Negative predictive value	Pr(~D | -)	90.68%
False + rate for true ~D	Pr(+ | ~D)	1.96%
False - rate for true D	Pr(- | D)	81.88%
False + rate for classified +	Pr(~D | +)	46.81%
False - rate for classified -	Pr(D | -)	9.32%
Correctly classified		89.28%

Notes: Calculated with STATA; Classified + if predicted Pr(D) ≥ 0.5; True D defined as *suppeu* ≠ 0

Table A6: Collinearity Test on Firm Characteristics

	VIF	*SQRT VIF*	*Tolerance*	*R-Squared*
suppst	1.33	1.16	0.7492	0.2508
suppfe	1.36	1.17	0.7338	0.2662
suppeu	1.22	1.1	0.8211	0.1789
sme	1.01	1.01	0.9857	0.0143
lnrdexp	1.3	1.14	0.7673	0.2327
highedu	1.13	1.06	0.8831	0.1169
mshare	1.05	1.02	0.9538	0.0462
national	2.98	1.73	0.3352	0.6648
international	3.15	1.77	0.3176	0.6824
regularly	1.2	1.9	0.8355	0.1645
qualcomp	1.03	1.01	0.9712	0.0288
east	2.01	1.42	0.4974	0.5026
donor	1.9	1.38	0.5258	0.4742
Mean VIF	1.59			

Notes: Calculated with STATA

Table A8: Collinearity Tests on Efficiency

	VIF	*SQRT VIF*	*Tolerance*	*R-Squared*
turnup[11]	1.00	1.00	0.9961	0.0039
suppst	1.22	1.10	0.8218	0.1782
suppfe	1.26	1.12	0.7954	0.2046
suppeu	1.17	1.08	0.8548	0.1452
Mean VIF	1.16			

Notes: Calculated with STATA

[11] Same results also with *turndown*, *rosup* and *rosdown*.

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