The Short-Run Production of School Outcomes and Fiscal Decentralization: Empirical Evidence from Germany

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Abstract
The effects of local public school spending and decentralization on school outcomes as an important measure of human capital are a subject of many international studies. We analyze the short-run effects of school expenditures from different federal levels on the rate of young people who successfully get a college entrance qualification using a regional database on Germany from 2000 to 2011. Using the local share of elderly, an election year dummy as well as a lagged expenditure variable as instrumental variables, we find positively significant impacts of the teacher density as a state input as well as of school expenditures by counties as the local input on the outcome variable. Furthermore, no significant effects of the decentralization measure are found.

JEL classification: I21; I22; R50

Key words: local public finance, educational federalism, educational outcomes

1. Introduction
There is a vivid discussion about the German school system, the number of young people who get a college entrance permission (Abitur) and the number of university students – especially since the German students’ results of the first PISA study shocked many politicians in 2001. The comparably low rate of young people getting the Abitur and therefore being able to enter college is often criticized when looking at the German education system (OECD 2008) as the Abitur is almost a prerequisite for a successful career and as it is an important measure of human capital.

Another special property of the German school system is decentralization. The impact of education decentralization on education outcomes have been analyzed in many (international) studies (e.g. Burki/Perry/Dillinger 1990; Roy 2011; Heredia-Ortiz 2007). The same is true for the impact of public
school spending (e.g. Hanushek 2003; Krueger 2003; Pritchett and Filmer 1999, Jackson/Johnson/Persico 2015; Hyman 2017). This paper provides the first empirical analysis on public school expenditures and decentralization on county level dealing with Germany. More precisely, the focus rests on the effects of local public school expenditures and decentralization on school outcomes.

In the last two decades, there has been no school decentralization reform in Germany. Thus, our empirical strategy builds on an interesting institutional variation instead: Schools are financed and decided on mainly by the state governments. The so called interior schools issues including teachers and curricula are decided on and financed by the states whereas the exterior school issues which is basically everything else – teaching material, buildings etc. - are financed and decided on by local authorities. The latter are the counties (and municipalities with county rights) or the municipalities – depending on the state, school type and sometimes on the individual schools. So the degree of decentralization differs considerably between and within states. This dual type of school financing is a rather unique characteristic of the German public school finance system (see Avenarius 2000, Schwarz/Weishaupt 2013).

So far, there is no analysis on the effects of local education spending and decentralization – including the county and municipality level- on education outcomes dealing with Germany. Even though the dual way of financing is a rather unique property (as is the segregated school system). This is the first research contribution.

The underlying research questions can be summed up as follows: Does the level of local public school expenditures influence school outcomes, namely the rate of young people who get the Abitur? What role does the degree of (finance) decentralization play?

Form a methodological point of view, we will perform a panel data analysis with a dataset on Western German counties from 2000 to 2013. To deal with possible endogeneity issues (e.g. Angrist/Krueger
we use an Instrumental Variable (IV) approach. Several different (financial) variables, namely the average business tax rate multiplier as well as the lagged expenditures per pupil by counties are used as instrumental variables. We include a Lewbel Instrumental Variable approach in addition which is another research contribution. (The restriction on the number of years in our panel dataset is one limitation of this study and makes it only possible to estimate short-run impacts.)

Our findings are in line with the existing related research contributions. The impacts of the teacher density are positively significant and the impacts of public school spending by counties on the rate of successful grammar school finishers are small but positive as well. Moreover, the effects of our decentralization measure appear to be insignificant.

The paper is structured as follows. Section 2 is a summary of related literature whereas section 3 clarifies the institutional background. In section 4, the empirical model is derived. The results are described in section 5 (including the extension) and the conclusion is drawn in the last section.

2. Background Literature

There are many related theoretical research contributions. One strand of theories predicts that decentralization improves education outcomes through better knowledge of local environment and needs (Fiske 1996, Heredia-Ortiz 2007), higher accountability resulting in higher incentives to perform well (Hanushek/Rivkin 2003).

On the other hand, the standard Microeconomic Theory suggests that decentralization leads to less economies of scale and therefore less efficiency. Moreover, it might result in higher inequalities in education expenditures and provision (e.g. Elmore/Fuller 1996).

The Coleman Report (Coleman et al. 1966) can be seen as the first influential empirical research contribution addressing our question. It showed no effects of a variation in per pupil spending on
student achievement in standardized tests.

Many studies using different (more sophisticated) methods and dealing with different countries followed and largely arrive at similar results (see Hanushek 2003 for a review): The relationship between educational inputs and student performance is found to be positive more often than negative and more often than positive (see also Hanushek 1986, Hanushelk 1996).

Secondly, many recent studies analyze this question using data on school finance reforms.

The majority of these studies analyzes the education decentralization reform in Michigan in 1994. It changed the finance system from a system which was financed locally through local property taxes to a more state financed system. More precisely, the so called foundation allowance was granted. This is an amount provided by the state which each district has to pay (at least) per pupil.

Hyman (2017) analyzes this school finance reform and the effects of increased primary school spending on students’ college enrollment and completion. He uses student-level data and the foundation allowance as an instrument for spending. Positive impacts are found. These positive effects are mostly found for initially urban and suburban, wealthier as well as higher achieving districts.

Chaudhary (2009) estimated the short run impacts of the school finance reform in Michigan (Proposal A) on education inputs and test scores, too. According to the latter reform, state revenues for education were raised and it brought a centralization of school finance from the local level to state level. He uses a difference-in-differences approach as well as an IV approach with the foundation allowance and its interaction with year dummies as instruments. The author finds that the reform leads to increased teacher salaries. Furthermore, he finds positive impacts on 4th grade test scores using the foundation allowance generated by Proposal A as an instrument in some of his regressions.

Roy (2011) and Papke (2005) also analyze the latter finance reform getting the following results: They find positive effects on outcomes - especially for districts with initially poor performance. These are contradictory findings compared to Hyman (2017).
Other authors empirically analyze different decentralization reforms in the US during the 1970s and 1980s. Jackson, Johnson, and Persico (2015) empirically analyze school finance reforms in the US during the 1970s and 1980s and find positive long run effects of education spending increases on education and economic outcomes - especially for people from low income families. The outcome measures are completed years of education, wage and incidence of adult poverty. They use the type of funding formula change as well as its timing as instruments for spending and compare the outcomes of different cohorts which are exposed to that reform. Event study and instrumental variable models are used.

Candelaria and Shores (2015) perform a similar analysis using differences-in-differences models and find that the reforms led to higher high-school graduation rates for high-poverty districts in the long run and to an increase in per pupil spending. Lafortune et al. (forthcoming) perform a comparable analysis yielding qualitatively identical results.

Thirdly, many studies analyze the decentralization reforms in Latin America yielding varying results. Faguet and Sánchez (2008), for example, compare the effects of decentralization on public education outcomes for the cases of Bolivia and Colombia. In Colombia, it increases enrollment rates in public schools whereas it made governments redirect resources to areas of greater need. They use OLS as well as IV estimations with lagged per capita tax measures as instruments. Many of those investigations, e.g. Burki/Perry/Dillinger (1999), only find positive effects if authority is directed to very decentral levels, such as school boards.

Chetty et al. (2014) focus on teachers as input factor trying to find out the long term effects of high value-added teachers (those who raise students’ test scores) in primary schools. They use a huge sample of district and tax records on primary school teachers and students and find out that pupils taught by high value-added teachers are more likely to attend college, achieve higher wages and are
less likely to have children early. In terms of methodology, they use OLS as well as dynamic panel estimations. 1 2

Using panel data on Swiss cantons, Barankay and Lockwood (2007) analyze the relationship between decentralization and the productive efficiency of the government. They find evidence that more decentralization leads to higher education attainment – especially for male students. Moreover, their study provides no evidence of any adverse effects across education types.

For Germany, empirical investigations on education federalism and inequality only exist on state level (e. g. Freitag/Schlicht 2009), not on county level. Pischke (2007) performs a study on the effects of the school year length on outcomes. Therefore, he uses the short school year in Germany as a variation. His results show that the latter variation implied higher grade repetition rates in primary schools and fewer pupils entering higher secondary schools. Nevertheless, it did not affect later (long run) earnings or employment.

A distinctly related strand of literature deals with the competitive effects of private schools – the most extreme case of school decentralization- on school outcomes. Dee (1998) uses 2SLS on a dataset on US school districts and finds that competition from private schools has a significantly positive impact on the high school graduation rates of public schools in the area. Patrinos (2010) analyzes the Dutch education system where the majority of schools are administered privately but funded by the government. Using an instrumental variable approach, he finds positive impacts of this system on test scores in math, reading as well as science. These results are in line with other investigations such as Hoxby (1994b).

1 Furthermore, there are studies which focus on the efficiency of schools (e. g. Hanushek 1986, Hanushek/Luque 2003). Jimenez and Paqueo (1996), for example, focus on cost efficiency (for a given achievement level) depending on the share of local expenditures. They find that a higher share of decentral expenditures lowers costs, ceteris paribus.

2 Some studies explicitly estimate education production or cost functions. One fundamental study on the education production function was published by Hanushek (1986). Pritchett and Filmer (1999) develop a theoretical model on the optimal choice of different education input factors and empirically find a relative overuse of teachers.
To sum up one can say that authors who address related research questions regularly face problems to deal with endogeneity, often using weak instruments. We also use (fiscal) instrumental variables and a decentralization measure (which is highly variable between German counties) instead of a school finance reform as there is no comparable reform in Germany during the time period considered. Our decentralization measure (see sections 3 and 4) is an interesting institutional variation and provides an alternative to the latter reforms. The same is true for the fiscal instrumental variables which are used (see sections 3 and 4). For Germany, it can be seen as an interesting case study for other categories of expenditures.

3. Institutional Background

Now we provide some background information on the German school system with a focus on the different types of upper secondary schools in Germany which provide a college entrance permission once they are finished successfully. Furthermore, we explain (local) public school financing in Germany and the role of counties.

3.1 The German School System

Traditionally, Germany has a three-branch school system. Children start to go to school at the age of six and spend four (or in some federal states six) years at elementary school. Afterwards, good students attend a grammar school (Gymnasium). After 9 years (or 7 years if elementary schools cover grades 1 through 6) at grammar school, they receive the degree “Allgemeine Hochschulreife” allowing them to enter any university or college upon successful graduation. Starting in 2010 in some Western German states, the duration of grammar schools was shortened such that the number of overall school years for grammar school pupils is 12 instead of 13 years (G9/7 reform). The latter reform was implemented in a rather flexible way varying between schools or counties of the same state. Recently,
a return to the traditional system G9/7 system is planned in most states.\(^3\)

The fourth school type is the vocational school which is almost unique in Germany. More precisely, the traditional dual German apprenticeship system consists of a theoretical part taught at vocational schools and a practical part in the company. Moreover, vocational schools offer tracks where adults or elder youngsters can reach a university of college entrance permission after they have finished secondary school instead of visiting a traditional grammar school.

There are two different kinds of college entrance permissions. *Allgemeine Hochschulreife* (AH) theoretically allows students to study at any higher education institution. It is possible to study a variety of different subjects at universities. The *Fachhochschulreife* (FH) only qualifies for studies at universities of applied sciences which offer only a limited amount of (rather applied) fields of studies. The FH can be achieved at several different types of vocational schools whereas the AH is obtained at grammar schools or at vocational grammar schools (special sub-type of vocational schools). (Hurrelmann 2013, Cortina et al. 2003)

### 3.2 (Local) Public School Financing in Germany

The public expenditures for grammar schools (and vocational schools) are two-dimensional in Germany: expenditures on the interior school issues and expenditures on the exterior school issues. The former consists of spending for teachers and are generally paid by the states (only in Bavaria the responsibility is partly local). The latter consist of everything except from teachers and curricula –

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\(^3\) Average students usually attend a secondary school (*Realschule*) which lasts six (or four) years. Once it is finished successfully, they are qualified to do an apprenticeship. The same is true for students with poor grades who usually attend a lower secondary school (*Hauptschule*) which lasts only 5 (or three) years. Pupils from that school type can apply for an apprenticeship afterwards. However, the latter two school types where gradually abolished starting in the first decade of the 21st century (the time periods analyzed here) and comprehensive schools (*Gesamtschulen*) where created instead. These schools have six (or four) grades. (Hurrelmann 2013, Cortina et al. 2003)
namely equipment and in some states non-teaching staff\(^4\) and are paid for by the so called *Schulträger* which are the counties or the municipalities (for vocational schools always counties). In Germany, the decision-making authority is always the same as the spending authority. (See Avenarius 2000, SchulG of the *Länder*, Schwarz/Weishaupt 2013 and graphic below)

(see Avenarius 2000, SchulG of the *Länder*, Schwarz/Weishaupt 2013)

### 3.2 German counties

There are 367 rural counties (*Landkreise*) with 178,448 inhabitants on average in Germany (2001). Moreover, 118 cities are municipality and county at the same time- these are the so-called cities with county rights which are also called counties in the following text.

So what is exactly the role of counties? One can distinguish between their compulsory tasks, their voluntary tasks as well as their assigned federal tasks. It is kind of a twin role, namely executing *Länder* laws on the one hand and providing supra-municipal goods and services and equalization tasks on the other hand.

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\(^{4}\) The non-teaching staff mainly consists of social workers and related staff. Depending on the state, this staff is either paid by the state or by the *Schulträger* and sometimes also jointly by both of these federal levels.
There is on the one hand the so called Kreistag, elected by the citizens of the respective county to represent them in certain affairs. It could be seen as the legislative (Bogumil and Jann 2009). On the other hand, there is the Kreisausschuss which is basically a committee created by the Kreistag as supervisory authority. Last but not least, the Landrat has very special dual tasks (Fuchs 2012): He is the head of the county’s government and therefore a local government authority as well as an administrative authority. One can say that he is executive (Bogumil and Jann 2009). There are quite a lot of differences between the different federal states concerning the detailed competences of the latter three local agents.

The counties cannot levy taxes but they can determine a certain “rate” of revenues (tax and others) of the municipalities within the respective counties that these municipalities have to pay to them. This is called Kreisumlage. Furthermore, there are revenues from vertical grants.

All in all, we see that this federal level is much less political autonomous compared to the state level. That is one reason why it is sometimes seen as the “forgotten level” concerning public economic research. Nevertheless, its effects on public and in our case school outcomes should be worth to analyze. (see Bogumil/Jann 2009, Fuchs 2012)

4. Empirical Analysis

4.1 Data and Hypotheses

We use an unbalanced panel dataset on Western German counties for the time period from 2000 to 2011 (leaving out all Eastern German counties because there were several regional reforms at county level during this period and leaving out more current years because of the G8/9 reform). The dataset includes 232 Landkreise and 87 municipalities with county rights but excludes the three German city states. In 2002, on average 81% of those pupils who were in a grammar or vocational school successfully got some form of university entrance permission two years later. There are high variances
in these quotas within Germany. The standard deviation of the former measure was around 19% in 2002. The latter quote was considerably higher in 2011, namely almost 103% with a standard deviation of 41% because of the flexible implementation of the reform.

Altogether, the share of pupils who successfully reach a college entrance qualification shows a positive time trend, especially since 2010 because of the latter reform (see graph 1).

The expenditures per pupil of counties for grammar schools were on average 843 Euros in 2002, with a standard deviation of 592 and a maximum of 3631 Euros. (They are on average 780 Euros for vocational schools but show a much higher variance for this school type.) The average share of municipal expenditures among all local expenditures (municipal plus county expenditures) for grammar schools is 58% with a variance of around 19%.

The teacher density - namely the number of teachers per student- is on average 0.0654 for grammar schools and 0.058 for vocational schools (2002).

In 2013, the staff expenditures for active officers at public schools (mainly for teachers) were about 4250 Euros per pupil (see Bildungsfinanzbericht 2016).

As we see in the institutional section, there are inputs for equipment from the county level which are the main focus of our analysis. On the one hand, this is a research gap for Germany and on the other hand, it is internationally relevant as it is comparable to analyses on school districts in the USA. Furthermore, the dual character of inputs as described in the institutional section is internationally rather unique but at the same time provides an interesting variation as there is no comparable decentralization reform. Therefore, it can be seen as an interesting different yet comparable case. Generally, there is no consensus concerning the empirical findings on the effects of (local) inputs on school outcomes (typically measured by graduation rates or test scores). Positive effects of county or
municipality spending on output as well as a relative overuse of teachers are found by Pritchett and Filmer (1999). This is the other reason why we differentiate between the input on exterior school issues and the teacher input. Apart from this, the level of the latter input is set according to predetermined rates which makes our focus on the further input even more reasonable.

According to Hanushek (2003), one would expect no significant effects. Other studies hint at rather positive impacts (e.g. Hyman 2017, Roy 2011) with contradictory findings only concerning the question which sub-groups profit most. That is the reason why we address the question whether there is any effect of spending on outcomes without any expected sign here (see also literature review).

The first hypothesis can be summed up as follows:

**H1:** The level of local public spending on grammar and vocational schools has a significant short-run impact on the share of young adults who get the *Abitur*.

From a theoretical point of view, there are two possible directions of the effects of decentralization on education outcomes, namely competition (Oates 1972) resulting in positive impacts of decentralization or a negative impact as it might lower efficiency as standard microeconomics theory suggests. Empirical findings on decentralization reforms are summarized in the previous section and hint at positive but small effects. There is no relevant decentralization reform in Germany. Nevertheless, the varying input share by municipalities for German grammar schools offer an interesting alternative source of variation.

So the second hypothesis is the following one:

**H2:** The degree of decentralization has a significant impact on the share of young adults who get the *Abitur*. 
4.2 Methodology

We explain the rate of successful grammar school graduates as a function of local (county level) inputs. More precisely, these inputs are local expenditures on exterior school issues as well as the teacher input by the state. Apart from that, our dependent variable is explained as a function of local sociodemographic and institutional factors. The latter causality is in line with current related research on education finance and other research contributions in the field of public finance.

As we focus on the effects of school spending by counties on county level school outcomes endogeneity might be a problem. Following Papke (2005), Hyman (2007) etc. we use a 2SLS specification to address this concern. 5 In our alternative specifications, we use the Lewbel (2012) approach to find synthetic instruments using a heteroscedastic covariance restriction. It has the advantage to perform better even in the case of weak instruments.

Consequently, our empirical model reads as follows.

\[
\text{(shareAbtiur}_a) = \alpha_i + p \ln \left( \frac{\text{localexp schools}_a}{\text{pupils}_a} \right) + c(\text{decentralization}_a) + \delta(X_a) + \theta_i + \kappa_r + \varepsilon_a \quad (1)
\]

\[
\ln \left( \frac{\text{local exp}_a}{\text{pupil}_a} \right) = a_i + c(Z_{a-1}) + d(X_a) + \ell_r + e_u \quad (2)
\]

The analysis is on county level (i). Our explanatory variables (X) are lagged by one year. Moreover, we take the logarithm of each variable keeping only the original scale if and only if a variable is a percentage or dummy.

The dependent variable in estimation (1) is the short-run school outcome variable, namely the rate of

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5 This is in line with the fact that the null hypothesis of endogeneity cannot be rejected once we perform an endogeneity test.
pupils who get the Abitur successfully. It is calculated by dividing the number of local pupils who successfully get their general university entrance permission (AH) (numerator) by the number of 11th graders from grammar schools, vocational grammar schools and comprehensive schools three years before (denominator). Both measures are given per school year so the time periods are congruent.

The existing literature identifies a number of different factors that determine or measure schooling outcomes, among them class size, teacher quality, test scores or graduation rates (e.g. Chetty et al. 2014, Angrist/Lavy 1999, Krueger 2003, Hanushek/Woessmann 2010). Our school outcome variable can therefore be seen as a conservative measure of school output.

The main explanatory variable is the input of a county. It is calculated by dividing the overall annual public grammar school expenditures of counties by the number of local grammar school pupils for the previous calendar year plus the same quotient for the calendar year two years before – dividing that sum by two. So it measures the average expenditures per grammar school pupil for the two calendar years before the graduation year. If a pupil graduates for example in summer 2012 it is the average expenditure per pupil in 2011 and 2010. We do not take annual expenditures divided by two to approximate the first half of the 11th grade or the last half of the 13th grade as those inputs would be simple averages/approximations. We only want to include inputs which are allocated de facto. So it is a short term input.

Unfortunately, one cannot identify how these expenditures are distributed among pupils of different grades so we have to make the simplifying assumption that the money counties spend is rather equally distribute among grades.

We also control for the teacher/pupil ratio for each county at grammar schools, a common measure which is used for the state input here. This is a good measure for the state school inputs as the wage of teachers is nationally almost equal and the allocation of teachers is based on fixed predetermined formula. Once again, we take an average of the last three school years before graduation.
Moreover, the share of teachers employed full-time is also included as a control variable.

Some additional control variables are worth to mention. One sort of controls is for the within school type pupils' structure (share of 11th graders for the analysis on grammar schools, comprehensive schools and other school forms leading to Abitur).

In order to address hypothesis 2, we control for our decentralization. To this end, we use the share of expenditures for grammar schools by municipalities divided by the overall local (municipalities plus counties) expenditures for grammar schools as a decentralization measure lagged by one year. It varies for institutional reasons.

Apart from that, we use socioeconomic control variables: Population density, the population share of foreigners, disposable income per capita in a county as well as the unemployment rate.

Moreover, we control for time variant characteristics of the sectoral structure using the local share of people working in the bank sector and the local share of people who work in the field of manufacturing as additional controls.

In order to control for the distribution of expenditures among grammar school pupils, we control for the share of pupils in 11th, 12th or 13th grade (who are analyzed here) among all local grammar school pupils assuming that local monetary inputs are allocated to the pupils of different grades and age proportionally to their share.

Finally, county fixed effects are included in each specification in order to control for the remaining unobserved heterogeneity. Most importantly, these could be differences in the local school structure such as a higher share of private schools, specific types of vocational schools where a lower share of expenditures are attributed to vocational grammar schools etc. Year fixed effects control for common changes across time. Standard errors are clustered at county level and robust to heteroscedasticity.
which is found by a White test.

As the expenditures per pupil may be endogenous, we have to use an IV approach. The share of elderly in the county is an instrument in our main estimations (Stage 1). One can intuitively argue that the share of elderly in a county does not affect the share of successful grammar school finishers in a county at all. Moreover, its relevance for the level of expenditures per grammar school pupil might be given as the expenditures for elderly people in a county could be seen as an alternative category of public expenditures. The second instrument – used in all IV estimations- are the expenditures per grammar school pupil included lagged by one year – a common procedure whenever any other strong instrument is missing- as it is highly correlated (see Fisher 1965).

In an alternative specification, we use a third instrument, namely a dummy on whether the change to the Doppik, a more modern bookkeeping system which was introduced in German public administrations during this time period in a flexible way, has already been done. It is, of course, only related to expenditures.

Secondly, we use an election year dummy and again the lagged expenditure variable as instruments in an alternative specification for robustness reasons. An election year should not affect school outcomes in any direct way.

Once again, an alternative specification including the Doppik instrument is added. These instruments are called Z in equation (1).

In the upcoming section, three specifications are implemented. The first one (1) is a standard OLS estimation without any instruments, the second one is a 2 SLS estimation using the instruments mentioned above (2) and the third one is a Lewbel (2012) Instrumental Variable approach without excluded instruments using synthetically generated instruments. This procedure assumes heteroscedasticity in the first stage regression and is very helpful when a proper or strong
instrument is missing which is true for our case as it is in many education economic studies.\(^6\)

5. Results and Discussion

5.1 Second Stage Results

Our second stage results are shown in table 2. In all specifications, we find significantly positive effects of the teacher/student ratio.

The effects of the local expenditures are positively significant but small in specification (2) to (5). In our OLS specification (1), the local input does not show any significant effect.

Moreover, our decentralization measure is insignificant in all specifications except from the IV specification (5) where it is negative and significant at the 5% level.

Nevertheless, insignificant effects of our decentralization measure can be shown in the majority of our estimations which is not in line with the results of many studies on decentralization reforms (e. g. Chaudhary 2009/ Hyman 2017, see section 2). Effects of decentralization might only be measurable in the long run. There might be countervailing effects of decentralization neutralizing each other.

The pupils’ structure is highly significant in all specifications with coefficients of the share of 11th to 13th grades being highly positive.

There are no surprising findings for any control variable. The unemployment rate shows negatively significant impacts. The same is true for the share of foreigners. Population density seems to exert a positive influence.

Besides, the share of people working in the banking sector has a significant and positive impact in all estimations.

Last but not least, our Lewbel specifications show qualitatively identical results.

All in all, the latter findings are not in line with the relative overuse of teachers found by Pritchett

\(^6\) The White test as well as the Breusch Pagan test indicate heteroscedasticity also in the first stage regression in our analysis.
and Filmer (1999) but with the positive but small (or neutral) effects of local input factors for exterior school issues found by some researcher (e. g. Hanushek 2003).

5.2 First Stage Results

The first stage results are summed up in table 3. Our coefficient for the share of elderly as an instrument is highly significant and positive for all estimations. As expected, the lagged expenditure variable is highly significant and positive for all model specifications. The same is true for our election year dummy and our Doppik dummy included as IVs in some alternative specifications.

Other fiscal variables are tested as instruments but are found to be insignificant as well (e.g. the average business tax rate multiplier). The endogeneity test of our endogenous regressor (local expenditures per pupil) is significant in all estimations (exogeneity is rejected). Moreover, the Kleibergen-Papp Wald F statistics is much bigger than 10 so the instruments are very strong in (3).

The Sargan statistic overidentification test of our instruments rejects the null hypothesis so overidentification can be rejected. The same is true for underidentification in both 2SLS estimations.

Robustness checks are performed and the latter results appear to be robust. An interaction term between school expenditures by counties and our decentralization measure seems to be insignificant. An alternative dependent variable including college entrance permission receiving students at vocational schools and expenditures for vocational schools and vocational school teachers respectively did not give any convincing results – probably because of the high amount of missings in data on vocational school students. A rather critical point are the data on teachers as they contain many missing variables – especially those for vocational schools which might partly explain the insignificance found for share FH in a robustness check including also FH graduated (see section 3) and the vocational schools providing it. Because of the insignificance of these results, they are not
shown here; the estimations are available upon request.

6. Conclusion

All in all, we find positively significant impacts of the teacher density as a state input and of school expenditures by counties on the outcome variable. This is in line with some research findings (e.g. Hanushek 2003 in a review). Particularly, it is in line with the findings by Hyman (2017) or Jackson, Johnson and Persico (2015) etc. as they find positive effects of school spending on outcomes for certain sub-groups. It is contradictory to the relative overuse of teachers found in some research contributions.

The effects of local school expenditures might be small in the short run because these expenditures are for exterior school issues such as teaching material. Even though these expenditures show a relatively high variation within and between counties, their effects on school outcomes might not be too strong or it might show in the long run. Furthermore, insignificant effects of the decentralization measure are found in most specifications. This somewhat contradicts the research findings on the decentralization reforms in the US. There might be countervailing effects of decentralization neutralizing each other. The decentralization measure is defined as a quotient of expenditures for exterior school issued from different decentral levels which could also explain the insignificance. Besides, financial participation by municipalities is rather rare. Moreover, we only consider a relatively short time period and such a variation might only be present and therefore showing effects in the long run.

To get more robust findings, the panel dataset should contain more years which means information on the local expenditures are needed for a longer time period. In a next step, the share of students attending private schools should be included as control variable. The data on the expenditures on vocational schools are another limitation as the expenditures for vocational grammar schools cannot be separately identified from the aggregated expenditure variable. However, the is a small but existing track in vocational school where pupils can yield a general university entrance permission. Another
critical point are the data on teachers as they contain many missing variables and exclude the state of Hesse.

Moreover, this German example with fiscal and other regional data again confirm the common problem in education economic research to find a strong (nontrivial) instrument.

One could say that a strong role of counties as the forgotten level can be shown here and the importance of the teacher input and therefore the role of the state in school financing is underlined by our findings. It somehow proves the efficiency of this type of decentralization with its dual type of school financing.

**Literature**


### Tables

#### Table 2: Second Stage regression results on Western Germany

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<td>0.851***</td>
<td>1.314***</td>
<td>0.922***</td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
<td>(0.125)</td>
<td>(0.127)</td>
<td>(0.129)</td>
<td>(0.378)</td>
<td>(0.139)</td>
</tr>
<tr>
<td>log Disp. income/capita (t-1)</td>
<td>0.0492</td>
<td>0.0539</td>
<td>0.0492</td>
<td>0.00380</td>
<td>0.281***</td>
<td>0.332***</td>
</tr>
<tr>
<td></td>
<td>(0.0692)</td>
<td>(0.0694)</td>
<td>(0.0685)</td>
<td>(0.0734)</td>
<td>(0.0880)</td>
<td>(0.0581)</td>
</tr>
<tr>
<td>shareOberstufe (t-1)</td>
<td>-1.062***</td>
<td>-1.082***</td>
<td>-1.062***</td>
<td>-0.727***</td>
<td>-0.291</td>
<td>-0.313</td>
</tr>
<tr>
<td></td>
<td>(0.230)</td>
<td>(0.227)</td>
<td>(0.228)</td>
<td>(0.212)</td>
<td>(0.319)</td>
<td>(0.212)</td>
</tr>
<tr>
<td>population density (t-1)</td>
<td>4.74e-05</td>
<td>4.75e-05</td>
<td>4.74e-05</td>
<td>-2.71e-05</td>
<td>-0.000110</td>
<td>-0.000116</td>
</tr>
<tr>
<td></td>
<td>(7.04e-05)</td>
<td>(6.96e-05)</td>
<td>(6.98e-05)</td>
<td>(5.90e-05)</td>
<td>(0.000166)</td>
<td>(8.88e-05)</td>
</tr>
<tr>
<td>log_GymauspK (t-1)</td>
<td>-0.00230</td>
<td>-0.000311</td>
<td>-0.00230</td>
<td>-0.00347</td>
<td>-0.137***</td>
<td>-0.00801</td>
</tr>
<tr>
<td></td>
<td>(0.00492)</td>
<td>(0.00628)</td>
<td>(0.00488)</td>
<td>(0.00504)</td>
<td>(0.0527)</td>
<td>(0.00556)</td>
</tr>
<tr>
<td>year dummies</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Constant</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>1,287</td>
<td>1,276</td>
<td>1,287</td>
<td>1,230</td>
<td>1,218</td>
<td>1,230</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.814</td>
<td>0.814</td>
<td>0.814</td>
<td>0.210</td>
<td>-0.836</td>
<td>0.156</td>
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<tr>
<td>Number of groups</td>
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<td>202</td>
<td>207</td>
<td>200</td>
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</tbody>
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Robust standard errors in parentheses  
*** p<0.01, ** p<0.05, * p<0.1

#### Table 3: First Stage regression results of 2SLS estimations on Western Germany

<table>
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<tr>
<th>VARIABLES</th>
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<th>(5')</th>
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<tr>
<td></td>
<td>log_GymauspK</td>
<td>log_GymauspK</td>
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Table 4: Generated Instruments (Lewbel 2012)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>GenInst(6')</th>
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<tbody>
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<td>shareGemeinden</td>
<td>0.004831</td>
<td>-0.007551</td>
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<td></td>
<td>0.0278</td>
<td>0.0237</td>
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<tr>
<td>Lehrerdichte</td>
<td>0.8578</td>
<td>0.9217</td>
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<td></td>
<td>0.127</td>
<td>0.139</td>
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<tr>
<td>log_EK/Kopf</td>
<td>0.04924</td>
<td>0.3322</td>
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<tr>
<td></td>
<td>0.0685</td>
<td>0.0581</td>
</tr>
<tr>
<td>shareOberst</td>
<td>-1.062</td>
<td>-0.3134</td>
</tr>
<tr>
<td></td>
<td>0.228</td>
<td>0.212</td>
</tr>
<tr>
<td>popdensity</td>
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<td>-0.0001164</td>
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<tr>
<td></td>
<td>7.0e-05</td>
<td>8.9e-05</td>
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<tr>
<td>log_Gymaus/pupil</td>
<td>0.002301</td>
<td>-0.008015</td>
</tr>
<tr>
<td></td>
<td>0.00488</td>
<td>0.00556</td>
</tr>
<tr>
<td>year fe</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

| N                   | 1287        | 1230        |
| rmse                | 0.0392      | 0.0378      |
| j                   | 0           | 0           |
| jdf                 | 0           | 0           |
| jp                  |             |             |

legend: b/se