Approaching effects of the economic crisis on university efficiency
A comparative study of Germany and Italy

Abstract
In this paper, we compare the efficiency of the Italian and German university system in the process of transforming public funding into the multiple outputs of a university, i.e. graduating students, publishing research, and patenting activity. We do this with a particular focus on the policies implemented following the financial crisis in 2007/08. Using a sample of 133 public universities, of which 73 public universities in Germany and 60 public universities in Italy, observed over the period 2006-2011, we find that Italian universities perform significantly better in terms of cost efficiency than German universities. The crisis does not show a general impact, while the treatment effect indicates that Italian universities coped better during the crisis than their German counterparts at a highly significant level.

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Keywords: higher education; economic crisis; governance; data envelopment analysis; malmquist productivity index.
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Approaching effects of the economic crisis on university efficiency

A comparative study of Germany and Italy

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1. Introduction

Universities, in particular public universities, are dichotomous institutions. On the one hand, they are recognized as important drivers of regional competitiveness, as the most important sources of new ideas, knowledge spillovers and providers of human capital (Audretsch, Lehmann, & Paleari, 2014; Lehmann & Menter, 2015). On the other hand, in the past decades, they have been criticized often as a static and bureaucratic institution, unable to cope with challenges, changes and exogenous shocks (Sav, 2016). This criticism has been at the basis of the large wave of reforms that has characterized the field worldwide in the last two decades. This study focuses on this dichotomous role by analyzing whether and how universities belonging to different university systems react to an exogenous shock like the financial crisis in 2007/08. The financial crisis has led to a drastically decline in national budgets, resulting in a drop of public spending, like spending in the higher education sector or public R&D (e.g. student by tertiary educational institutions (OECD, 2016)). This hampered public universities to fulfill their mission, as public spending are the main financial sources in continental Europe. University managers, Rectors or Presidents, have thus to cope with this exogenous shock and reorganize their universities.

Europe seems to be stuck-in-the-middle between US-American and Asian universities while the former are exceptionally good and the latter catching up quickly (Audretsch et al., 2014). The European university landscape is considered as bringing forth hybrids of state-/market-orientation and de-/centralization. The Bologna process, initiated in 1999, is one policy approach to put the European university system towards a more market-based system. Standardizing Bachelor and Master Degrees should stimulate the mobility of students within and between countries, fostering the competition of universities to attract the best students and thus enhance efficiency (Donina, Meoli, & Paleari, 2015; Froehlich, 2016). Studies, evaluating whether or not this policy initiative has led to an increase in efficiency are scare. This paper
tries to cope with this topic by estimating the efficiency of universities in two main countries of Europe, Italy and Germany. Relying on a unique panel dataset consisting of all public universities in Italy and Germany, we apply a non-parametric approach – Data Envelopment Analysis (DEA, see Charnes, Cooper, and Rhodes (1978)) – to estimate efficiency scores of universities and to evaluate how they differ across the two countries before and after the financial crisis. The financial crisis in 2007/08 is taken as a treatment effect to estimate difference-in-differences estimations. This estimation method allows comparing whether and how the efficiency scores vary in accordance of the different political systems before and after the treatment has occurred.

We select these two countries for several reasons. First, university systems are characterized by path dependencies. In these respects, both countries are characterized by a joint historical development since the foundation of the first university in Bologna in 1088. Both countries show similarities in the restructuring of the university landscape following the Bologna reform, a change from a Diploma system to the Bachelor/Master system. Today, both countries are also characterized by large regional inequalities. While Germany is faced with a large and increasing disparity between the West (the former FRG) and the East (former GDR) gap (Agasisti & Pohl, 2012; Audretsch & Lehmann, 2016), Italy is faced with a North-Middle-South gap, which seems to be cemented since decades. Finally, both university systems – different from e.g. Anglo-Saxon systems – follow the Humboldtian vision and mission: the interrelatedness of research and teaching.

Besides these similarities, both systems differ in an important way in their governance structures. While universities in Germany are rather autonomous and under the authority of the 16 Federal States (Audretsch & Lehmann, 2016), the Italian system is characterized by a centralized governance system. Additionally, the Italian as well as the German system used to be state-oriented systems while Italy started to introduce market-oriented measures like
performance-based funding. This difference in the governance structure – centralized in Italy and decentralized in Germany – makes a comparison of the two countries a special one. First, because the effects of a centralized/decentralized approach of higher university policy could be directly measured. The question “Does university policy matter” could be analyzed on a national level instead of just relying on different types of universities (Audretsch & Lehmann, 2005). Centralization combined with the turning away from a state-orientation to a market-orientation allows to react quicker to exogenous shocks because (i) more information is collected in one centralized institution that can make use of them more easily than federal states that rely on less information and thus, less negotiation power, (ii) implementation of decisions can be enforced more quickly than with many different decision making entities. Secondly, such a comparison does not only reveal whether or not university policy matters but also how and why. In the last years, several more or less exogenous shocks have treated the higher education sector, most of all the financial and euro crises in 2007/08. As consequence of the financial crisis, most countries reduced their public funding for universities (European University Association, 2016). A comparison of the two countries may offer insights, whether or not or how this shock has treated the universities in both countries regarding their efficiency. In particular, two different results could be expected. First, that the overall effect is positive for Italy, i. e. increasing efficiency. A reduction in financial resources may force the university managers, their rectors or presidents, to re-organize and increase efficiency. Otherwise, such an exogenous shock may destroy formal and informal organization structures and routines, increasing inefficiency. While in Germany the only notable change observed is a stagnation of third-party funds by industry (which is an increasing but not really important financial source for German universities), Italian universities are faced with a larger cutback. The latter, however, treated the universities in a different way, depending on their individual negotiation power. We assume that a centralized and market-oriented system – with all the belonging decisions – that has to face economic restraints is able to react quicker and more efficient, be it
in terms of policies, processes or resource distribution, than decentralized systems that are assumed to have an overview in trouble in allocating resources efficient and quick.

Our paper adds to previous research in several ways. The study closest to ours is the contribution of Agasisti and Pohl (2012). They also compare Italy and Germany using DEA showing that efficiency scores of public universities in Germany are on a higher level compared to those in Italy, but that both systems converge between 2001 and 2007. We add to this study by including a full sample of all public universities in Germany and Italy and, since they are drawing on two years (2001 and 2007) ending before the economic crisis, a longer time period from 2006 to 2011 capturing the treatment effect. Another important study is Sav (2016), the only study we are aware that focuses directly on the effect of the impact of economic crisis on the efficiency of universities. Our study adds to this work in several ways. Firstly, we place our study in a less market based context, continental Europe. Secondly, we compare two different governance regimes and include a broader set of universities over a longer period.

The findings of our study are of relevance to three target groups: politicians, university managers and academics as such. Politicians might benefit from understanding mechanisms and effects of political actions that come to term in a system of relative stability when unforeseen shocks are intervening. University managers can prepare university structures for the effects of exogenous shocks and academics might get a better understanding of the system in which they are embedded. The reminder of this proposal is as follows: The next section provides a review of the literature. Section 3 gives insights to our theoretical arguments. In the 4th section we introduce the data set, the DEA and estimation methods as well as a short overview on the research design. Our results are discussed in section 5, before we summarize and conclude in section 6.
2. Literature Review

A fruitful and promising literature has been emerged analyzing the performance of universities in the last decades (Emrouznejad, Parker, & Tavares, 2008). In the lack of market prices and the specific type of production function, measuring performance of universities has been a challenge for academic research, leading to an often more qualitative than quantitative literature. In their seminal paper Charnes et al. (1978) introduce a nonlinear, nonconvex programming method with a new definition of efficiency which enables the evaluation activities of not-for-profit entities, like departments or universities. Since then the method has not only gained several improvements, like considering fixed or variable economies of scale, different measures of performance, time considering indices, but has been the starting point of a new and promising field of research: New public management, and in particular, the economics and management of the education sector and its institutions (J. Johnes, 2006a, 2006b).

Subsequently, academic research has focused on the evaluation of individuals, departments or different types of universities, either private or public business schools (Thursby & Kemp, 2002), comparing different governance systems like Anglo-Saxon systems (Lehmann & Warning, 2004; Thursby & Thursby, 2002) and the European system (Agasisti, Catalano, Landoni, & Verganti, 2012; Agasisti & Johnes, 2009; Kempkes & Pohl, 2010), considering institutional and systematic differences (Agasisti & Pérez-Esparrells, 2010; Agasisti & Pohl, 2012), or the impact of environmental endowment (Agasisti & Pohl, 2012).

Departmental DEA studies have in common that they are emphasizing the need to evaluate departments in order to not disadvantage or privilege well performing or underperforming departments (Agasisti et al., 2012; Beasley, 1990; G. Johnes & Johnes, 1993). However, we argue that firstly, we do acknowledge the need to have comparable entities what we ensure by focusing on public universities. This is also explained e.g. by the different production and utility
functions of private and public universities (Ahn & Seiford, 1993). Secondly, evaluating universities is of special interest because they represent a coherent organizational entity that is e.g. negotiation partner for the government. They are located in between a homogenous institutionalized setting and heterogeneous accumulation of faculties. The university level appears to be the only level that provides the possibility of examining the interplay and relation of the three missions – to which we will come back later – as they are consistent among countries (Bonaccorsi, Daraio, & Simar, 2006). Considering strategic orientation and institutional as well as environmental factors that are affecting universities is nowadays essential with regards to the positioning in the higher education context, an advantageous allocation of scarce resources and the development of group-specific strategies (Warning, 2004). Taking this one step further, it is beneficial to compare among different countries in a timeframe: universities are influenced by their countries’ actions and put into practice diverse strategies to cope with surrounding policies and influence factors based on their individual position (Agasisti & Haelermans, 2016; Agasisti & Pérez-Esparrells, 2010).

The DEA approach allows to measure efficiency and to compare units – such as universities – with the dilemma of multi-product character and heterogeneous in- and outputs (J. Johnes, 2006a). This is specifically advantageous because universities are considered to fulfill three missions: the classical Humboldtian missions (i) teaching and (ii) research as well as the emergent third mission meaning the contribution of universities to society by (iii) innovation (Etzkowitz & Leydesdorff, 2000). Thus, previous contributions evaluated efficiency in terms of teaching (Afonso & Santos, 2005; J. Johnes, 2006b), research (Agasisti et al., 2012; Chu Ng & Li, 2000) or innovation (Caldera & Debande, 2010; Thursby & Kemp, 2002; Thursby & Thursby, 2002). However, due to the advantage of including heterogeneous factors, the focus in university DEA research lies on a combination of research and teaching (Abbott & Doucouliagos, 2003; Arcelsus & Coleman, 1997; Athanassopoulos & Shale, 1997;
Lehmann & Warning, 2004). Until now the third mission is increasingly examined in detail but barely or not explicitly included in combined efficiency evaluations (Agasisti & Pérez-Esparrells, 2010). Considering the third mission not only individually but also in the interplay with teaching and research is crucial particularly for knowledge societies. This form of society is typical for developed countries – such as Italy and Germany – and depends on (i) generation of highly qualified human capital ensured by university teaching, (ii) generation of future-oriented knowledge ensured by basic research and (iii) the translation of academic knowledge to industrial applicability ensured by entrepreneurial activities of universities (Audretsch & Lehmann, 2016). Even though, universities do not have the explicit aim to achieve efficiency, using an efficiency score like DEA is an unbiased measure of the performance in translating state efforts to universities’ missions which is a basic interest of society.

Our study builds on these important findings, so in the following we will base our theoretical arguments on the existing DEA literature that corresponds to our research project with regards to exogenous shocks and university systems, environmental factors, as well as institutional factors.

3. Theory

While the analysis of exogenous shocks is widespread in business related research, e.g. in terms of financial crises, company announcements or scandals and so forth, it is emergent for university related research (Agrawal & Cooper, 2015; Erkens, Hung, & Matos, 2012). As investments in education are investments in the future labor market it is standing to reason that exogenous shocks that are affecting the university system today will have a lagged effect in the future, e.g. in terms of human capital. Further, the analysis of exogenous shocks implies policy and management implications to improve and prepare Higher Education systems for unforeseen challenges.
In fact, one of the greatest challenges in the past decade was the financial crisis in 2007/08. Proceeding from the subprime mortgage crisis in the US the crisis also had enormous effects on Europe, especially Southeastern countries of the European Union and its economically weaker members. Italy suffered from a sharp decline of the GDP by over 15% (Germany: decline by 5% with rapid recuperation), followed by severe budget cuts and tax increases (Bozio, Emmerson, Peichl, & Tetlow, 2015). This affected also the formerly introduced formula-based funding models in the Italian Higher Education context (Agasisti & Pérez-Esparreis, 2010; Donina et al., 2015). The effects of that policy especially on the Italian Higher Education system compared to a more stable system like in Germany have not been analyzed yet. We do not know which effect those policies had and thus, several outcomes of our research design are possible.

In the following we outline the expected impact of the economic crisis as well as the influence of governance scope (decentral / central) and governance orientation (state / market). We describe benefits and costs of a decentralized system, which is found in the German case, as well as of a centralized system, which is depicted in the Italian case. After that we give an overview and explain implications of an either state- or market-oriented governance. In Germany we observe a state-oriented system while Italy recently turned from a state- to a market-oriented system like depicted in Figure 1. Following this we outline environmental and institutional variables that are found to be important for university efficiency.

**Economic Crisis**

With regards to the economic crisis, universities could experience a drastic decrease of the efficiency scores. As described by Roberts (2007), universities like private firms, are combining several input variables to output variables. This process is based on complementarities among the different input variables according to their relation to output or choice variables. This complexity makes a simple linear optimization impossible, so the only way to improve
performance is like a trial and error approach leading to a satisfying result. An exogenous shock thus, destroys the underlying production process, leading to new outcomes and have to be reorganized in the same way. If this holds, we should observe a decline in the efficiency scores, followed by consequent improvement after the treatment effect. Restricted by data availability we expect to capture at least a decline of efficiency scores after the crisis.

Findings of Gawellek and Sunder (2016) regarding the Excellence initiative\(^1\) or Brown, Dimmock, Kang, and Weisbenner (2014) regarding donation deductions show that systems react to both, positive and negative stimuli. Also applying DEA, Sav (2016) analyses descriptively the effects of the crisis on US-American universities’ efficiency. The results show a decline in the scores caused by the crisis, and that over time universities seem to very slightly gain efficiency (2010/11), followed by a new decline in the latter period (2012/13). Considering the nature of different directions – positive rewarded incentives (Gawellek & Sunder, 2016) vs. negative budget cutting (Brown et al., 2014; Sav, 2016) – it is interesting, that the strongly differing US-American and German system seem to experience similar effects.

Thus we expect that the economic crisis influences efficiency in general negatively.

\textit{Decentralization versus Centralization}

Political economy approaches outlined the benefits and costs of (de)centralization focusing on the provision of local public goods and corresponding conflicts of interest. Basically, the following arguments were put forward in favor of decentralization: (i) decentralized governments (in our case German federal state government that is responsible for higher education) understand better local interests and preferences and thus, are more efficient in allocating resources (meaning financing, staff,…); (ii) decentralized governments can be made more accountable for their actions, are monitored more directly by elections and thus, are reliant

\(^{1}\) German federal and state governments launched the Excellence Initiative in 2005 to support outstanding research and to enable selected universities competing worldwide.
on public good providers (namely universities) to act more efficient; (iii) other states might benefit from experiments that can be introduced on a smaller state instead of country level\textsuperscript{2}.

However, for the first two arguments a major problem is detected in restricted or limited information for the state’s government which might lead to opportunistic behavior on the side of universities (Lockwood, 2006; Oates, 1972). Another drawback of this view might be the underestimation of allocation spillover effects that not only occur on regional levels but also in a broader scope.

For the case of universities we assume that the decentralization benefits for governments especially in terms of efficiency – preference-matching and accountability – might not fully unfold due to the constancy of the public goods provided by universities and their bureaucratic institutional character as well as due to a dispersed decision making. First, the provision of teaching and research (innovation upcoming) is relatively homogenous in terms of pure provision – not quality – and thus, accountability in terms of good provision is more or less secured. Second, preferences in terms of universities do not vary much across federal states: most wish to have international competitive universities and institutions for the “general supply”. Especially in countries with comparably small distances a country-wide oversupply and corresponding inefficiency might be the consequence – in our case Germany.

In the German decentralized university system we assume that universities have a stronger negotiation power regarding financial resources due to a less informed negotiation partner in the states’ ministries (the federal states in Germany manage at a minimum one and at a maximum twelve universities). Consequently, decision makers are subject to incomplete contracts, asymmetric information and bounded rationality (Simon, 1959, 1972; Williamson, 1973). This results in universities having a better opportunity to negotiate, to enforce their own

\textsuperscript{2} (iv) The competition argument is in this university context obsolete, as universities would not move within states.
interests in a decentralized system and ultimately have room for opportunistic behavior. The interest of university managers is not necessarily being efficient – as this is not a compulsory task of universities – but allocating resources to “fun” activities like research excellence or prestigious study programs that are usually quality related as well as time- and money-consuming (Leitner, Prikoszovits, Schaffhauser-Linzatti, Stowasser, & Wagner, 2007).

In other words, federal states might have an advantage by knowing about local interests within their states but are relatively loose from the other states which leads to oversupply. Additionally, the actors are subject to asymmetric information allowing an eventual opportunistic behavior by universities. Both points could result in an poorly informed incentive strategy that is realized in the respective state but not cross-borders.

An advantage of centralization can be inferred by perspectives that are suggested by Besley and Coate (2000) who point out that costs of centralization are considered to be the search of a “one fits all” solution and insensitivity of local needs while decentralization costs information and speed of uniform implementation. We argue that (i) a “one fits all” solution does not necessarily mean that everyone receives the same but rather that districts are considered diverse and supported according to their needs, short: flexibility, and (ii) the insensitivity to local needs is solved by representative democracy: each district is represented in the central government by their elected representatives, consequently the interests of localities are considered and this is combined with the advantage of central information. However, we acknowledge that this might lead to new conflicts of interests that result in winning of minimum coalitions and uncertain misallocation (Besley & Coate, 2003).

Centrally organized systems like Italy benefit from better and more direct steering possibilities due to a faster response time, wide ranging implementation competence and less asymmetric information. The authority collects aggregated information of universities centrally and negotiates with universities on this basis. This makes it easier to distribute resources equally or
unequally if one knows about all the other actors, here universities, their prerequisites, possibilities and negotiation subjects. This implies that obtaining reliable information is beneficial to prevent opportunistic behavior. Centralized governance simply makes it possible to follow a macrosocial approach rather than an scattered one. To generate a comparative advantage in the global competition we assume that a centralized system would strategically specialize the respective universities in its system generating efficiency effects. However, this is in the European-Continental context bound to the principle of unity of research and teaching which is different e.g. to the Anglo-American systems. The before mentioned strategy might be implicit by actions of decision-makers or explicit by a specific planning process (Porter, 2008). Thus, we assume that a decentral governance of universities results in less efficiency compared to a central governance.

State- versus Market-orientation

In the context of university systems and their reactions to exogenous shocks, we look to the before outlined general system arrangement (centralization / decentralization) and the orientation towards state- or market-based policies wich might help to handle disadvantages in the efficient allocation of ressources of (de)centralized systems. We will include ideas that are named differently but express in our purpose the same: state-orientation includes and is in our understanding synymous for hierarchical organizing (Williamson, 1991) which requires cooperation (Roberts, 2007) often resulting in a long-term planning strategy; market-orientation fosters initiative which is outlined by Roberts (2007) and characterized by flexibility. Roberts (2007) describes the mentioned mechanism in a firm environment what we transfer to the university system: Firm managers as well as politicians determine by choosing a strategy how much of initiative (focus of reliance on the individual institution) and how much of cooperation (focus of reliance on the state) is deliberate.
State-oriented organizing is characterized by e.g. on the one hand long-ahead global budget planning and a connected reliance on future income and on the other hand bureaucratic, static processes and comparably slow decision making. According to Williamson (1991) they are benefitting from strong administrative control and coordinated adaptability (if bilateral dependency exists). This model can only generate a weak effect intensity of incentives and shows disadvantages compared to market mechanisms if it comes to situations in which unilateral dependency – the usual case in a state-university relation – occurs.

The state-oriented case can be observed in the German system where budgets are negotiated on a 3-5 years basis. Although, performance agreements are mostly installed they remain vague and act often more as a guideline (der Smitten & Jaeger, 2012). An adjustment is barely possible if an exogenous shock like the financial crisis comes up. Concerning the effects of the crisis on this trend the first outcome is like the null-hypotheses – the financial crisis shows no effect on the efficiency scores of universities, i.e. there is no change in the management of universities caused by the treatment effect market-orientation and centralization. Either because budgets, routines and processes are strongly path dependent and could not be changed immediately, confirming the bureaucratic and static view of public universities. Or because the output of universities was adjusted to the previous change in input measures. Especially for the inert German university system this seems valid with the exception of third-party funds by industry that constitute a very small share of total funds (Berger & Stenke, 2011). Although decentralization is considered as factor of local implementation rapidity, the coordination between states and central government, the strong dependency on state funds and the comparably fast economic recovery results in a relatively stable setting. Thus, Germany is seen as a relevant reference group for testing the hypothesis with the difference-in-differences estimation.
A market-oriented organization is on the one hand quicker in decision implementation because they apply situation-specific incentives and it enhances competition amongst institutions, e.g. by introducing performance-based contests. On the other hand market-orientation might cause pressure by making institutions feel as if they were walked by performance indicators. Turning to the opposite argument of Williamson (1991) market-orientation would lead to a loss of administrative control, difficulties in adapting to externalities and strong power of incentives. Market mechanisms are expected to lead to a better institutional performance as long as externalities do not play an important role, otherwise, cooperative or hierarchical mechanisms are needed to overcome efficiency lacks (Roberts, 2007).

Italy turned in the last decades from a state-oriented to a market-oriented system by the introduction of market mechanisms like performance-base funding formulas (Cattaneo, Meoli, & Signori, 2016; Donina et al., 2015). The market-oriented policy can overcome some problems of centralization and vice versa. Namely, when it comes to externalities and corresponding bureaucracy of a centralized system which might be solved by adjustable measures. Less asymmetric information in a centralized system can to some extent counteract the need for cooperation that is needed for becoming efficient.

Thus, the financial crises could lead to an increase in the efficiency level. A connection of financial support to performance outcomes in research and teaching forces the management to allocate the scarce resources in a more efficient way, i.e. reducing organizational slack or X-inefficiency or a shift towards those units which are the most critical for the output. This effect could e.g. be found in the European airline industry that had to deal with several shocks but steadily improved due to changing business models and reduction of inefficiencies (Duygun, Prior, Shaban, & Tortosa-Ausina, 2016).

Thus, we expect that Italy develops regarding efficiency better after the crisis than Germany.
Environmental Factors

Further, changes in efficiency could vary according to different institutional and environmental settings observed in economically weaker and stronger regions (Agasisti & Pérez-Esparrells, 2010; Agasisti & Pohl, 2012). Lehmann and Menter (2015) show the co-evolutionary development of universities and their environment. Broad parts of previous research in a European context showed the positive impact on efficiency of being located in an economically stronger region (Agasisti & Johnes, 2010; Agasisti & Pohl, 2012; Kempkes & Pohl, 2008, 2010; Warning, 2004). However, the Anglo-Saxon system is considered to benefit from a more specified university system that allows to identify comparative advantage easier and to build on a group-specific strategy (Agasisti & Johnes, 2009; Lehmann & Warning, 2004). Presumably, this also leads to size effects that could not be traced in a one-system study for the UK (Lehmann & Warning, 2004) but were outlined in a UK and Italian comparison (Agasisti & Johnes, 2009). The Continental European context shows that economic endowment as well as size should be considered (Agasisti & Pérez-Esparrells, 2010; Agasisti & Pohl, 2012). Conversely, it is interesting that in an extremely state-governed environment like China weaker regions are operating on a higher efficiency level and further improve over time (Chu Ng & Li, 2000). Chu Ng and Li (2000) explain this with the pace of economic development and the effort by the government to make economically weak regions competitive. As Continental-European systems are more state governed than e.g. the Anglo-Saxon systems it seems reasonable to control for economic development. We expect regions with bigger growth and less unemployment to influence efficiency positively.

Institutional Factors

Institutional factors determining a university include the size of a university, the composition of faculties, especially the existence of a medical faculty, as well as the international reputation (e.g. Agasisti & Pohl, 2012; Bonaccorsi et al., 2006; Kempkes & Pohl, 2010).
Size as determining factor by economies of scale and scope might be explained by various arguments concerning all three missions. We would expect an inverse U-shaped relation with efficiency for several reasons: Firstly, the efforts required to fulfill e.g. the teaching mission is not proportionally growing as one teacher might set mostly equally efforts to teach fifty or hundred students. Small classes require relatively more administrative effort per students than medium sized classes resulting in inefficiencies, big classes of up to 1.000 students require fixed resources and increased administrative effort. Secondly, the indivisibility of production technologies described by Roberts (2007) similarly applies to universities. Most fields require a minimum of facilities to deliver decent research, innovation and teaching which cannot be split flexibly according to actual needs, e.g. research equipment, human capital, laboratories, classrooms and so forth. Thirdly, the administration as secondary or supportive activities might benefit only to some extent by scale effects, e.g. small universities may not be fully exploiting administrative staff while big universities are expected to create inefficiencies by a bloated administration. Bonaccorsi et al. (2006) provide a comprehensive discussion on scale effects in universities.

With regards to size we observe mixed evidence: Agasisti and Johnes (2009) assume descriptively the size to be a factor of efficiency as Italian universities are comparably bigger but less efficient than smaller, more specialized UK universities. They trace this to scale effects that small universities benefit more from than large universities that already exhausted them. Wolszczak-Derlacz and Parteka (2011) find contrary results by including UK and six Continental European countries showing that bigger universities tend to be more efficient due to positive scale effects. When considering licensing and R&D income, Caldera and Debande (2010) show for Spanish universities a robust positive effect of university size which might be due to beneficial signaling effects in the attraction and innovation process of bigger universities. By using nonparametric methods Bonaccorsi et al. (2006) show no effects of scale
and scope for universities. What they have in common is that they assume a linear trend. Based on the assumptions above and in accordance with the at first sight contradictory evidence of previous research, we will control for an inverse U-shaped relation of university size.

Medical faculties show a more homogeneous picture as having – in general – a negative effect on university efficiency due to the augmented financial requirements, administrative peculiarities and presumably also because of the size of universities that have a medicine faculty (Agasisti & Pohl, 2012; Chapple, Lockett, Siegel, & Wright, 2005; Kempkes & Pohl, 2010; Wolszczak-Derlacz & Parteka, 2011). However, Caldera and Debande (2010) show the positive effect a medical faculty can have on R&D contracts. Based on findings in DEA settings that combine research and teaching we expect a negative relation to efficiency. In general, it is important to notice that a medical faculty and size of a university correlate on a moderate level (in our dataset 0.51) which might lead to an overemphasis.

The aspect of international reputation has not been employed for the evaluation of university efficiency yet. This might be due to the criticism on rankings as such but also because rankings are considered being just another way of evaluating universities. In fact, G. Johnes and Johnes (1993) find little correlation between the efficiency of departments and a research ranking of the University Funding Council. However, the more criticism arises the more attention rankings get and this leads to our give-and-take assumption: like a self-fulfilling prophecy, the ascription of quality by rankings ensures to attract e.g. higher qualified research and teaching personnel, better students and of course, more prestigious industry relations and thus, serves as a quality indicator (Daraio, Bonaccorsi, & Simar, 2015). This is important to understand the relationship of efficiency and quality that might compensate or enrich each other. Especially, one could expect that becoming an university with very high reputation is cost-intensive and thus, might have negative effects on efficiency in the short run and positive effects in the long run (Gawellek & Sunder, 2016).
4. Dataset and methodology

Our empirical analysis relies on a dataset comprising 133 public universities, of which 73 public universities in Germany and 60 public Italian universities. From the full list of German and Italian universities, we excluded specialized universities, like those only focusing on arts, like music or theatre or those turning from private to public university in the respective timeframe. The dataset is in a balanced panel structure ranging from 2006-2011. We follow previous literature and characterize universities by different input and output variables, like the number of graduates, staff or financial endowment, as provided by the Federal Statistic Office Germany and the Italian Ministry for University and Research. Performance measures like publications or patents were extracted from Scopus. Eurostat provided control variables for the regression analysis like GDP per capita (Purchasing Power Standard) and unemployment rate by NUTS-2 level. The variables, their sources and descriptive statistics are depicted in table 1 for the DEA variables correlations of our control variables are shown in table 2.

Our approach is a two step analysis by using DEA in the first and a regression analysis in the second step. For our DEA analysis we define output variables according to previous studies and the three missions of universities: teaching measured by graduates, research measured by publications and the third mission measured by patents (Acs, Anselin, & Varga, 2002; Agasisti & Pohl, 2012; Charnes et al., 1978; Toutkoushian, Porter, Danielson, & Hollis, 2003; Warning, 2004). A difficulty of using DEA is that zero values cannot be handled properly. Some universities do not generate patents or publications in some points of time in the observed timeframe. We orientate on Sueyoshi and Goto (2013) and Thompson, Dharmapala, and Thrall (1993) and add a small number (0.1) for zero values. As our main goal consists in measuring the efficient translation of state efforts to the three missions, we will use state funding as an input (Agasisti & Pohl, 2012; Kempkes & Pohl, 2010). The output-oriented constant returns to scales assuming models is described by Charnes et al. (1978):
The retrieved scores range from 0 being not efficient to 1 being on the efficient frontier. So the formula is subject to:

\[
\sum_{r=1}^{s} Y_r u_r \leq 1
\]

with \( v_r, u_i \geq 0; i = 1, 2, \ldots, m; r = 1, 2, \ldots, s; j = 1, 2, \ldots, n; \)

\( u \) and \( v \) are determined most beneficially for each DMU to be on or reach the efficiency frontier.

We will make use of the basic CCR model with output-orientation, which is the optimization of output at a given input, assuming constant returns to scale (Charnes et al., 1978; Cooper, Seiford, & Tone, 2006; Lehmann & Warning, 2002).

\[
\min_{u_r, v_i} \sum_{i=1}^{m} x_{i0} v_i
\]

Subject to:

\[
\sum_{r=1}^{s} Y_r \mu_r = 1
\]

\[- \sum_{r=1}^{s} Y_r j \mu_r + \sum_{i=1}^{m} x_{ij} v_i \geq 0
\]

And \( \mu_r, v_i \geq 0 \)

As we draw on longitudinal data we will further outline the Malmquist index, which is indicating the productivity change over time, and its decomposition to the pure efficiency change and to the technical change as proposed by Färe, Grosskopf, Norris, and Zhang (1994).

The Malmquist index is defined as (Färe et al., 1994):

\[
M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left( \frac{D_b(x^{t+1}, y^{t+1})}{D_b(x^t, y^t)} \right) \left( \frac{D_o(x^{t+1}, y^{t+1})}{D_o(x^t, y^t)} \right)^{1/2}
\]
The pure efficiency change describes the relative change of the distance from the efficiency frontier and is decomposed by the first part of the index:

$$\text{Efficiency change} = \frac{D_i^{t+1}(x^{t+1},y^{t+1})}{D_i^t(x^t,y^t)} \quad [5]$$

The technical change of efficiency is the relative potential for productivity increase, in other words the frontier shift change or innovation potential. It is described by the second part of the index and unraveled by the first part indicating the shift of frontier as such and the second part indicating the shift of DMU in $t$ (Färe et al., 1994; Grosskopf, 2003):

$$\text{Technical change} = \left[ \frac{D_i^t(x^t,y^t)}{D_i^{t+1}(x^{t+1},y^{t+1})} \right]^{1/2} \quad [6]$$

If the productivity is increasing the indices will take values $> 1$, if productivity decreases indices will take values $< 1$. A value of 1 indicates no change which does not necessarily mean no change in components but in terms of Malmquist, pure efficiency or technical change (Färe et al., 1994).

Based on the retrieved CCR efficiency scores we apply difference-in-differences estimation methods with the financial crisis as an exogenous event or treatment effect (Angrist & Pischke, 2014; Lehmann & Menter, 2015).

$$\text{DEA}_{i,t} = \beta_0 + \beta_1 \text{Treatment group (Italy)}_{i,t} + \beta_2 \text{Treatment period (2008-2011)}_{i,t} + \beta_3 \text{Treatment effect (Italy/2008-2011)}_{i,t} + \beta_4 \text{Hospital}_{i,t} + \beta_5 \text{University size}_{i,t} + \beta_6 \text{University size}^2_{i,t} + \beta_7 \text{Shanghai100} + \beta_8 \text{Regional development,} + (\alpha_t + \epsilon_{i,t}) \quad [7]$$

In our estimation the reference group is Germany (0) whereas the treatment group is Italy (1). The treatment period “economic crisis” is starting in 2008. The treatment effect is the interaction of the treatment group Italy during the treatment time 2008-2011. Our first model
will focus on this national treatment effect and the second model will additionally include our control variables. As previous studies suggest, we control for university hospital (Agasisti & Pohl, 2012; Warning, 2004), the size of university (students and students², in order to control for non-linear effects of size) (Agasisti & Pérez-Esparrells, 2010; Kempkes & Pohl, 2008), being in the top 100 universities in the Shanghai ranking as a measure of prestige, the type-specific workload of professors (student/professor) and for the economic development of the region (growth rate of GDP/capita and unemployment rate on NUTS2 level) (Agasisti & Pohl, 2012; Kempkes & Pohl, 2010).

Our estimates are based on panel regressions. We will firstly use the random-effects panel regression that is capturing the country effect [7]. This implies that unobserved heterogeneity (\(a_t\)) is uncorrelated with the observed characteristics and thus, component of the residues (\(\varepsilon_{i,t}\)). Additionally, this allows us to control for time consistent variables in contrast to the fixed-effects model like country, one of our main interests. To test for robustness we employ and contrast our results by two different regression models: a two-stage fixed-effects and a cluster-robust OLS estimation (results can be found in the attachment).

For the two-stage-fixed-effects model we (i) estimate the fixed-effects regression which is obviously not possible for our time-invariant variables like country and university hospital. The country effect is a strong determinant in our models. As unobserved time-invariant factors are considered to enter the error term (\(\varepsilon_{i,t}\)) we (ii) predict the error term and regress as a second step our time-invariant variables on \(\varepsilon_{i,t}\) (applicated similarly e.g. by Froehlich, 2016).

As a second robustness check, we use an OLS estimation with cluster-robust standard errors. This allows to consider errors that exist and correlate within a cluster – in our case one university across each observation period – but is uncorrelated across clusters (Cameron & Trivedi, 2009).
5. Results and discussion

We first derive the efficiency scores using DEA techniques. Figure 2 depicts the trends and standard deviation for German and Italian universities showing that Italian universities are in general more cost-efficient than German universities in transforming public resources into outputs.

Our results show that German universities lose consistently efficiency starting from 2008. This results partly contrast with the results of Agasisti and Pohl (2012), though their selection of inputs differ from our analysis, focused on efficient translation from state funds. The financial measures for the Italian system were in relation considerably lower while outputs were relatively on a similar or higher level than for the German system which causes less efficiency for the latter in terms of cost efficiency. The constant improvement of Italian universities could be driven by a decreasing input of state funds compared to the steady input level of German universities. Indeed, following the financial crisis at the end of the years 2000’, the cuts to government funding for higher education systems have been particularly severe in Italy, up to a -16% inflation-adjusted change between 2010 and 2013 (European University Association, 2016). The Italian development is more dynamic first decreasing, then increasing and stabilizing efficiency before decreasing again. However, only slight changes appear which seems reasonable in the higher education context.

Figures 3, 4 and 5 display the geometric means of the Malmquist index, the pure efficiency change as well as the technical change (Färe et al., 1994). What becomes obvious is that Italy and Germany had fairly similar levels of overall productivity change before the crisis but drifted
apart afterwards. After deteriorating under 1.0 Italy recovered and held the recovery at an improving level. German universities could trace this improvement in 2009 but deteriorated again in the following years. This can be traced back to post-crisis reforms that forced Italy to adjust processes in order to meet e.g. performance requirements given by the budget formula.

[INSERT SOMEWHERE HERE FIGURE 3]

If we consider pure efficiency change in terms of improvement we look at the shift the DMU made according to the efficiency frontier over time (Figure 4). We can identify that Italian universities moved more and more closer to the efficiency frontier while Germany universities lost position which is followed by a recuperation. Scoring mostly over 1.0 Italian universities caught up to the frontier continuously, however with more and more reduced speed. German universities at the contrary score under 1.0 (except for 2008) and thus, lost position with respect to the efficiency frontier over time compared to Italian universities. The main drop is registered in 2009 when also the minor up going trend of CCR scores reversed to a slight but steady decrease. We see this as the difficulty of coping with a non-changing setting that is confronted with the elevating Italian counterparts that could not be chased in Germany.

[INSERT SOMEWHERE HERE FIGURE 4]

Färe et al. (1994) interpret the technical change as the “evidence of innovation” displaying the relative potential of an increase in productivity due to technical change. Basically, this means an expansion of the frontier generated by the connected reallocation of activities based on the
input of state funding towards the measured outputs (Thursby & Kemp, 2002). In this part of the decomposition, Italian universities experience on average a deteriorating phase in 2008 but recover steadily. German universities seem to develop better than Italian ones (also in the general dropdown in 2008) until 2009 but then deteriorate again in 2010.

In Table 3 we present our empirical results for the influence of the economic crisis on Italy and Germany using random-effects panel regression (table 3). The two-stage fixed effects (table 4a and 4b) and cluster-robust OLS (table 5) estimations substantiate the robustness of our core results:

The country effect is most influential and highly significant what seems reasonable looking at the DEA scores in Figure 2. This means that Italian universities are significantly better in terms of cost efficiency than German universities. The crisis as such taking place from 2008-2011 does not show a general impact (unless a significant negative impact in the cluster-robust estimation). The treatment effect, meaning the interaction of Italian universities during the crisis, is significantly positive and robust in both models and all estimations. In the cluster-robust estimation this effect becomes even stronger by including our control variables. This indicates that Italian universities coped better during the crisis than their German counterparts at a highly significant level.
Although austerity might have had negative effects in other fields, the introduction of various higher education reforms in Italy influenced the development of the cost efficiency of Italian universities positively. The implementation of competitive funding mechanisms with the Valutazione triennale della Ricerca, VTR, in 2003, and more recently the Valutazione della Qualità della Ricerca, VQR, in 2011, affected the strategic behavior and research productivity of universities significantly (see Cattaneo et al. (2016) for an analysis of the reforms). Through the so-called Gelmini Reform in 2010 steering got even more tightened and marked a turn away from the classical European continental model (for an in-depth analysis see Donina et al. (2015)). Those reforms led in particular to a massive change in the governance framework. Even though, Germany introduced e.g. the Exzellenzinitiative to provide additional funding by federal government and states, a non-performance or non-participation did not have consequences on the general funding process. While the German system is decentralized and steering on a state level with a guaranteed autonomy for universities, the Italian system is centralized and changing from this “steering at a distance” to “tightening regulation” (Donina et al., 2015). In terms of efficiency, the Italian system created an advantage by introducing competition-oriented measures compared to the relatively stable and more classical European continental German system.

However, the Shanghai ranking e.g. is outlining the quality or at least international visibility of a university in the global competition. The cluster-robust estimation (table 5) shows a highly significant negative impact of being a Top 100 Shanghai university. We assume that this could hint at the distinct trade-off in higher education because cost-effectiveness considerations and the production function differ from private enterprises: Cost efficiency is not necessarily connected to mastering global competition on research and teaching. One has to invest to “create” world’s leading universities. However, those results are not robust in the other models. In this context, further research should focus on the usability of installing the Exzellenzinitiative
that aimed at establishing German universities that are globally competitive – also in an international context.

Further, we find the negative influence of hospitals on university efficiency which is widely discussed in literature, however, this result is not robust. Even though, signs for the size effect are coherent with the expected inverse U-shaped relationship, we do not have enough empirical evidence to support this hypothesis. Results are also suggesting a significant small negative effect of the student/professor ratio. This could indicate that the workload of professors in terms of teaching activities is connected to the efficiency performance of universities. The reallocation of efforts towards the measured outputs could explain this relationship. Surprisingly, regional factors are found not significant in our estimation. This might be explained by a strong country effect catching already e.g. unemployment or growth of GDP/capita.

6. Conclusions

The focus of this study is to empirically estimate whether and how public universities in Germany and Italy were affected by the financial crisis in 2007/08. We use DEA techniques to shed light on the efficiency of universities in both countries and employ difference-in-differences estimation models to discover the influence of the financial crisis. Using a unique panel data set covering all public universities in Germany and Italy from 2006-2011, our results strongly point out that the efficiency of universities is significantly shaped by the national governance structure. While universities in Italy are in general under the authority of the government, their individual negotiation power strongly depends on their individual strength and endowment. This seems to shape efficiency positively in times of relative uncertainty like the financial crisis. In contrast, universities in Germany, which are under a federal authority, but less independent in their negotiation power suffer more during the economic crisis in terms
of efficiency. To put it another way, reforms and restructuring during the financial crisis caused Italian universities to cope better during the crisis than their German counterparts in terms of efficiency. Finally, we find university characteristics as influencing university efficiency while environmental endowment does not show significant results.

Does this mean that German university budgets should be cut? The uncomfortable truth is that either cutting input or improving output would be mandatory if the aim is to become efficient. For responsible politicians this means that either they cut budget and risk to destroy existing production processes or they encourage universities to change underlying processes to generate more output, e.g. by providing incentives. The Italian way shows that the introduction of market-oriented mechanisms helped to change to more efficient production processes which ultimately lead to a more flexible reaction to an exogenous shock. With the introduction of the Excellence initiative one step towards this direction has already been made without ultimate sanctioning those not willing or able to adjust – which might be more socially acceptable.

While the effects of the Excellence initiative on efficiency have already been investigated in a national comparison (Gawellek & Sunder, 2016) this perspective cannot really catch how already excellent universities would have developed without becoming excellence university. Additionally, further research should include e.g. the Netherlands to contrast the results with another decentrally organized system that is market-oriented and e.g. France that is centrally organized and state-oriented in order to get a better understanding for the interplay of governance scope and orientation (see Figure 1).

In this context, a discussion of politicians, university managers and society on if, how and why efficiency should play a role in Higher Education is overdue. Not only quantity also excellence and the price of excellence should be regarded in efficiency research. Especially, the role of quality in research and teaching as a factor that is cost-intensive should be considered as ranking data might not have caught excellene sufficiently.
Our study provides first results analyzing whether and how a financial crisis affects public universities. However, the study is characterized by several potential limitations, like the omitted variable problem, or the miss-specification of the estimation techniques. We do not find – as previous studies suggest – an empirical evidence for the assumption of a disadvantage of unemployment or the growth of GDP per capita. However, this might be due to the underestimation of structural regional effects that cannot be captured by the employed variables or were already caught by the country dimension. The gap of South Italy to North Italy as well as of East Germany to West Germany is still evident. Being located in Southern Italy or Eastern Germany implies not only a stronger need for development and financial support but also the difficulty of attracting e.g. research funds of nonexistent short-distance companies. Independent regions of Italy do also play a role due to their specific character and organization that is similar to the federal states approach of Germany. Those structural and institutional differences should be considered for further research.
7. Bibliography


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Chu Ng, Y., & Li, S. K. (2000). Measuring the research performance of Chinese higher education institutions: an application of data envelopment analysis. Education Economics, 8(2), 139-156.


8. Tables and Figures

<table>
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<th>Orientation</th>
<th>Scope</th>
<th>Centralization</th>
<th>Decentralization</th>
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<td></td>
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Figure 1: Comparison of systems according to governance orientation and governance scope. [] indicate countries that are not

![Figure 2: Trends of mean DEA scores of Italy and Germany including standard deviation 2006-2011. Source: Own calculations using MaxDEA. Data Basis: Federal Statistic Office Germany; Italian Ministry for University and Research; Scopus.](image-url)
**Figure 3**: Trends of Malmquist Productivity Change of Italy and Germany 2007-2011. Source: Own calculations using R. Data Basis: Federal Statistic Office Germany; Italian Ministry for University and Research; Scopus.

**Figure 4**: Trends of Malmquist Efficiency Change of Italy and Germany 2007-2011. Source: Own calculations using R. Data Basis: Federal Statistic Office Germany; Italian Ministry for University and Research; Scopus.
Figure 5: Trends of Malmquist Technical Change of Italy and Germany 2007-2011. Source: Own calculations using R. Data Basis: Federal Statistic Office Germany; Italian Ministry for University and Research; Scopus.
Table 1: Descriptives

<table>
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<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Obs.</th>
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<td>315,978</td>
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Sources: ¹ Own calculation (MaxDEA) ²Federal Statistic Office Germany; Italian Ministry for University and Research ³Scopus ⁴Eurostat

Table 2: Correlations

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### Table 3: Regression Results

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<thead>
<tr>
<th>Diff-in-Diff</th>
<th>CCR Efficiency</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group (Italy)</td>
<td>0.39*** (0.03)</td>
<td>0.34*** (0.04)</td>
<td></td>
</tr>
<tr>
<td>Treatment Period (2008-2011)</td>
<td>-0.01 (0.01)</td>
<td>-0.01 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Treatment Effect (Nation x Crisis)</td>
<td>0.06*** (0.01)</td>
<td>0.06*** (0.01)</td>
<td></td>
</tr>
</tbody>
</table>

#### University characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>-0.06** (0.03)</td>
</tr>
<tr>
<td>Students</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td>Students²</td>
<td>-0.00* (0.00)</td>
</tr>
<tr>
<td>Students/Professor</td>
<td>-0.00** (0.00)</td>
</tr>
<tr>
<td>Shanghai Top 100</td>
<td>-0.03 (0.03)</td>
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</tbody>
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#### Regional factors

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Growth GDP/capita</td>
<td>-0.07 (0.05)</td>
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<tr>
<td>Unemployment</td>
<td>0.00 (0.00)</td>
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<table>
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<th>0.40*** (0.05)</th>
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<tbody>
<tr>
<td>Number of observations</td>
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<td>798</td>
</tr>
<tr>
<td>Number of universities</td>
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</tr>
<tr>
<td>Observations per university</td>
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<td>6</td>
</tr>
</tbody>
</table>

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01; Random-effects panel regression

### Table 4a: Regression Results

<table>
<thead>
<tr>
<th>Diff-in-Diff</th>
<th>CCR Efficiency</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group (Italy)</td>
<td>omitted</td>
<td>omitted</td>
<td></td>
</tr>
<tr>
<td>Treatment Period (2008-2011)</td>
<td>-0.01 (0.01)</td>
<td>0.01 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Treatment Effect (Nation x Crisis)</td>
<td>0.06*** (0.01)</td>
<td>0.04*** (0.01)</td>
<td></td>
</tr>
</tbody>
</table>

#### University characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>omitted</td>
</tr>
<tr>
<td>Students</td>
<td>-0.00 (0.00)</td>
</tr>
<tr>
<td>Students²</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td>Students/Professor</td>
<td>-0.00*** (0.00)</td>
</tr>
<tr>
<td>Shanghai Top 100</td>
<td>-0.01 (0.03)</td>
</tr>
</tbody>
</table>

#### Regional factors

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Growth GDP/capita</td>
<td>-0.03 (0.05)</td>
</tr>
<tr>
<td>Unemployment</td>
<td>0.01** (0.00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cons</th>
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<th>0.61*** (0.06)</th>
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</thead>
<tbody>
<tr>
<td>Number of observations</td>
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<td>798</td>
</tr>
<tr>
<td>Number of universities</td>
<td>133</td>
<td>133</td>
</tr>
<tr>
<td>Observations per university</td>
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<td>6</td>
</tr>
</tbody>
</table>

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01; Fixed-effects panel regression
### Table 4b: Regression on residuals

<table>
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<tr>
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<th>Residuals</th>
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</thead>
<tbody>
<tr>
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<td>(3b)</td>
<td>(4b)</td>
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<tr>
<td>Treatment Group (Italy)</td>
<td>0.04*** (0.00)</td>
<td>0.29*** (0.03)</td>
</tr>
<tr>
<td>Hospital</td>
<td>-0.03 (0.03)</td>
<td></td>
</tr>
<tr>
<td>_cons</td>
<td>0.46*** (0.00)</td>
<td>-0.12*** (0.02)</td>
</tr>
</tbody>
</table>

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01; Generalized least squares random-effects regression

### Table 5: Regression Results

<table>
<thead>
<tr>
<th></th>
<th>CCR Efficiency</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>Diff-in-Diff</td>
<td>Treatment Group (Italy)</td>
<td>0.39*** (0.03)</td>
</tr>
<tr>
<td>Treatment Period</td>
<td>Treatment Period (2008-2011)</td>
<td>-0.01 (0.01)</td>
</tr>
<tr>
<td>Treatment Effect</td>
<td>Treatment Effect (Nation x Crisis)</td>
<td>0.06*** (0.01)</td>
</tr>
<tr>
<td>University characteristics</td>
<td>Hospital</td>
<td>-0.04 (0.04)</td>
</tr>
<tr>
<td></td>
<td>Students</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Students²</td>
<td>-0.00* (0.00)</td>
</tr>
<tr>
<td></td>
<td>Students/Professor</td>
<td>-0.00*** (0.00)</td>
</tr>
<tr>
<td></td>
<td>Shanghai Top 100</td>
<td>-0.06*** (0.02)</td>
</tr>
<tr>
<td>Regional factors</td>
<td>Growth GDP/capita</td>
<td>-0.09 (0.06)</td>
</tr>
<tr>
<td></td>
<td>Unemployment</td>
<td>0.01* (0.00)</td>
</tr>
<tr>
<td>_cons</td>
<td>0.30*** (0.02)</td>
<td>0.19** (0.08)</td>
</tr>
</tbody>
</table>

Number of observations: 798, 798; Number of universities: 133, 133; Observations per university: 6, 6

Cluster-robust standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01; Ordinary least squares regression