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## Property rights and transaction costs: The role of ownership and organization in German public service provision

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# DISCUSSION PAPER

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# Property Rights and Transaction Costs - The Role of Ownership and Organization in German Public Service Provision\*

Maria Friese<sup>†</sup>, Ulrich Heimeshoff<sup>‡</sup> and Gordon Klein<sup>§</sup>

February 2018

## Abstract

This paper provides evidence that ownership and organization matters for the efficiency of provision of public services. In particular, we find that pure private ownership is more efficient than pure public ownership, and public ownership is more efficient than mixed ownership. The delegation of management in different legal forms also has an impact, highlighting the importance of the design of the government-operator relationship. We apply a structural approach of production function estimation ensuring precise determination of total factor productivity for a panel of German refuse collection firms between 2000-2012. We project total factor productivity estimates on ownership and organization. Our results are in line with the trade-offs implied by the property rights literature and provide important policy implications regarding the organization of public service provision.

*Keywords:* productive efficiency, refuse collection, public service.

*JEL Classification:* D2, H1, L3.

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# 1 Introduction

For many decades, there has been an extensive public debate on the right provision of utilities and infrastructure, which are mostly acknowledged as basic tasks to be provided by the government and which are often subject to major externalities. While in the 1990s many privatizations were observed, for instance in the European telecommunications sector, there are plenty of current examples where the opposite, a renationalization of utilities and infrastructure has taken place. An example is New Zealand's railway, which was first privatized in the 80's and 90's and was then renationalized in the 2000s.<sup>1</sup> In Germany, the City of Hamburg's formerly privately owned electricity network was purchased back by the municipality following a public referendum.<sup>2</sup> Aside from policy debates of pure public or private ownership, there are persistent discussions on mixed ownership, such as public-private partnerships, which are aimed at equilibrating the advantages of private and public actors.<sup>3</sup>

An long discussion about these issues exists not only within the context of policy-making, but also in the academic literature. While the traditional view of economists generally favors private provision of services and utilities (Bennett and Johnson, 1979), there are influential papers showing that public provision of goods and services may lead to positive or negative outcomes depending on the characteristics of the service considered (Hart, Shleifer, and Vishny, 1997). Likewise – the empirical literature shows that, depending on the circumstances, private or public provision may be the most efficient (for a survey, see Villalonga, 2000).

Our paper adds to this literature by analyzing the efficiency of basic public services in Germany, considering the role of ownership as one important determinant. Several theories have been advanced to delineate in which situations private or public provision of services is optimal. These works are closely related to literature which seeks to explain what factors delimit the size of the firm (the classic make-or-buy decision). The property rights literature advanced by Grossman and Hart (1986), argues that when *specific rights* cannot be fully specified due to transaction costs, *residual rights* –

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<sup>1</sup><http://www.kiwirail.co.nz/about-us/history-of-kiwirail.html>

<sup>2</sup><http://www.hamburg.de/energiewende/4110666/ergebnis-volksentscheid/>. Within the German context, there are several other example of reversing previous privatizations, especially in the energy sector (Monopolkommission, 2014).

<sup>3</sup>For instance, there is a long tradition of Private-Public-Partnerships in the British health service, see [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/266818/07\\_PPP\\_28.11.13.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266818/07_PPP_28.11.13.pdf).

i.e. ownership of vertically dependent layers – can serve to influence decisions in cases where all actions cannot be laid out ex-ante. The importance of relationship-specific investments in production then determines the optimal organization of firms along the value chain.

The logic of the property rights literature has been used to analyze whether public services should be provided by the government or a private firm (Hart et al., 1997). Taking into account that real-world contracts are incomplete due to transaction costs, the authors derive scenarios under which either publicly or privately provided service is optimal. This is mainly determined by the underlying trade-off between the potential for cost reduction on the one hand and a possible deterioration in quality that may go along with this on the other hand. If quality may be harmed by an excessive incentive of cost reduction, public provision is optimal. On the other hand, if quality is contractible or its deterioration is not a big concern,<sup>4</sup> the case for private provision is higher since agency problems in public firms may be tackled.

Our study goes beyond purely looking at ownership by also taking into account additional aspects of productivity. An important determinant for productivity besides from ownership lies in the relationship between the government as the organizer and the firm. This may include, for example, how detailed service requirements are given to the firm, the precise role of the government and the firm in terms of control, organization and management, or the freedom with which a firm can make business decisions. We include these factors in the analysis by considering the legal status as an efficiency driver in addition to ownership, since legal form impacts government-firm relations in our setting. These are effects beyond those from pure ownership, such as corporate governance (Hart, 1995).<sup>5</sup> If we find productivity differences within publicly-owned firms, we may attribute this to the degree of contractual completeness or the informational “closeness” between firm and government, which are both influenced by legal status. We explain this in more detail in section 2.1.

We estimate a production function in value added using the technique introduced by Akerberg, Caves, and Frazer (2006) and project total factor productivity (TFP) derived

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<sup>4</sup>If quality is contractible, private firms have a strictly higher incentive for cost reduction as they do not require the approval of the government. The same will hold if quality is not too important. Quality in this context refers to what is demanded by the government (for example that all students receive a good level of education), not necessarily what consumers would be willing to pay for.

<sup>5</sup>We will use the term *institutional setting* to refer to those factors which are determined by the legal status.

from this function on ownership and legal status. This approach overcomes the classical endogeneity problem that exists when unobserved productivity is correlated with input choice by using moment conditions that are exogenous to the stochastic element of productivity. This is an advantage of our estimation procedure in comparison to former studies analyzing the public-private dichotomy. In our productivity equation, we control for factors that might be potentially correlated with ownership in order to obtain an unbiased estimate. Lastly, we perform a robustness check to make sure that our results are not driven by heterogeneity in output prices.

We utilize a unique self-created dataset for the German market for public services, which includes refuse collection and related services.<sup>6</sup> This sector is likely to have the outstanding feature mentioned by Hart et al. (1997, p. 1154), namely that the quality dimension seems to be less important than the reduction of costs. Therefore, the working hypothesis that pure cost efficiency (or its mirror, technical productivity) should be one of the main goals in the provision of these services is naturally justified. The dataset consists of firm-level information from 2000 to 2012 including 865 city-year observations from municipal firms operating in large German cities. The data allow us to analyze differences between public and private companies and hybrid forms where public and private partners jointly hold shares in the refuse collector. Moreover, we can distinguish between three different types of institutions (having different legal statuses) offering garbage collection. The first type is refuse collection under a government contract (contracting out), the second type is refuse collection by an independent municipal firm (delegation), and the third is refuse collection by the municipality itself (government provision). This particular setting allows us to separate the impact of the two different layers of agency costs on efficiency.

Many empirical studies have considered the role of ownership for different sectors. Considering the waste sector, recent meta studies include Bel, Fageda, and Warner (2010) and Simões and Marques (2012). However, there is little empirical work directly focusing on several layers of agency costs, i.e. the combination of ownership and organization jointly. Cullmann et al. (2016) include legal status in an efficiency analysis of energy supply companies and do not find any significant differences between them. In the context of waste disposal, Dijkgraaf and Gradus (2015) include measures that go beyond pure ownership by distinguishing between one-municipality firms and a number

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<sup>6</sup>The data consists of information gathered directly from German cities combined with data from the AMADEUS database.

of municipalities jointly forming an entity and do not find an effect on efficiency.

Our research provides us with two main results. First, private firms are unambiguously more efficient in operation. Maintaining that there is large potential for cost reduction in this sector,<sup>7</sup> this result confirms the claim made by Hart et al. (1997) who predict private provision to be superior because ownership leads the private manager to perform more cost reduction than a government employee. Further, we show that the same does not hold in situations where private ownership is only partial. Mixed firms in our sample perform worse in terms of efficiency compared to fully public firms, and even more so compared to private ones. The often-advocated advantage of semipublic firms, i.e. that they combine efficiency-enhancing motives of the private sector with the role of the government to prevent quality losses, may therefore not materialize.

Our second result concerns the importance of the organizational setting in which a firm operates. Here, we find that contracting out per se – discounting the ownership effect – and government provision perform equally well in terms of efficiency, while delegation to an independent municipal firm brings with lower efficiency. Further, we find that the degree of specialization negatively affects productivity, while population size has a positive effect. Our findings speak directly to how public services should be organized, which in turn may have important implications for consumer welfare.

The paper is structured as follows: The next section discusses the background of the German refuse collection market with emphasis on regulatory issues and structures ideas around TFP in public utilities. Section 3 presents our empirical strategy. In Section 4 we present and discuss the results and address their robustness. Section 5 concludes and presents some directions for future research.

## 2 Productivity of public services

### 2.1 Institutional background

Our study focuses on evaluating the performance of firms offering public services, with waste collection being a major business activity that all firms fulfill. Waste collection means picking up waste from households or firms and disposing of it, either by incineration or recycling. Most of the firms also fulfill other tasks relevant for the

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<sup>7</sup>For example, cost savings can be obtained by optimizing the route of collection vehicles, which leads to a decrease in fuel costs. Such an implementation would not affect the quality of collection for the consumer and might even lead to less disturbance by trucks in city traffic.



public infrastructure, for example city cleaning, drainage, (green) surface maintenance and management of cemeteries. The firms are effectively regional monopolies, as state-level laws prevent the presence of several operators. They do face competition on some segments of their activities, however.<sup>8</sup>

Public services in Germany are administered by municipalities or cities, which enjoy considerable autonomy in the way of organizing them. A city may choose, amongst others, the mode of execution (own provision/delegation), the involvement of private firms and the legal form of the operator. They may also influence the financing mix, e.g. by forming a semipublic company in which both parties invest a share of capital. In practice, we can observe much heterogeneity in the way public services are organized. The principal is thus the local authority (town hall) initiating the service, whereas the agent is the hired firm in charge of the actual provision. The actual remuneration of the firm depends on the organizational form it has. Roughly speaking, firms set prices for some business activities and get a transfer from the municipality for others. When final consumers can be identified (e.g. with refuse collection), individual consumer prices are indirectly set by the authority using a type of cost-of-service regulation and laws prescribe “cost-based prices” on the basis of past accounting costs (Klusemann, 1998). For tasks related to public infrastructure common to all citizens, the community sets an (internal) price which is passed on to the firm. For all services provided to private firms, prices can be set freely.

There are three basic organizational models, which we call contracting out, delegation and government provision.<sup>9</sup> Under contracting out, the municipality assigns all execution to a private-law (limited liability) firm, which can have public, private or semipublic ownership. The reason we classify it as contracting out is that the relationship between the city and the firm is formalized in a long-term contract (usually around 20 years). This contract includes the remuneration of the firm, defines the business relation and the service characteristics.<sup>10</sup> The reimbursement for all services provided to the public must legally be closely related to its costs. Contracts may be renegotiated, but

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<sup>8</sup>Regulation applies to the provision of tasks used implicitly or explicitly by private consumers. This includes, for example, refuse collection from private households, who are obliged to dispose of their garbage by using the service provided, but not from private firms, which can choose among several suppliers, so that the collector can freely charge prices.

<sup>9</sup>The legal implications of delegation are based on an overview provided by Institut für Fortbildung und Verwaltungs-Modernisierung (2016).

<sup>10</sup>The description of the institutional framework is based on the works by Hövelborn (2014) and Schulze Wehninck (2008), as well as a selection of publicly available contracts.

are usually fixed for some time, in which payments are adjusted to a general price index.

The second mode, delegation, occurs when a city founds a public-law municipal firm. In this case, the firm is not only operator, but also organizer: it sets fees, employs its own workers and may make independent business decisions. These organizational tasks are normally fulfilled by the city under contracting out and government provision. The precise division of responsibilities between firm and city is not as formalized as in the case of contracting out. Rather, the municipality intends to retain supervision by appointing local government members to the advisory board.

Third, government provision occurs when the firm is directly associated with the municipality and has the legal status of an owner-operated municipal enterprise. This implies that the firm's action is judicially not separable from it.<sup>11</sup> Importantly though, the firm has defined boundaries in terms of book-keeping and may hire its own workers. The same accounting rules apply to all types of firms so that data is comparable. Therefore, it is distinct from a public agency.<sup>12</sup>

There are thus some differences here with respect to the classical “make or buy” decision of the government that is analyzed in Hart et al. (1997). First, contracting out can also occur to a firm under public (or semipublic) ownership. Second, we distinguish between two different types of public provision, delegation and government provision, which differ in their managerial “closeness” to the city. In the former case, management and operation are outsourced to another public entity (even though the city has some final control rights), while in the latter, we can speak of classical in-house-provision as it has been used in the theoretical literature.

## 2.2 Empirical studies on public vs. private provision

The role of ownership for public services has created an abundance of literature (for a survey, see Megginson and Netter, 2001). Also, municipal waste collection has been considered in the literature as one example of a public service. Typically, the empirical studies estimate a cost function and analyze cost difference between private and public provision. Ownership as one determinant of production costs is generally treated as a binary variable, i.e. *private* includes all types of contracting-out agreement, whereas

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<sup>11</sup>For example, any contract the firm enters into is made in the name of the municipality.

<sup>12</sup>A “classic” public agency in Germany uses staff of the municipality and its financial planning is done within the city's overall budget. Further, accounting rules differ from the ones prescribed for other firms.

*public* provision occurs when the service provider is a municipality.

This type of analysis has been performed for several countries. Dijkgraaf and Gradus (2003) study the Netherlands using data from 1996 to 2007 and report cost savings of 15 – 20% from contracting out, and later reproduce the general finding using different data (Dijkgraaf and Gradus, 2007). Reeves and Barrow (2000) consider Ireland and likewise find significant cost savings from private provision (around 45%). Using Swedish data on 115 municipalities, Ohlsson (2003) finds no direct effect of public vs. private provision on production costs. An empirical study on Norwegian refuse collectors by Sørensen (2007) analyzes ownership effects between regular public companies and those jointly held by *several* municipalities and finds that the latter are less cost efficient than their one-municipality counterpart. He attributes this to the existence of higher agency costs for firms with several (municipal) shareholders.

Overall, a meta study on the difference between public and private provision conducted by Bel et al. (2010) for solid waste collection shows mixed results, with a slight tendency towards the superiority of private provision. However, many of the studies are characterized by small sample sizes and use estimation procedures that do not reflect the recent progress made in the estimation of total factor productivity (TFP).

We contribute to and improve this literature in several ways. First, we take into account the classic bias that occurs when efficiency is related to factor use by estimating TFP as the residual from the production using the procedure developed by Akerberg et al. (2006), which the previous studies estimating cost functions do not do. Second, we dig deeper into the role of ownership by analyzing the case of semipublic firms. Furthermore, we also address some productivity effects that may occur independent of ownership, but that are rather due to the precise organization of the firm. Lastly, we are analyzing unique panel data from Germany that has not been used in previous research. The results are also likely to apply in the context of other developed countries.

### **2.3 Organizational structure and productivity**

We proceed by summarizing theoretical arguments on the provision of public services. To do this, we draw on aspects that have been (explicitly or implicitly) discussed in the property rights literature by Grossman and Hart (1986) and applied to the public-private context by Hart et al. (1997). We complement the literature review by discussing the potential role of mixed firms for technical efficiency. When *organizational structure*

that the utilities display – of which ownership is one component – has an influence on production costs, such an effect will be mirrored in total factor productivity because of the duality between cost and production functions.

At the heart of the discussion about the provision of public services is the recognition that the delegation of a task invokes a relationship during which the goals of the principal (in this case the government) may not align with those of the hired agent. Classical agency literature is concerned with motivating the provider of a task in order to overcome problems of moral hazard and/or asymmetric information. From a pure incentives viewpoint, ownership plays no role, as both government officials and private firms need to be motivated to perform (Hart et al., 1997). The result rests on the assumption that contracts are complete and enforceable.

Considering the organizational forms discussed in section 2.1, the (local) government a) contracts out the service to a limited-liability company of public, mixed, or private ownership, b) transfers production and organization to another public institution, c) produces the service in-house by transferring the task to a municipal enterprise. It is not hard to argue that all organizational modes will exhibit some agency cost, whether the hired manager is a public official or represents a private firm.<sup>13</sup> Yet, private firms may perform better because they extenuate the agency problem, e.g. through threat of takeover, bankruptcy or the market for ownership rights (Villalonga, 2000). Ownership best serves to control managers if it is concentrated and direct, which is a main result of corporate governance theory (Fama and Jensen, 1983). Private firms in our sample generally have more concentrated ownership, whereas publicly-owned firms ultimately have citizens as their final owner.

An additional reason why private provision may be superior is when public services have high cost-saving potential and quality is not too important. In a seminal paper, Hart et al. (1997) analyze government make or buy decisions using a theoretical model to study privatization. The basic trade-off between public and private provision of a service hinges on a comparison of investments in quality and cost savings of the potential operator. Private companies tend to underinvest in quality, but are generally more cost efficient than public agencies. Government agencies invest more into higher quality than private companies, but fail to provide enough cost innovations.

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<sup>13</sup>For the case of a public firm, the key point here is that the hired (government) manager cannot be fully controlled by the (local) government. Even though politicians hold board positions at the municipal enterprise, they are not involved in day-to-day business operations, so that managers have discrepancy in their decision-making.

Arriving at this conclusion rests on the assumption that contracts are incomplete, i.e., that neither quality- nor cost innovations can be contracted upon ex-ante. In the case of government provision, the public manager is not being rewarded with the full benefits of cost and quality improvements. Under private provision, the firm is the residual claimant of cost-reducing effort because it owns the assets. Beyond that, Hart (2003) argues that cost advantages of private firms are further enhanced through lower costs of contracting. Interestingly, the case of garbage collection is mentioned explicitly by Hart et al. (1997, p. 1154), who argue that “the damage to quality resulting from the private contractor [...] is probably trivial”, reaching the conclusion that private provision would be superior.<sup>14</sup>

In this literature, joint ownership is not discussed very frequently. In reality, the mixed enterprise, where public and private partners jointly own and operate a company through a consortium, is observed often.<sup>15</sup> Such a form has been advocated by practitioners for relieving fiscal distress and improving operational expertise, while at the same time mitigating the risk of quality deterioration created by private ownership (Bennett, James, and Grohmann, 2000; Buso, Marty, and Tran, 2017). However, Estrin and Perotin (1991) suggest that potential conflicts between private and public interest may affect firm’s ability to perform efficiently.<sup>16</sup>

With respect to the role of ownership in our empirical analysis, we might expect a positive effect of private ownership, supported by the theoretical and empirical literature presented here. There is no such predisposition towards mixed firms, because they are rarely considered as their own category in empirical studies. Any potential effect on their role is highly policy relevant because the costs and benefits of private involvement in public firms is a frequent point of debates. Further, our analysis will later reveal whether there are productivity differences *within* publicly-owned firms due to their precise legal form and corresponding internal organization.

Our brief survey of the theoretical and empirical literature on public versus private ownership and managerial practices shows that both matter. The literature is still

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<sup>14</sup>One can imagine that for other sectors this is not the case. In water provision for example, where quality is probably more important, Wallsten and Kosec (2008) do not find an effect of ownership on performance.

<sup>15</sup>Such mixed enterprises (also called institutional PPP), have a dominant share of public ownership in our sample and are characterized by the sharing of risk and profit.

<sup>16</sup>A related point is made in a theoretical contribution alluding to potential problems between partners of a consortium arising from imperfect monitoring capabilities, essentially an agency conflict within a firm (Martimort and Pouyet, 2008, p.400). See also Schmitz (2001), who analyzes partial privatization and finds that it may be the optimal mode of provision in some cases.

ambiguous as to whether public or private provision is more efficient, but there is a tendency towards superior efficiency of the private offering. Gains in efficiency are generally not solely related to privatization, but also to changes in organizational structure and management practices, which often differ significantly between public and privately-organized organizations. In empirical studies very often only one of these determinants is analyzed with respect to its effect on efficiency. However, we can test both aspects by including institutional setting separately from ownership.

### **3 Empirical strategy and data**

We consider that in the long run, firms' objective is profit maximization, given the required service provision by the municipality. Therefore, we estimate a production function where the obtained residuals measure deviations from optimal behavior, i.e. the firm's technical efficiency. The impact of firm characteristics, legal status and ownership, on efficiency is examined by regressing predicted efficiency scores on the organizational structure and a set of firm covariates.

#### **3.1 Production function**

We follow the general strand of the literature that uses structural estimation to obtain unbiased coefficients of the production function as pioneered by Olley and Pakes (1996) (referred to from now on as OP) and extended by Levinsohn and Petrin (2003) (referred to from now on as LP). The key component of both approaches is the approximation of unobservable productivity through observed choices: OP use investment levels, whereas LP propose a flexible input (e.g. material costs). Both approaches, however, have some associated weaknesses. The OP approach leads to much data loss if there are many statistical units with negative or zero investment. On the other hand, the LP approach suffers from the more fundamental critique that it does not identify the labor coefficient in the first stage if labor and materials are flexible inputs and chosen simultaneously. This criticism stems from Akerberg, Caves, and Frazer (2015) (ACF from now on) who have subsequently developed a closely related estimation method that mitigates this problem. Therefore, we employ one variant of the estimation strategy suggested by ACF in response to the LP procedure. The ACF methodology has been used extensively in

applied work (see, e.g., Lee, McCullough, and Town, 2013; Parrotta and Pozzoli, 2012).<sup>17</sup>

When considering productive efficiency, a regulated firm must have sufficient organizational freedom over the usage of inputs (hire workers, buy intermediate products) and the determinants for production (capital structure, schedule of operation) in order to benefit from improvements in technological efficiency. We therefore consider briefly the production process of communal services. After receiving the planning for the next period (generally a year) from the municipality, an operator's manager may adjust its labor force and/or capital according to the production requirements. Note that the firm also owns the capital and that it consists mainly of trucks and other vehicles. Most material costs are incurred at the time production occurs. For waste collection, for instance, material costs are mostly composed of incineration fees for collected garbage that are incurred at the time of disposal.

We assume that different municipal tasks can be represented by the same technological relationship requiring the same inputs.<sup>18</sup> Output for operator  $i$  in period  $t$  is measured by real value added  $Y$  (revenue minus cost of material) produced by combining labor  $L$  and capital input  $K$  according to the Cobb-Douglas production function

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + u_{it}, \quad (1)$$

where lower-case letters denote the logarithm.<sup>19</sup> From our estimation, we have excluded firms that were active also in the electricity, gas and water distribution industry and only reported global financial figures. For those, it is unlikely that a common production technology exists among tasks.

The unobserved part of the production function can be split into two components according to  $u_{it} = \omega_{it} + \varepsilon_{it}$ , where  $\omega$  includes a constant. The first term  $\omega_{it}$  is productivity observable to the firm, whereas  $\varepsilon_{it}$  is an idiosyncratic, unanticipated shock. Importantly, management may decide to adjust the firm's input levels after the firm has been affected by a productivity shock. An estimation that does not take this into account suffers from the well-documented simultaneity bias, as first suggested by Mundlak (1961).<sup>20</sup> Using

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<sup>17</sup>See [http://webuser.bus.umich.edu/jagadees/other/acf\\_code.html](http://webuser.bus.umich.edu/jagadees/other/acf_code.html) for details on the technical implementation.

<sup>18</sup>Recall from section 2.1 that firms can perform several public service tasks.

<sup>19</sup>We prefer the estimation of a value added production function in order to aggregate products within a firm as well as to compare firms with different products (Lee et al., 2013).

<sup>20</sup>Notice that we do not face selection bias, as the firms in our sample do not face the risk of bankruptcy (at least on a practical level).

OLS on equation (1) would thus produce biased results, because unobserved productivity would be correlated with input choice.<sup>21</sup> A fixed-effects estimation would solve the problem only if the productivity were time-invariant, which is unlikely to be the case.

In order to take these well-known problems into account, we implement the semiparametric approach by ACF whose main idea is that a firm's material input demand is invertible and can be used as a proxy for productivity. Productivity is assumed to evolve as a first-order Markov process:  $p(\omega_{it}|I_{it}) = p(\omega_{it}|\omega_{it-1})$ , where  $I_{it}$  is the firm's current information set. As described previously, labor is chosen before  $t$  so a firm's material demand contains current labor and can be expressed as  $m_{it} = f(l_{it}, k_{it}, \omega_{it})$ . If it is strictly increasing in  $\omega$ , it can be inverted and substituted into (1) which results in

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + f^{-1}(l_{it}, k_{it}, m_{it}) + \varepsilon_{it}. \quad (2)$$

The function  $f^{-1}(\cdot)$  is proxied with a third order polynomial in labor, capital and materials and estimation of (2) constitutes the first stage necessary to net out unexpected production shocks.

The expected productivity can be expressed as  $E[\omega_{it}|I_{it}] + \xi_{it} = E[\omega_{it}|\omega_{it-1}] + \xi_{it}$ . In our application, we approximate this process with a third order polynomial. To identify the coefficients of the production function, it is necessary to find a choice variable orthogonal to the innovation in productivity  $\xi_{it}$ . Specifically, we use the moment condition that

$$E \left[ \xi_{it} \begin{vmatrix} l_{it} \\ k_{it} \end{vmatrix} \right] = 0, \quad (3)$$

which implies that labor and capital were chosen in  $t - 1$ . Akerberg et al. (2015) stress that this moment condition is valid if there are, for example, slacks in hiring and firing. For the case of the municipal services, staffing decisions must be made well in advance and approved by the responsible board. In addition, there are significant notice periods. However, our results are not sensitive to this assumption.<sup>22</sup>

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<sup>21</sup>In our estimation, we use OLS estimation as a benchmark and find no outstanding differences compared to the preferred estimation procedure.

<sup>22</sup>Appendix B provides estimation results for the production function and TFP regressions when lagged labor is used in the moment condition.



### 3.2 Productivity equation

Our primary interest lies in investigating how heterogeneity in estimated TFP scores can be explained by the firm’s organizational structure. They can be recovered from the estimates of the production function as  $\hat{\phi}_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it}$ , where  $\hat{\phi}$  is the predicted value of the first stage that serves to eliminate idiosyncratic production shocks. The equation to be estimated reads as

$$\log(TFP) = \alpha_0 + \alpha ORGSTR + \mathbf{X}\boldsymbol{\beta} + \epsilon, \quad (4)$$

The equation aims at estimating the effect of the organizational structure on (the log of) TFP recovered in the previous step. It contains a constant  $\alpha_0$ . The variable *ORGSTR* comprises the legal status and ownership structure. In particular, we consider five levels for a firm’s organizational structure: *MUNI*, where the ownership is public and the management is integrated in the city government. *INST*, where the ownership is public and the management is separated from ownership in a public legal form, *LIM\_PUB*, where the ownership is public and the management separated in a private legal form, *LIM\_SEMPUB* where the ownership is shared public and private and the management is in a private legal form and finally *LIM\_PRIV*, where the ownership is private and the management is separated in a private legal form. The general problem of omitted variable bias is tackled using a set of covariates captured in  $\mathbf{X}$ . In particular, we control for the population of the city as a major productivity shifter because there may be returns to scale. Moreover, we take into account whether the firm observed is a specialized firm.<sup>23</sup> Given that there may be regional differences, for example due to economic conditions, we will control for state fixed effects. The inclusion of this is important because it is likely to be correlated to the variable of interest. The equation contains an i.i.d. error component captured in  $\epsilon$ .

Still, other issues may exist. There will be a problem of reverse causality if more efficient firms are more likely to display one organizational structure than another. If, for example, bureaucrats in cities with more efficient operators are more likely to select the legal form of limited-liability, the causality would be reversed and estimation of (4) would lead to biased results. This argument is related to a finding in the theoretical literature on contract choice, where a firm is offered a menu of different regulatory contracts and

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<sup>23</sup>We define this variable in the empirical strategy.

self-selects itself into one according to its efficiency type (see, e.g., Laffont and Tirole, 1993). In the context of our investigation, this would mean that in cities with more efficient operators bureaucrats would rather choose one specific legal status.

In practice, such considerations may not be a major issue, as regional characteristics seem to play an important role in explaining the chosen organizational structure. For example, 22% of operators are limited-liability in Bavaria, whereas this fraction is 58% in the state of North Rhine-Westphalia. Over all the years studied, we observe that 54% of operators are a municipal enterprise, 11% are a public-law institution and 34% are limited liability companies. Changes are quite rare: three firms adopted private ownership, eight firms changed ownership from public to semipublic and two reversed ownership to fully public. Regarding changes in legal status, we observe that from the municipal enterprise, four switched to the public-law institution and two to limited liability. We are thus confident that state fixed effects capture unobserved variables correlated with organizational structure.

A second issue may be a bias due to unobserved heterogeneity. Since the data does not provide enough temporal variation to introduce firm-specific fixed-effects, we control for covariates driving the efficiency as the population and the degree of specialization. Still, we take into account the already mentioned state-level fixed effects that account for structural differences across the country, such as a slightly different legislative setting or general economic conditions.

Third, we perform a robustness check to ensure that the prices are not driving the results we observe. Since we do not have output data and cannot impose this kind of productivity measure we correlate the ownership and organizational form on prices we have for a cross section in one year. This regression shows whether there are structural correlations between organizational structure and prices, which would diminish our results.

### 3.3 Data and summary statistics

The data used in this paper are extracted from cities' mandatory reports on their financial stakes in firms.<sup>24</sup> They contain financial information, along with additional details such as employment data, ownership structure and legal status of the municipal firm. Supplementary information was taken from other publicly available sources (see

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<sup>24</sup>These are called *Beteiligungsbericht*: the obligation to publish such a report is prescribed by state laws.

Appendix A) as well as the proprietary AMADEUS database. This newly created data set comprises 70 municipal operators of large German cities through the years 2000-2012.<sup>25</sup> The data are restricted to the population of cities because rural areas often commission to several sub-contractors. Thus, sensible data is not available and the classification into an organizational form is much less obvious (Bataille and Steinmetz, 2015).

As described in section 3.2, we group the legal forms into three categories: limited liability companies (*LIM*), public-law institutions (*INST*) and the owner-operated municipal enterprise (*MUNI*). A firm is defined as publicly owned if at least 95 % of the owners are public actors (cities, institutions etc.), as semipublic if the state holds at least 51 % and as private if the public share is less than 51 %. Semipublic firms always have an absolute majority held by the municipality and their share of public ownership in the sample ranges from 51 to 60 %. Our empirical analysis is concerned about the effects of *both* ownership and legal status. Given that firms with an amount of private shareholding must adopt the legal form *LIM*, we can combine this information and obtain five levels for a firm’s organizational structure: *MUNI*, *INST*, *LIM\_PUB*, *LIM\_SEMPUB* and *LIM\_PRIV* (see Appendix D for details).

Table 1 summarizes input (relative to value added, aside from labor) and output variables of the production process used in this study. We report the summary statistics by organizational structure: Columns (1) and (2) contain the municipal firm and the institution, while Columns (3) to (5) summarize the limited-liability companies (with public, semipublic and private ownership, respectively).

As described in the previous section, we rely on value added data to characterize output. Table 1 includes the dependent variable value added and also reports revenue. Furthermore, we report for information purposes the yearly quantity of collected waste (measured in tonnes).<sup>26</sup> We have information on two inputs of the production function. The input labor measures the number of employees working in the firm, while capital is represented as the value of tangible assets (including land, motor vehicles, equipment and machinery). The proxy variable materials, used for inverting out productivity,

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<sup>25</sup>“Large city” in this context means that a city does not belong to another district, i.e. that it is independent (German: *kreisfreie Stadt*).

<sup>26</sup>Note that we are not able to use this physical quantity measure in our estimation. First, some firms collect all types of waste (e.g., also paper, glass and plastic), whereas others do not. There is no reliable information for this allocation for most of the sample period. Second, some firms deliver other types of public services which are relevant in terms of revenue shares, for which quantity data does not exist.

represents expenditures for raw materials (including energy, intermediate inputs and purchased services). All monetary inputs and outputs are expressed in 2000 prices using respective deflators.<sup>27</sup>

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<sup>27</sup>Revenue: consumer price index for garbage collection fees (averaged with fees for drainage if the firm is active in this segment also). Material expenses: intermediate inputs price index. Labor expenses: consumer price index. Capital: gross fixed capital formation index. See Appendix A for sources.

Table 1: Summary statistics: means (and standard errors) by organizational structure.

	Municipal firm	Public institution	Public lim.-liab.	Semipublic lim.-liab.	Private lim.-liab.	Total
Quantity of waste	48892.83 (54013.20)	218906.41 (298230.70)	80022.41 (85751.37)	72607.73 (59849.13)	41678.73 (9265.35)	79628.18 (132407.80)
Revenue	40537.20 (35628.93)	132030.09 (170023.23)	40242.22 (28911.94)	47444.84 (50224.18)	41581.97 (9127.23)	51901.30 (72665.08)
Value Added	23891.15 (21074.32)	88154.02 (129720.06)	24272.18 (20227.33)	30392.09 (31601.79)	20950.79 (5080.62)	32205.92 (52532.84)
Number of workers	370.46 (299.57)	1457.13 (2029.75)	394.76 (336.93)	473.05 (418.81)	145.09 (24.08)	511.26 (821.20)
Tangible assets / Value added	5.08 (6.48)	2.06 (2.11)	1.04 (0.99)	0.80 (0.43)	2.58 (1.04)	3.25 (5.14)
Material expenses / Value added	0.80 (0.51)	0.75 (0.54)	0.81 (0.82)	0.55 (0.30)	1.00 (0.23)	0.76 (0.57)
Population	212185 (209575)	908511 (1121427)	276185 (240418)	301671 (215851)	158410 (69692)	313871 (473298)
No. of obs.	448	98	174	134	11	865
No. of firms	35.3	8.9	13.4	11.1	1.2	69.9

*Notes:* All monetary values measured in thousands of Euros. Quantity is the collected solid waste in tonnes.

## 4 Estimating equations and results

### 4.1 Production function

Table 2 provides the estimates for the production function. We report OLS first and then the results using the ACF algorithm. Given endogeneity problems when applying OLS, which are circumvented by the ACF methodology, the OLS estimates are used as a benchmark. Column (1) provides the OLS benchmark for value added. Both capital and labor are positively and significantly correlated to the outcome in value added.

The results based on the ACF algorithm are highly significant and very similar to those obtained by OLS. To examine returns to scale, we test whether the sum of labor and capital coefficient test is equal to one against the two-sided alternative. The  $t$ -test cannot reject the hypothesis of constant returns to scale ( $p = 0.58$ ). This result fits with those previously obtained in the literature when one considers larger municipalities and cities, as we do in our analysis. For the estimation of a cost function, Dijkgraaf and Gradus (2015) find an output coefficient very close to one. Similarly, Stevens (1978) obtains constant economies of scale for cities with a population size of over 50.000 inhabitants.<sup>28</sup>

Table 2: Production function estimates

Variable	OLS	ACF
Labor	0.8321*** (0.0130)	0.8245*** (0.0577)
Capital	0.1578*** (0.0080)	0.1507*** (0.0345)
No. of obs.	865	865

*Notes:* Standard errors in parentheses. Standard errors derived using block bootstrapping with 200 replications for the columns with ACF estimates.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>28</sup>The 5 % percentile of the population in our sample is 49.851.

## 4.2 Total factor productivity

To analyze efficiency difference, we use equation 4), which describes the impact of a firm’s organizational structure on TFP. We run this regression with OLS using standard errors clustered at the establishment level.<sup>29</sup>

The four levels of this main variable of interest are *INST*, *PUB\_LIM*, *SEMPUB\_LIM* and *PRIV\_LIM*: the institution and three types of limited-liability companies with varying ownership. We thus compare each organizational structure with the fifth (baseline) category *MUNI*, which we had previously defined as traditional public provision. Because each firm offers a slightly different portfolio of city services, we control for possible effects of specializing in some of them. The variable *SPE* takes on the value of 1 if the firm only carries out garbage collection and street cleaning services.

Our main specification uses the TFP measures from the value added production function. The results from estimating the baseline equation (4) are presented in Table 3. Column (1) controls for our four indicators of organizational structure. Interestingly, only the effect of *PRIV\_LIM* is highly significant at the 1% level with a coefficient of 0.2574, indicating that private firms organized in a limited-liability company are approximately 29% more efficient than the baseline group *MUNI*.<sup>30</sup> Given that the other categories are not significantly different from the baseline group the absolute productivity advantage is similar to the other groups.

Still, an important driver for productivity may be the population. This effect is controlled for in column (2), indicating that city population is highly significant and positively shifts productivity. While the coefficient for the *PRIV\_LIM* remains nearly unchanged, the coefficients for *INST* and *SEMPUB\_LIM* become negatively significant. These coefficients indicate that these organizational structures perform less efficiently than the baseline category. One might expect that the category *SEMPUB\_LIM* is more efficient, e.g. due to private know-how in the operation. Given the strong effect of private ownership on productivity this seems surprising.

We can only speculate about the reason for these results. One possible explanation is that the production process is harmed if there is a strong interest divergence. While private owners will probably aim for profit maximization, the public actors may have

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<sup>29</sup>There is not enough time variation in the organizational structure to identify the coefficients using a fixed-effects methods, which is why we will use OLS with controls in estimating equation (4). The path dependency of the organizational structure strengthens the point that there is no strategic selection, which would lead to reverse causality.

<sup>30</sup>All effects are computed according to  $\exp(c) - 1$ , where  $c$  is the estimated coefficient.

quality objectives. This could have several effects. First, internal disputes between the partners may lead to a delays in investment or innovations.<sup>31</sup> Second, such a dichotomy may keep managers from making business decisions that satisfy both constraints.<sup>32</sup> If the provision is totally private, however, the incentive to appropriate rents leads to superior technical productivity, which is in line with cost efficiency in well-defined contractual arrangements (see Hart, 2003).

The effect that *INST* performs worse than the two other public categories could stem from various sources. First, the relative autonomy of this environment may limit municipal supervision and thus may exacerbate conflicts between citizens, municipalities and the firm. Such an arrangement may also create informational barriers impeding firm performance due to changing or vague goals (Estrin and Perotin, 1991). This is different for the other two types of public firms: *PUB\_LIM* have discretion over *how* the task is performed, but control is executed by monitoring contract compliance and by organization of firms with private legal status.<sup>33</sup> For municipal provision, such formal contracts do not exist, but since they are integrated into the government, informal control can be easily achieved. This point relates to an analysis done by Amaral (2008), who relates the government’s capacity for expertise and control with the autonomy margin of the firm (in addition to ownership). He postulates that they should go hand in hand: higher autonomy which will increase innovation incentives should be accompanied by corresponding control mechanisms preventing opportunistic behavior.

Controlling for firms that only offer the garbage services (column 3), one can see that specialized firms are less productive, indicating some form of economies of scope between tasks. Also, the productivity effect of semipublic firms decreases and loses significance slightly below the 10% threshold.

To check whether the results remain, we control for state-fixed effects in column (4).<sup>34</sup> Given that state-level differences exist in the pattern of organizational structure, introducing these dummies leads to an increase in the validity of the effects

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<sup>31</sup>Of course, contracting imperfections are likely to exist in the real world. The role of bargaining frictions in PPP is analyzed in a recent paper by Schmitz (2015), thereby extending standard property rights models, which assume that ex-post bargaining is efficient.

<sup>32</sup>Eckel and Vining (1985) report some evidence that managers in mixed companies receive unobtainable targets, e.g. high cost efficiency and extensive social goals, which leads to some sort of “cognitive dissonance”.

<sup>33</sup>This legal form may voluntarily found a supervisory board. Further, these types of firms are often held by publicly-traded firms, which always have an advisory board.

<sup>34</sup>The results are also robust to the inclusion of year-fixed effects, but these turn out insignificant in the specification.



explained previously. We again find a significant negative impact on productivity for *SEMPUB\_LIM* (around 5%). The category *INST* has a negative productivity effect of equal magnitude (5 %), while there is no difference between *SEMPUB\_LIM* and the baseline group. Most importantly, we still observe a highly significant effect of private firms of around 32%. Population and degree of specialization also impact productivity. Interestingly, we see that it is not only ownership that matters, but also the particular institutional setting. Taking into account the whole table, we conclude that the importance of ownership is complemented by the relation between the principal and the operator of the service, which in our analysis has been mirrored by the legal status.

The main results of column (4) are robust to the inclusion of other variables that could shift productivity. Further, when we introduce year dummies, we cannot reject the hypothesis that they are jointly equal to zero, indicating that there is no clear time pattern in the evolution of productivity.

Table 3: TFP Regressions

Variable	(1)	(2)	(3)	(4)
INST	−0.0059 (0.0424)	−0.0613*** (0.0232)	−0.0531** (0.0224)	−0.0523** (0.0241)
PUB_LIM	0.0178 (0.0278)	0.0127 (0.0288)	0.0328 (0.0268)	0.0245 (0.0334)
SEMPUB_LIM	−0.0404 (0.0288)	−0.0472* (0.0278)	−0.0395 (0.0282)	−0.0539** (0.0254)
PRIV_LIM	0.2574*** (0.0363)	0.2656*** (0.0362)	0.2475*** (0.0385)	0.2834*** (0.0373)
pop $10^{-7}$		0.8006*** (0.1177)	0.9394*** (0.1318)	0.9998*** (0.2019)
specialized			−0.0489** (0.0228)	−0.0589*** (0.0222)
Constant	3.5745*** (0.0179)	3.5571*** (0.0185)	3.5736*** (0.0224)	3.6006*** (0.0570)
State-fixed effects	No	No	No	Yes
$R^2$	0.08	0.15	0.18	0.27
No. of obs.	865	865	865	865

*Notes:* Dependent variable is  $\log(TFP)$ . Standard errors clustered at the firm level in parentheses. All states that consist only of one city have been assigned to the geographical neighbor region (Berlin=Brandenburg, Bremerhaven and Bremen=Lower Saxony, Hamburg=Schleswig-Holstein).

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

### 4.3 Robustness check: addressing potential price bias

A potential caveat in the usage of industry deflators is when output or input prices are heterogeneous, because measured TFP would contain price and “true” efficiency effects. This occurs, for example, when large firms have market power in the product market (Klette, Griliches, et al., 1996). In our analysis, the existence of a price bias would prove most problematic when differences are structural in the sense that they were correlated with the organizational structure whose impact on productivity we are analyzing. If, for example, firms of one organizational form were charging consistently higher prices for their output, one would overestimate true productivity because part of it would be solely due to prices.

We address this question by studying the association between organizational structure and output prices using garbage collection fees gathered and provided by SPIEGEL ONLINE (2008) and Verivox (2008). This data is available for a cross section of the year 2008 and covers 62 of 76 firms in our sample. For the subsequent analysis, we use these fees to compute an average price per liter of waste.<sup>35</sup> These fees only serve as a rough proxy for output prices because they comprise only one business line (garbage collection) that the firm is involved in. However, this is not too problematic since this line is most important in terms of revenue shares. They are the best available measures of prices at the individual firm level and their usage can serve to alleviate concerns one could have with using general price deflators in our empirical analysis.

To this end, we run a simple OLS regression of average price on the categories of organizational structure. The results are presented in Table 4. There seems to be a positive association between *PUB\_LIM* and output prices, significant at the 1 % level, while all other structures do not show any association. The results do not change when we include potential cost shifters.<sup>36</sup> We should therefore address what this finding implies for the robustness of the analysis of technical efficiency provided in the previous section.

Given the insignificant coefficients on semipublic and private ownership, this robustness check refutes the suspicion that the superiority of private firms and the inferiority of semipublic firms in terms of technical efficiency could be due to higher or

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<sup>35</sup>Reported are the fees charged for weekly collection of residual waste, calculated on the basis of a four-person household. The four pricing categories are: 60l, 120l, 240l and 1.100l. We compute per liter prices and then take the unweighted average over the four categories.

<sup>36</sup>If we include average wage in the equation, for example, results and associated significance levels do not change.

Table 4: Relation between prices and organizational structure

Variable	
INST	−0.5736 (0.3661)
PUB_LIM	1.1615*** (0.3040)
SEMPUB_LIM	−0.0601 (0.2925)
PRIV_LIM	−0.7710 (0.8497)
Constant	2.7465*** (0.1594)
$R^2$	0.30
No. of obs.	62

*Notes:* Dependent variable is average fee per liter, baseline category = *MUNI* (public provision). Population size (*POP*) included as control.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

lower prices, respectively. Concerning the *PUB\_LIM* category, this analysis would tend to suggest that we may be *overestimating* their productivity effect, i.e. this type could be less efficient than the baseline category *MUNI* (classical public provision). On the other hand, it is possible that the same pattern, i.e. higher prices, exists with respect to input prices, which would cancel out a potential bias and speak against overestimation of the effect. Unfortunately, neither data on material prices nor better output price data is available, so that we cannot further investigate this question. Most importantly, though, this analysis does not provide evidence that heterogeneity in output prices drive the results obtained for semipublic and private ownership.

## 5 Conclusion

Our paper analyzed the productive efficiency of public services using a newly-created data set from Germany. Productivity estimates have been obtained by employing the well-established ACF procedure and projecting the obtained residuals on the firm's organizational structure. This method circumvents the endogeneity problem of the

production function that arose in previous studies examining the productivity effects of private provision of refuse collection services.

Our analysis shows that not only ownership, but also legal status and the accompanying contractual practices influence the way in which inputs are converted to output. We find that the private provision of refuse collection is most efficient. Comparing this with other forms of ownership, we find a non-linear relationship in the degree of private ownership. That is, mixed-ownership models such as public-private partnerships are less efficient than pure public entities.

Moreover, we see that the contractual arrangement is important in the way of how to organize a public company. Legal forms that separate ownership and management seem to have a lower efficiency, which may be explained by typical principal-agent problems. These results are generally in line with the intuitive examples provided by the property rights literature and provide evidence that transaction cost arguments are highly relevant for organizing public utilities.

The results found are important for policy debates worldwide regarding the most appropriate organization of public utilities. If utilities are organized in a contracting-out arrangement, the results propose a superiority over pure public or private service provisions. A combination of semipublic entities like public-private partnerships seems to bring together more the disadvantages from both private and public worlds than their advantages. In public entities the organizational form matters. If there is a separation of management and ownership, private legal forms are more able to reap efficiency benefits than public legal forms including the separation.

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## A Data sources – overview

This is an overview of the different sources used. For a complete overview of individual sources, see the online appendix.

1. *Firm characteristics.* Reports on stake-holding (“Beteiligungsberichte”) of the city, provided by the cities themselves or public libraries and archives. Employee data supplemented by usage of the Amadeus database of Bureau van Dijk and direct information from the firms. Ownership information supplemented by firm database Hoppenstedt.
2. *Financial Data (balance sheet, income statement).* Reports on stake-holding (“Beteiligungsberichte”) of the city, provided by the cities themselves or electronic information systems of city councils. Supplemented by annual statements from electronic information systems of city councils or official homepage of the firm. Supplemented by usage of Bundesanzeiger (online publisher of yearly accounts), Bundesanzeiger Verlag GmbH.
3. *Quantity data.* Statistisches Bundesamt.
4. *Deflators.* Consumer price index, producer price index: Statistisches Bundesamt. Intermediate inputs price, Gross Fixed Capital Formation price series: EU Klems.
5. *Lines of business.* Derived from the reports-on stakeholding (“Beteiligungsberichte”) and own research (using the firms’ homepages).
6. *Regional characteristics.* Surface area, population of the city: Statistisches Bundesamt.
7. *Output prices.* Study of garbage collection fees, SPIEGEL ONLINE and Verivox (2008).

## B Robustness check: labor as non-dynamic input

The two tables A1 and A2 display the results of production function and TFP regressions, respectively, when moment condition (3) is changed to include capital,  $k_{it}$ , and *lagged* labor,  $l_{i,t-1}$ .

Table A1: Production function estimates with alternative moment condition

Variables	
Labor	0.8374*** (0.0768)
Capital	0.1487*** (0.0365)
No. of obs.	865

*Notes:* Standard errors in parentheses. Standard errors derived using block bootstrapping with 200 replications.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table A2: TFP Regressions with alternative moment condition

Variable	(1)	(2)	(3)	(4)
INST	−0.0145 (0.0381)	−0.0581** (0.0231)	−0.0496** (0.0224)	−0.0496** (0.0238)
PUB_LIM	0.0145 (0.0281)	0.0104 (0.0291)	0.0311 (0.0269)	0.0242 (0.0333)
SEMPUB_LIM	−0.0448 (0.0282)	−0.0501* (0.0278)	−0.0422 (0.0280)	−0.0560** (0.0252)
PRIV_LIM	0.2658*** (0.0375)	0.2723*** (0.0375)	0.2536*** (0.0398)	0.2844*** (0.0388)
pop 10 <sup>−7</sup>		0.6301*** (0.1286)	0.7731*** (0.1308)	0.8436*** (0.2079)
specialized			−0.0503** (0.0230)	−0.0614*** (0.0229)
Constant	3.5236*** (0.0182)	3.5100*** (0.0190)	3.5270*** (0.0229)	3.5561*** (0.0580)
$R^2$	0.08	0.13	0.16	0.24
No. of obs.	865	865	865	865

*Notes:* Dependent variable is  $\log(TFP)$ . Standard errors clustered at the firm level in parentheses. All states that consist only of one city have been assigned to the geographical neighbor region (Berlin=Brandenburg, Bremerhaven and Bremen=Lower Saxony, Hamburg=Schleswig-Holstein).

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## C Legal forms

LAW SYSTEM	CONTRACTUAL FREEDOM	LEGAL FORM
public law	tied	Eigenbetrieb, eigenbetriebsähnliche Einrichtung
public law	free	Körperschaft des öffentlichen Rechts, Anstalt des öffentlichen Rechts
private law	free	GmbH, GmbH & Co. KG

## D Tabulation of variable *ORGSTR*

LEGAL STATUS	CONTRACTUAL FREEDOM	OWNERSHIP		
		Public (> 95%)	Semipublic (60 – 51%)	Private (< 50%)
public law	tied	<i>MUNI</i>		
public law	free	<i>INST</i>		
private law	free	<i>LIM_PUB</i>	<i>LIM_SEMPUB</i>	<i>LIM_PRIV</i>

## E Individual data sources (intended as online appendix)

city	area code	sources
Aachen	5334002	2009: JA 2010 <sup>b</sup> , 2010: JA 2010 <sup>b</sup> , 2011: JA 2011 <sup>b</sup> , 2012: JA 2012 <sup>b</sup>
Augsburg	9761	2002: BB 2004; 2003: BB 2005; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012
Baden-Baden	8211	2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Bamberg <sup>b</sup>	9461	2000: JB 2000; 2001: JB 2001; 2002: JB 2002; 2003: JB 2003; 2004: JB 2004; 2005: JB 2005; 2006: JB 2006; 2007: JB 2007; 2008: JB 2008; 2009: JB 2009; 2010: JB 2010; 2011: JB 2011; 2012: JB 2012
Berlin	11	2000: BB 2001; 2001: BB 2002; 2002: BB 2004 - Bd. I; 2003: BB 2004 - Bd. I; 2004: BB 2005 - Bd. I; 2005: BB 2006 - Bd. I; 2006: BB 2007 - Bd. I; 2007: BB 2008 - Bd. I; 2008: BB 2009 - Bd. I; 2009: BB 2010 - Bd. I; 2010: BB 2011 - Bd. I; 2011: BB 2012 - Bd. I; 2012: BB 2013 - Bd. I
Bielefeld	5711	2000: 10. BB; 2001: 11. BB; 2002: 12. BB; 2003: 13. BB; 2004: 14. BB; 2005: 15. BB; 2006: 16. BB; 2007: 17. BB; 2008: 18. BB; 2009: 19. BB; 2010: 20. BB; 2011: 21. BB; 2012: 22. BB
Bochum	5911	2000: BB 2005/2006; 2001: BB 2005/2006; 2002: BB 2005/2006; 2003: BB 2005/2006; 2004: BB 2005/2006; 2005: BB 2005/2006; 2006: BB 2006/2007; 2007: BB 2007/2008; 2008: BB 2008/2009; 2009: BB 2009/2010; 2010: BB 2009/2010; 2011: BB 2011; 2012: BB 2012
Bottrop	5512	2003: BB 2008; 2004: BB 2008; 2005: BB 2008; 2006: BB 2008; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Brandenburg	12051	2003: 8. BB (2003-2005); 2004: 8. BB (2003-2005); 2005: 8. BB (2003-2005); 2006: 9. BB 2006; 2007: 10. BB 2007; 2008: 11. BB 2008; 2009: 12. BB 2009; 2010: 13. BB 2010; 2011: 14. BB 2011; 2012: 15. BB 2012
Braunschweig	3101	2001: VI. BB; 2002: VII. BB

Bremerhaven	4012	2000: HP 2002/2003, WP 2002, HP 2000/2001, Bd. I, WP 2000; 2001: BA 2001; 2002: BA 2002; 2004: BA 2005; 2005: BA 2005; 2006: BA 2006; 2007: BA 2007; 2008: BA 2008; 2009: BA 2009; 2010: BA 2010; 2011: BA 2011; 2012: BA 2012
Chemnitz	14511	2002: 11. BB; 2003: 11. BB; 2004: 11. BB; 2005: 12. BB; 2006: 13. BB; 2007: 14. BB; 2008: 15. BB; 2009: 16. BB; 2010: 17. BB; 2011: 18. BB; 2012: 19. BB
Coburg	9463	2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Cottbus	12052	2000: BB 2003; 2001: BB 2003; 2002: BB 2003; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005
Darmstadt	6411	2006: BB 2007; 2007: BB 2008; 2008: BB GJ 2008; 2009: BB GJ 2009; 2010: BB GJ 2010; 2011: BB GJ 2011; 2012: BB GJ 2012
Delmenhorst	3401	2003: BB Stand 31.12.2005; 2004: BB Stand 31.12.2005; 2005: BB Stand 31.12.2005; 2006: GB 2007; 2007: GB 2007; 2008: GB 2008; 2009: GB 2009; 2010: GB 2010; 2011: GB 2011; 2012: GB 2012
Dessau	15101	2000: BB 2000; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006
Dessau-Roßlau	15001	2007: 2. BB; 2008: 3. BB; 2009: 4. BB; 2010: 5. BB; 2011: 6. BB; 2012: 7. BB
Dortmund	5913	2000: BB 2000/2001; 2001: BB 2001/2002; 2002: BB 2002/2003; 2003: BB 2003/2004; 2004: BB 2004/2005; 2005: BB 2005/2006; 2006: BB 2006/2007; 2007: BB 2007/2008; 2008: BB 2008/2009; 2009: BB 2009/2010; 2010: BB 2010/2011; 2011: BB 2011/2012; 2012: BB 2013/2012
Dresden	14612	2000: BA 2000; 2001: BB 2002; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Duisburg	5112	2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Düsseldorf	5111	2000: BB 2000; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: GB 2011; 2012: GB 2012
Eisenach	16056	2005: BA 2006; 2006: BA 2006; 2007: BA 2007; 2008: BA 2008; 2009: BA 2009; 2010: BA 2010; 2011: BA 2011; 2012: BA 2012

Emden	3402	2004: WP 2007 <sup>b</sup> ; 2005: WP 2007 <sup>b</sup> ; 2006: BB 2011, WP 2007 <sup>b</sup> ; 2007: BB 2011, WP 2008 <sup>b</sup> ; 2008: BB 2011, WP 2009 <sup>b</sup> ; 2009: BB 2011, WP 2010 <sup>b</sup> ; 2010: BB 2012, WP 2011 <sup>b</sup> ; 2011: JA 2012, WP 2012 <sup>b</sup> ; 2012: JA 2012, WP 2013 <sup>b</sup>
Erfurt	16051	2000: BB 2001 <sup>d</sup> ; 2001: BB 2002 <sup>d</sup> ; 2002: BB 2003 <sup>d</sup> ; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Essen	5113	2000: BA 2000; 2001: BB 2004; 2002: BB 2005; 2003: BB 2006; 2004: BB 2007; 2005: BB 2008; 2006: BB 2009; 2007: BB 2010; 2008: BB 2011; 2009: BB 2012; 2010: BB 2013; 2011: BB 2014; 2012: BB 2015
Flensburg	1001	2000: BB 2001; 2001: BB 2002; 2002: BB 2003; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Frankenthal	7311	2010: HP 2013 <sup>b</sup> ; 2011: HP 2013 <sup>b</sup> ; 2012: HP 2014 <sup>b</sup>
Frankfurt a.M.	6412	2001: BB 2002; 2002: BB 2003; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2012
Freiburg	8311	2005: BA 2006; 2006: BA 2006; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Gelsenkirchen	5513	2000: BB 2000 <sup>e</sup> ; 2001: BB 2001 <sup>e</sup> ; 2002: BB 2002 <sup>e</sup> ; 2003: BB 2003 <sup>e</sup> ; 2004: BB 2004 <sup>e</sup> ; 2005: BB 2005 <sup>e</sup> ; 2006: BB 2006 <sup>e</sup> ; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Gera	16052	2000: BB 2004; 2001: BB 2004; 2002: BB 2004; 2003: BB 2004; 2004: BB 2004; 2005: BA 2005; 2006: BA 2006; 2007: BA 2007; 2008: BA 2008; 2009: BA 2009; 2010: BA 2010; 2011: BA 2011; 2012: BA 2012
Göttingen	3152	2000: BB 2005; 2001: BB 2005; 2002: BB 2005; 2003: BB 2005; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Hagen	5914	2000: BA 2001; 2001: BA 2001; 2002: BA 2003; 2003: BA 2003; 2004: BA 2004; 2005: BB 2007; 2006: BB 2007; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Halle	15002	2000: BA 2001; 2001: BA 2001; 2002: BA 2002; 2003: BB 2005; 2004: BB 2005; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008



Hamburg	2	2000: 4. BB 2000; 2001: 5. BB 2001; 2002: 6. BB 2002; 2003: 7. BB 2003; 2004: 8. BB 2004; 2005: 9. BB 2005; 2006: 10. BB 2006; 2007: 11. BB 2007; 2008: 12. BB 2008; 2009: 13. BB 2009; 2010: 14. BB 2010; 2011: 15. BB 2011; 2012: 16. BB 2012
Hamm	5915	2000: BB 2002/03; 2001: BB 2002/03; 2002: BB 2002/03; 2003: BB 2003/04; 2004: BB 2003/04; 2005: BB 2003/04; 2006: BB 2003/04; 2007: BB 2009/10; 2008: BB 2010/11; 2009: BB 2010/11; 2010: BB 2010/11; 2011: BB 2011/12; 2012: BB 2012/13
Hannover	3241	2003: BB 2008; 2004: BB 2008; 2005: BB 2008; 2006: BB 2008; 2007: BB 2008; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012; 2013: BB 2013
Heilbronn	8121	2002: BB 2005; 2003: BB 2005; 2004: BB 2005; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Herne	5916	2003: JA 2003 <sup>b</sup> ; 2004: JA 2004 <sup>b</sup> ; 2005: BB '08; 2006: BB '08; 2007: BB '08; 2008: BB '09; 2009: BB '10; 2010: BB '11; 2011: BB '12; 2012: BB '13
Jena	16053	2004: BB 2005; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Kaiserslautern	7312	2007: BB 2009; 2008: BB 2010; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Kiel	1002	2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Koblenz	7111	2004: JA 2005 <sup>b</sup> ; 2005: JA 2005 <sup>b</sup> ; 2007: HP 2009; 2008: HP 2010; 2011: HP 2013; 2012: HP 2014
Krefeld	5114	2003: BB 2004; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Köln <sup>c</sup>	5315	2005: BB 2009; 2006: BB 2009; 2007: BB 2009; 2008: BB 2009; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Landau	7313	2008: JA 2009; 2009: JA 2010; 2010: JA 2011; 2011: JA 2012; 2012: BB 2003

Leipzig	14713	2001: BB 2003; 2002: BB 2004; 2003: BB 2005; 2004: BB 2006; 2005: BB 2007; 2006: BB 2008; 2007: BB 2009; 2008: BB 2010; 2009: BB 2011; 2010: BB 2012; 2011: BB 2013; 2012: BB 2014
Leverkusen	5316	2004: Amad; 2005: BA 2006; 2006: BA 2006; 2007: BA 2007; 2008: BA 2008; 2009: BA 2009; 2010: BA 2010; 2011: XIX. BB; 2012: XX. BB
Ludwigshafen	7314	2000: 7. BB; 2001: 8. BB; 2002: 9. BB; 2003: 10. BB; 2004: 11. BB; 2005: 12. BB; 2006: 13. BB; 2007: 14. BB; 2008: 15. BB; 2009: 16. BB; 2010: 17. BB; 2011: 18. BB; 2012: 19. BB
Lübeck	1003	2000: WP 2000; 2001: BB 2003; 2002: BB 2004; 2003: BB 2005; 2004: BB 2006; 2005: BB 2007; 2006: BB 2008; 2007: BB 2009; 2008: BB 2010; 2009: BB 2011; 2010: BB 2012; 2011: BB 2013; 2012: BB 2014
Magdeburg	15003	2002: BB 2007, JA 2003 <sup>b</sup> ; 2003: BB 2007, JA 2003 <sup>b</sup> ; 2004: BB 2007, JA 2004 <sup>b</sup> ; 2005: BB 2007, JA 2005 <sup>b</sup> ; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Mainz	7315	2000: BB 2002, Bd. II; 2001: BB 2002, Bd. II; 2002: BB 2003, Bd. II; 2003: BB 2004, Bd. II; 2004: BB 2007, Bd. II; 2005: BB 2007, Bd. II; 2006: BB 2007, Bd. II; 2007: BB 2009, Bd. II; 2008: BB 2009, Bd. II; 2009: BB 2010, Bd. II; 2010: BB 2011, Bd. II; 2011: BB 2012, Bd. II; 2012: BB 2013, Bd. II
Mannheim	8222	2000: BB 2001; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Mönchengladbach	5116	2000: BB 2001; 2001: BB 2002; 2002: BB 2003; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Mülheim an der Ruhr	5117	2000: BB 2001; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010/11; 2011: BB 2011/11; 2012: BB 2012
München	9162	2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Münster	5515	2000: BB 2001/2002; 2001: BB 2001/2002; 2002: BB 2006; 2003: BB 2006; 2004: BB 2006; 2005: BB 2006; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012

Neustadt <sup>b</sup>	7316	2000: JA 2000; 2001: JA 2001; 2002: JA 2002; 2003: JA 2003; 2004: JA 2004; 2005: JA 2005; 2006: JA 2006; 2007: JA 2007; 2008: JA 2008; 2009: JA 2009; 2010: JA 2010; 2011: JA 2011; 2012: JA 2012
Nürnberg	9564	2001: JA 2002 <sup>b</sup> ; 2002: JA 2002 <sup>b</sup> ; 2004: JA 2005 <sup>b</sup> ; 2005: JA 2005 <sup>b</sup> ; 2006: JA 2006 <sup>b</sup> ; 2007: JA 2008 <sup>b</sup> ; 2008: JA 2008 <sup>b</sup> ; 2009: JA 2009 <sup>b</sup> ; 2010: JA 2010 <sup>b</sup> ; 2011: JA 2012 <sup>b</sup> ; 2012: JA 2012 <sup>b</sup>
Oberhausen	5119	2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Offenbach <sup>b</sup>	6413	2000: JA 2000; 2001: JA 2001; 2002: JA 2002; 2003: JA 2003; 2004: JA 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Oldenburg	3403	2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Osnabrück	3404	2000: BB 2001; 2001: BB 2002; 2002: BB 2003; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Passau <sup>b</sup>	9262	2000: GB 2000; 2001: GB 2001; 2002: GB 2002; 2003: GB 2003; 2004: GB 2004; 2005: GB 2005; 2006: GB 2006; 2007: GB 2007; 2008: GB 2008; 2009: GB 2009; 2010: GB 2010; 2011: GB 2011; 2012: GB 2012
Pirmasens <sup>b</sup>	7317	2007: JA 2008, HP 2009; 2008: JA 2008, HP 2010; 2009: JA 2009, HP 2011; 2010: JA 2010, HP 2012; 2011: JA 2011, HP 2013; 2012: JA 2012, HP 2014
Potsdam	12054	2000: BA 2000/6. BB; 2001: 8. BB; 2002: 8. BB; 2003: 9. BB; 2004: 10. BB; 2005: 11. BB; 2006: 12. BB; 2007: 13. BB; 2008: 14. BB; 2009: 15. BB; 2010: 16. BB; 2011: 17. BB; 2012: 18. BB
Remscheid	5120	2000: BB 2002; 2001: BB 2002; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Rosenheim	9163	2000: BB 2002; 2001: BB 2002; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Rostock	13003	2000: BB 2000; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012

Salzgitter	3102	2001: BB, HP 2004, Bd. II; 2002: BB, HP 2004, Bd. II; 2003: BB, HP 2005, Bd. II; 2004: BB, HP 2006, Bd. II; 2005: BB, HP 2007, Bd. II; 2006: BB, HP 2008, Bd. II; 2007: BB, HP 2009, Bd. II; 2008: BB, HP 2010, Bd. II; 2009: BB, HP 2011, Bd. II; 2010: BB, HP 2012, Bd. II; 2011: BB, HP 2013, Bd. II; 2012: BB, HP 2014, Bd. II
Schwerin	13004	2000: 4. BB; 2001: 5. BB; 2002: 6. BB <sup>§</sup> ; 2003: 7. BB <sup>§</sup> ; 2004: 8. BB <sup>§</sup> ; 2005: 9. BB; 2006: 10. BB; 2007: 11. BB; 2008: 12. BB; 2009: 13. BB; 2010: 14. BB; 2011: 15. BB; 2012: 16. BB
Solingen	5122	2000: BB 2002; 2001: BB 2002; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010
Speyer <sup>b</sup>	7318	2000: JA 2000; 2001: JA 2001; 2002: JA 2002; 2003: JA 2003; 2004: JA 2004; 2005: JA 2005; 2006: JA 2006; 2007: JA 2007; 2008: JA 2008; 2009: JA 2009; 2010: JA 2010; 2011: JA 2011; 2012: JA 2012
Stuttgart	8111	2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Suhl	16054	2002: BB 2003; 2003: BB 2004; 2004: BB 2005; 2005: BB 2006; 2006: BB 2007; 2007: BB 2008; 2008: BB 2009; 2009: BB 2010; 2010: BB 2011; 2011: BB 2012; 2012: BB 2013
Trier	7211	2001: BB 2001-2002; 2002: BB 2001-2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Ulm	8421	2000: 6. BB 2000; 2001: 7. BB 2000; 2002: 8. BB 2000; 2003: 9. BB 2000; 2004: 10. BB 2000; 2005: 11. BB 2000; 2006: 12. BB 2000; 2007: 13. BB 2000; 2008: 14. BB 2000; 2009: 15. BB 2000; 2010: 16. BB 2000; 2011: 17. BB 2000; 2012: 18. BB 2000
Weimar	16055	2001: BB 2003; 2002: BB 2004; 2003: BB 2005
Wiesbaden	6414	2000: BB 2000; 2001: BB 2001; 2002: BB 2002; 2003: BB 2003; 2004: BB 2004; 2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Wilhelmshaven	3405	2000: BB 2003, BB 2001; 2001: BB 2004, BB 2001; 2002: BB 2004, BB 2003; 2003: BB 2004; 2004: BB 2007; 2005: BB 2007; 2006: BB 2007, SP 2006; 2007: BB 2010, SP 2007; 2008: BB 2010; 2009: BB 2010; 2010: BB 2011, SP 2010; 2011: BB 2013; 2012: BB 2013

Wolfsburg	3103	2005: BB 2005; 2006: BB 2006; 2007: BB 2007; 2008: BB 2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Worms	7319	2005: JA 2006 <sup>b</sup> ; 2006: JA 2006 <sup>b</sup> ; 2007: JA 2008 <sup>b</sup> ; 2008: JA 2008 <sup>b</sup> ; 2009: JA 2009 <sup>b</sup> ; 2010: JA 2010 <sup>b</sup> ; 2011: JA 2011 <sup>b</sup>
Wuppertal	5124	2000: BB 2000; 2001: BB 2002; 2002: BB 2002; 2003: BB 2005; 2004: BB 2005; 2005: BB 2005; 2006: BB 2005; 2007: BB 2007/2008; 2008: BB 2007/2008; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012
Würzburg	9663	2001: JA 2001 <sup>b</sup> ; 2002: JA 2002 <sup>b</sup> ; 2003: JA 2003 <sup>b</sup> ; 2004: JA 2004 <sup>b</sup> ; 2005: JA 2005 <sup>b</sup> ; 2006: JA 2006 <sup>b</sup> ; 2007: JA 2007 <sup>b</sup> ; 2008: JA 2008 <sup>b</sup> ; 2009: BB 2009; 2010: BB 2010; 2011: BB 2011; 2012: BB 2012

<sup>a</sup> Taken from electronic database of the city council (Ratsinformationssystem).

<sup>b</sup> Information provided or supplemented by the city.

<sup>c</sup> Supplemented using the operator's homepage.

<sup>d</sup> Information provided by Stadtarchiv, Erfurt.

<sup>e</sup> Information provided by Institut für Stadtgeschichte, Gelsenkirchen.

*Note:* Sources for financial data by fiscal year, the name is the one chosen by the respective data provider, e.g. *2005: BB 2006* indicates that information for the year 2005 is taken from the document named *Beteiligungsbbericht 2006*. Amad=AMADEUS, BB=Beteiligungsbbericht, GB=Geschäftsbericht, HP=Haushaltsplan, JA=Jahresabschluss, JB=Jahresbericht, SP= Stellenplan, WP=Wirtschaftsplan. Area code identifies the city (*Amtlicher Gemeindeschlüssel*). For Aachen and Hannover, the consortium of cities and districts has been chosen (Städteregion Aachen and Region Hannover) that also constitutes the market size of the provider.

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