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Reverse privatization as a reaction to the competitive environment: Evidence from solid waste collection in Germany

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Reverse Privatization as a Reaction to the Competitive Environment

Evidence from Solid Waste Collection in Germany

*Juri Demuth, Hans W. Friederiszick and Steffen Reinhold**

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- 23. April 2018 –

After earlier waves of privatization, local governments have increasingly taken back control of local service provisions in some sectors and countries and, instead, started providing those services themselves (reverse privatization). Using a unique panel data set on the mode of service provision for solid waste collection for German municipalities covering the years 2003, 2009, and 2015, we investigate motives for reverse privatization. Our results show that, in deciding whether to insource or not, municipalities react to the cost advantages of private suppliers as well as to the competitive environment, with more switching to insourcing in concentrated markets. Furthermore, we find local contagion effects, that is, insourcing is more likely if municipalities close by also provide services themselves, whether in horizontally or vertically-related markets. Implications for competition law enforcement are discussed.

Keywords: local privatization, state-owned enterprises, competition law enforcement, mergers, logit regression

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1 Introduction

In recent years, German municipalities have taken back control of service provision from the private sector in the areas of energy, water, and waste collection, and have started providing those services themselves.[1] The process toward insourcing (in the following "reverse privatization") has reversed earlier waves of privatization during the 1980s. In this paper, we attempt to understand this process by analyzing municipalities' motives for the choice of the mode of service provision in the German solid waste collection sector.

More specifically, we focus on the role of local competition in a municipality's decision, be it in the form of competition between private operators and/or the availability of neighboring municipalities offering services themselves in horizontally or vertically-related markets. This paper thereby stays in the tradition of recent literature interpreting state action within the standard antitrust framework instead of the framework's non-application due to non-market behavior.[2]

Municipalities in Germany, as in most Western countries, have in their respective jurisdiction a legal monopoly on service provision in the solid waste collection industry. In this context a municipality can decide whether to rely on public provision (through in-house provision, a publicly owned firm or inter-municipal cooperation) or contract out to private suppliers in competitive bidding (or opt for some form of private-public partnership).[3]

An inherent trade-off in the choice of the municipality stems from the relative cost advantages of private suppliers versus the loss of control when contracting out. On the one hand, private suppliers potentially have some cost advantages both because their contracts provide better incentives to contain costs and because they are more flexible in generating economies of scale across municipal borders. To the extent that sufficient competition among private suppliers assures the (partial) pass on of efficiency gains to the municipality, contracting out may be considered preferential by the municipality.

By contracting out, on the other hand, the municipal decision-maker gives up control over the process, and this control might be valuable because it allows the municipality to also pursue additional objectives like employment or service quality. This is relevant specifically if the alternative objectives are not contractible, that is, the outcome is not observable. In-house provision may then be more efficient in providing the service, given these constraints.[4]

Correspondingly, one would expect reverse privatization to happen in the case of insufficient competition at the moment of re-tendering a contract and when cost-efficient public alternatives, for example, in the form of the experience of neighboring municipalities in providing the service, are available. These hypotheses are tested in this paper.[5]

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[1] This is a rather new development. In 2007 Bel and Fageda (2007) FN18 still formulated: "Recent studies show that reverse privatization may be an emerging issue in countries like the US […] and Canada […]. As of now, such a phenomenon does not seem to exist in the European Union." In Germany this trend has triggered an intensive political debate. Most recently a group of German trade associations, including the Federal Association of German Waste, Water and Raw Materials Industries (BDE), complained about an unequal level playing field with state-owned companies. (BDE, 15.3.2018, https://www.bde.de/presse/newsletter-archiv/showNL?nl=2673)

[2] See Konkurrensverket, 2009

[3] In general, a municipality also has the option to not offer a specific service, also known as "service shedding." This alternative is, however, not feasible in this sector as garbage collection is a legal obligation to the municipality. Monopolkommission, 2013, p.494 to 497, describe the legal and historic background of waste collection in Germany.

[4] See Hart, Shleifer, and Vishny, 1997

[5] In addition to this general trade-off, there might be fiscal motives in choosing between different modes of service provision, and/or the motive to exploit or restrain opportunities for political patronage. (Political patronage builds on the argument that politicians can win support from public employees when offering services in-house.) Ideology is also seen as a potential motive for or against privatization and nationalization, respectively. Accordingly, our analysis will control for these factors.

Our analysis relies on a unique panel data set of more than 11,000 German municipalities for the years 2003, 2009, and 2015. Given the time dimension of the data we can analyze changes in the mode of service provision for two waves of reverse privatization.[6] The paper offers the first empirical assessment of the German waste collection market beyond descriptive analysis and adds to the emerging literature on reverse privatization, offering an assessment based on the data of switching behavior.

Typically, three categories of factors influencing the choice of the mode of service provision are distinguished in the literature: economic efficiency, fiscal constraints, and political processes and ideological attitudes. Our data set allows us to control for a rich set of control variables covering those categories, including population and density measure, tax revenue and debt levels, voting behavior and unemployment rates.

In addition, in order to analyze the impact of local competition and public activity on the decision to insource, we calculated regional catchment areas around each municipality based on a 100km radius and calculate local market shares for each catchment area. Based on these market shares, the HHI and concentration ratios of the three largest providers (CR3) are calculated. In order to measure the regional effects of neighboring public activity we calculate the share of municipal provision in the neighborhood, based on a 25km circle around the target municipality. Additionally, in order to measure public activities at other stages of the value chain, a variable was constructed indicating the proximity to the next municipal waste incinerator plant. Based on these two variables we can test for local contagion effects across municipalities in horizontally or vertically-related markets.

In our empirical analysis we find that the likelihood of insourcing rises (i) with increased concentration among private suppliers ("competition effect"), (ii) a larger share of municipal provision in the neighborhood, and (iii) with municipalities' activity at other stages of the value chain (together referred to as "contagion effect"). These results are derived in a logit model framework controlling for demographic, political, and economic factors.

Two policy conclusions are drawn from these empirical findings: First, the decision of a municipality to reverse privatization is taken strategically, that is, in response to the outside options available in the market. The strategic behavior of a municipality therefore has the potential to restrain the market behavior of private firms and, hence, should be taken into account in a competitive assessment of regional markets, that is, within the context of merger proceedings.

Second, competition and contagion effects strengthen each other, as reverse privatization reduces the availability of cost-efficient private suppliers in neighboring regions and thereby increases the incentives for reverse privatization there as well. Hence, waves of privatization and its reversal occur: a self-enforcing spiral toward one or the other extreme (within some limiting factors) may arise. While an efficient outcome of such cyclicality seems to us to be at least questionable,[7] the optimal policy response to breaking cyclical behavior is less clear: establishing a centralized (i.e., national not local)

[6] Many of the empirical studies in this field rely on cross-sectional data, i.e., information on which municipality is served publicly and which by private operators. As pointed out in Bel and Fageda (2007, p.528–529), only studies based on switching behavior reflect motivations for (reverse) privatization accurately due to the inertia of the decision process of municipalities regarding the mode of provision of public services.

[7] As we cannot assess the deeper reasons behind the contagion effects, we cannot draw any robust conclusion on the efficiency aspect of cyclicality.

decision process is the most natural answer to this problem but it requires abandoning the benefits of decentralization, that is, local representation and competition of systems.

The paper is organized as follows. We first discuss the related empirical literature. Then, we present the underlying dataset and descriptive statistics. In the empirical assessment chapter, we carry out a visual analysis of the data before presenting our econometric model and the results. A final section discusses our findings.

2 Related Literature

A broad literature exists discussing motives for local privatization. The solid waste collection and water distribution sectors are – given data availability – two of the most often analyzed sectors. The majority of earlier empirical work relies on US data, though. It is only recent empirical work that has covered Europe, with studies for the solid waste collection sector analyzing markets in the Netherlands, Spain, and Scandinavia (and to a very limited extent also the UK and Italy). There is no empirical paper, beyond purely descriptive analysis, assessing motives for local privatization for German markets, be it on solid waste collection or related public services.

Most of the literature focuses on privatization (and relies only on cross-sectional data). Reverse privatization, being a rather recent trend, has been observed and assessed in the academic literature so far mostly in the US and Canada,[8] and more recently in the Netherlands.[9] The German competition authority identifies a tendency toward reverse privatization from mid-2000 onwards, specifically in the energy sector but also in waste collection, water markets, and the broadband sector.[10]

Typically, three categories of factors influencing the choice of mode of service provision are distinguished in the literature: economic efficiency, fiscal constraints, and political processes and ideological attitudes.[11] We summarize the findings of the empirical literature on local privatization by applying this categorization. The literature review begins with overview articles by Bel and Fageda from 2007/2009. Thereafter, we summarize the results of recent individual studies analyzing switching behavior in the mode of service provision. Given the evidence of country-specific effects in the literature, we order the review according to the jurisdiction covered.

Bel and Fageda, 2007/2009

Bel and Fageda (2009) undertake a meta-analysis of 32 existing studies of factors explaining local privatization for a range of different services, including solid waste collection.[12] They find that fiscal constraints and political and ideological considerations were important for US cases published in the 1980s. In recent studies, covering European regions more prominently, the influence of the political processes and ideological attitudes becomes less clear, though. There is some indication that ideology plays a more prominent role in large cities, while fiscal considerations and political considerations are more important drivers of privatization in smaller municipalities.

Regarding economic efficiency, US municipalities – in comparison to European municipalities – tend to be driven more by efficiency considerations. The latter result is potentially caused by less frequent cooperation between municipalities in the US than in Europe, incentivizing privatization to take advantage of the scale effects of cross-regional service provision.

More generally, the authors conjecture that studies focusing on one single service instead of a range are better able to capture scale economies, and flag the highly idiosyncratic character of many studies, limiting the potential for generalization. In their 2007 paper the authors come to the conclusion that

[8] Bel and Fageda, 2007, FN18
[9] Gradus et al. 2014
[10] Bundeskartellamt, Hintergrundpapier - Arbeitskreis Kartellrecht vom 02.10.2014, p.17/18
[11] Bel and Fageda, 2007
[12] Most of the studies covered (24 out of 32) are related to the US. From the single service studies covered the majority focus on solid waste collection (8 out of 15), that is, the service under consideration also in this paper. See Table A1 of their paper.

most of the empirical studies in this field rely on cross-sectional data. According to the authors, this may explain weak and inconsistent results in the literature.[13]

United States

López-de-Silanes et al. (1997) study the factors driving local privatization and the reverse privatization of public services in the United States. Their paper looks at the determinants of the mode of service provision for a broad range of services in a cross-section of US counties in 1987, focusing on political and fiscal variables. In this setting, identification of the effects is mostly derived from state-to-state variation in clean-government laws, labor market regulations, and state constraints on counties' budgeting decisions. Furthermore, they also investigate the determinants of switching between 1987 and 1992. In general, they find evidence of political motives being important for privatization. Clean-government laws and state laws restricting county spending encourage privatization; strong public unions discourage it. Regarding reverse privatization, they find union and labor market pressure to be the two most important factors stimulating reverse privatization. The results, based on switching behavior (i.e., variation over time), call into question the robustness of the cross-sectional analysis to some extent as coefficients are typically lower and less significant. The authors do not find a general trend toward privatization or reverse privatization during the period analyzed.

Warner et al. (2012) also analyze a dataset of US municipalities. Their dataset covers the years 2002 to 2007, allowing them to analyze switching behavior over time more rigorously. They find over this period ongoing experimentation on insourcing and outsourcing with approximately 23.5 percent of contracts for which the mode of service provision changed, around half of it toward private service provision and the other half toward in-house provision.[14] The authors find asset specificity to be one main course for reverse privatization as well as a lack of past monitoring: reverse privatization seems to be a response to hold up problems and limited oversight. They conjecture that while the number of alternative private suppliers does not explain insourcing,[15] mixed service provision is found to have a negative impact on insourcing: having both public and private provision in parallel allows for indirect monitoring and replacement threat, making reverse privatization unnecessary.[16]

The Netherlands

Dijkgraf et al. (2003) analyze a cross-sectional dataset covering all Dutch municipalities in 1998. They find that public provision is more likely for municipalities with a high number of inhabitants[17] and for municipalities receiving high transfers from central government. While they find some evidence of political patronage being relevant (measured by the share of public employees and unemployment), political ideology (measured by the share of various political parties) seems to be less relevant for the choice of the mode of service provision.

Gradus et al. (2014) analyze the mode of service for solid waste collection based on a panel dataset of Dutch municipalities, covering the years 1998 to 2010. The authors distinguish between five different

[13] Bel and Fageda, 2007, p. 528/529.
[14] For earlier time periods (1992 to 1997) the authors show that the share of contracts for which the mode of service provision changed lay at 29% (11% of the points are related to reverse privatization) and 30% during the period 1997 to 2002 (of which 18% relate to reverse privatization). (Hefetz and Warner, 2007) p.557.
[15] This result stays somehow in conflict to their earlier finding on a reduced dataset covering the years 1992 to 1997. Here, Hefetz and Warner (2004) find that an insufficient number of private suppliers suppresses privatization and (weakly) incentivizes in-house provision.
[16] There are further papers assessing motives for privatization for US counties or cities, i.e., Levin and Tadelis 2010 which analyzes a cross-sectional dataset of US cities and various services, including solid waste collection. Given the focus of our paper on European municipalities and switching behavior we do not summarize their results here.
[17] A positive relationship between public provision and number of inhabitants is observed up to around 300,000 inhabitants. In the Netherlands only three cities exhibit more inhabitants.

modes of service provision: in-house collection, outsourcing to neighboring municipalities, municipal cooperation, municipal enterprises, and through private enterprises (ordered according to the degree of inside production versus outside production). Around a half of the municipalities analyzed change the mode of service provision during the observation period. Of those, two-thirds switched toward (partial) outside production, that is, toward a mode closer to private enterprise provision, and one-third toward (partial) inside production, that is, toward a mode closer to in-house production. Focusing on the first part of the observation period (1998 to 2004) more switches toward outside production (privatization) are observed than in the second period (2005 to 2010) where the share of changes toward inside production (in-house provision) increases. Within a logit model framework, the authors find (weak) evidence of ideological motives for switching, specifically toward privatization. Regarding reverse privatization, no statistical significant effect is found but for the counterintuitive result that socialist democrats oppose reverse privatization. More generally, the authors find that richer municipalities are less likely to privatize; a result which is confirmed by a broader study of 12 different services in the Dutch market (Schoute et al. 2017).

Schoute et al. (2017) show that asset specificity and measurement difficulty increases the probability of in-house provision versus private firm provision. Regarding solid waste collection, survey results – collected from an expert panel of 30 municipal financial managers responsible for solid waste collection in the Netherlands – indicate that solid waste collection is perceived as a service with rather specific assets (in comparison to other services) while measurement of output is considered rather simple.[18] Hence, an ambiguous expectation regarding the mode of service provision prevails regarding solid waste collection. Indeed, the authors find a broad variety of modes of service provision for this industry. Regarding political factors, the authors find that left wing-oriented municipalities prefer municipal services in cooperation with other municipalities, whereas right wing-oriented municipalities prefer services provision by private firms. The governance structure of a municipality also matters for the mode of service provision chosen (output orientation vs. input orientation).

Spain

Bel and Miralles (2003) analyze the role of economic and political factors for the local privatization of solid waste collection in municipalities in Catalonia, Spain. Their dataset is based on a survey that also collects the date of privatization for a specific municipality. This allows us to conduct an analysis around the point in time of change, limiting the shortcomings of a cross-sectional analysis. The authors find that privatization is more common in mid-sized municipalities (non-linear relationship) and that the private provision of services by neighboring municipalities increases the likelihood of privatization.[19] The rationale for this effect is seen in economies of scale for private offerings, and the potential of a local government to compare the management of the services with that of the neighboring municipalities, which in turn chooses to privatize.[20] They do not find fiscal motives to be important nor does ideology bias the decision to privatize.

Also, Bel et al. (2008) ask whether inter-municipal cooperation competes with privatization as a means of realizing economies of scale. They address this question based on a sample of 559 Spanish municipalities in the solid waste collection and water distribution sectors in the year 2003. They find that privatization is more common for solid waste collection than for water distribution, arguing that this is consistent with higher transaction costs in water distribution due to high asset specificity. The

[18] This is consistent with the survey outcome of city managers in the US which considers measurement of output to be very simple for solid waste collection but the risk of hold up problems, i.e., asset specificity, to be moderate. Levin and Tadelis (2010), p.522.
[19] This result is confirmed in Bel et al. 2013.
[20] Neighboring effects are also found by Asensio (2009) for the privatization of local water services in Catalonia, Spain. While in a first privatization wave in the Eighties water privatization was more likely in regions where there had been no previous privatization, a positive relationship is found for the second wave of privatization (in the Nineties). During the second wave, concerns about service efficiency became more relevant than replacing old infrastructure.

authors find that inter-municipal cooperation is sometimes used as an alternative to local privatization as inter-municipal cooperation is negatively related with privatization.

Scandinavia

Ohlsson (2003) analyzes a data set covering Swedish solid waste collection markets. The data set is based on a survey carried out by the Swedish competition authority in 1989 and covers the costs and ownership information of solid waste collection in 115 of Sweden's 284 municipalities. In roughly half of the municipalities included in the assessment waste collection was organized completely or partially by the municipality, in the other half by private firms. While the focus of his work is on how to correctly measure cost differentials between private and public firms the author also analyzes the municipalities' decision to choose between public or private provision. He finds that municipalities that carried out a cost analysis ex ante had a higher probability of privatizing; ideology (measured indirectly by the share of single-family houses) also influenced the privatization decision. Interestingly, the author finds that without controlling for a potential selection bias the costs of private firms are measured as being 13 percent higher instead of 6 percent lower than the costs of public firms, meaning private firms are chosen specifically when costs of collection are high.

Sorensen (2007) analyzes the role of dispersed public ownership (inter-municipal cooperation) for the Norwegian solid waste collection markets (data for 2005 for 434 municipalities, excluding Oslo). While most of the waste collection is organized by the municipalities (85 to 90%) significant variation does exist in the number of municipalities that hold joint ownership of the company providing services. The authors find that dispersed ownership significantly reduces the efficiency of the service provision (6% efficiency loss moving from one owner to a dispersed ownership structure) typically outweighing the positive effect of economies of scale. A result which is confirmed by Garrone et al. (2013) who analyze 27 inter-municipal cooperations in Italy serving multiple services.

UK

For the UK solid waste collection market Bivand and Szymanski (2000) use data on waste collection costs to measure the spatial impact from the introduction of a compulsory competitive tendering. While municipalities offered services before in-house, the change in regulation required competitive tendering. The authors find a spatial correlation of waste collection costs for close-by municipalities before the policy change but no, or attenuated correlation thereafter. This is in line with local learning between municipalities offering the service in-house. Competitive tendering replaces the imperfect (locally shared) information with a more informative market-wide signal.[21]

Germany

Privatization of waste collection services was the dominant trend during the 1980s in West Germany, and since unification also in eastern Germany. In the waste collection industry the Waste Disposal Law of 1986 further spurred the trend to privatization (see Friedländer, 2013). However, since the late 1990s, observers have noted a reversal in this trend.[22]

Böckers et al. (2017) analyze a data set on the mode of service provision for solid waste collection for German municipalities. The descriptive analysis is based on a cross-sectional data set for the year 2015.

[21] See also the discussion of potential contagion effects in Dijkgraf et al. (2003, p.556).
[22] For the German context see Bardt et al. (2010), Monopolkommission (2013), Bataille and Steinmetz (2014), Engartner (2009), Verbücheln (2009), Wollmann (2013).

They find that municipalities serve around 34 percent of all municipalities covered by the study[23] but that these municipalities represent 62 percent of the inhabitants, that is, in-house provision of solid waste collection services seem to be most common in urban/more densely populated regions. The focus on highly populated regions is considered by the authors as evidence of cherry-picking by municipalities, serving those regions which can be served most profitably.

There are also a few empirical papers on the trend of reverse privatization in related sectors, other than solid waste collection, in Germany. Cullmann et al. (2016), for instance, find an increasing number of public firms and increasing revenues in the energy sector. However, the revenue of private firms expanded by even more, resulting in a slightly reduced share of in-house provision over the time period 2006 to 2012 in the energy sector. Hence, in contrast to what we find in the German solid waste collection sector, the authors do not find a trend of reverse privatization in the energy sector.[24][25] The conflicting results between different sectors again highlight the importance of sector-specific analysis as already flagged in Bel and Fageda (2009).

[23] The statistics on public vs private provision of services are broadly consistent with what we find in our dataset. Minor differences can be explained by the broader coverage of our dataset as Böckers et al. (2017) had to rely on publicly available information and, hence, do not include some regions which are served by private firms.

[24] This result stays in conflict, though, with the finding of the German competition authority. (Bundeskartellamt, Hintergrundpapier - Arbeitskreis Kartellrecht vom 02.10.2014, p.17–18.

[25] One potential reason for this different trend is the lack of cost advantages of private firms in this industry segment. In relation to the provision of drinking water in Germany Zschille (2016) finds, for instance, no substantial cost benefits due to consolidation. The drinking water supply is predominantly served by public utilities and is highly fragmented in Germany.

3 Data and descriptive statistics

For the analysis, we rely on two main data sources: (i) the municipality data set providing information on the mode of service provision in each municipality, and (ii) public statistics on various aspects of the municipalities' characteristics. In the following, we describe the underlying data.

3.1. Mode of service provision

The municipality data set[26] covers more than 11,000 German municipalities for the years 2003, 2009, and 2015. The number of municipalities declined over the observation period from over 13,358 in 2003 to 11,253 in 2015 because of administrative mergers between municipalities. Given the time dimension of the data we can analyze changes in the mode of service provision for two episodes of reverse privatization, namely 2003 to 2009 and 2009 to 2015.

The municipality data set consists of information on the supplier who holds a certain solid waste collection contract in a municipality or whether the municipality provides this service in-house. Among municipalities the data set also identifies inter-municipal cooperation as another form of in-house provision where different municipalities cooperate in providing the service.[27] Municipalities that do not provide services in-house are required to hold a procurement auction. It is possible that a municipal company will participate in a procurement auction in a neighboring municipality. Public-private-partnerships are also identifiable in the data set, and it is possible to identify the group to which the private partner belongs.

From this information we create a dummy variable taking the value 1 if the municipality provides services in-house, 0 otherwise. That is, service provision by the municipality itself or by cooperation with another municipality is considered in-house provision as a competitive tender is not required. Alternatively, service provision by a private supplier, by a municipal enterprise participating in a competitive tender and provision by a private-public partnership are considered to be an external provision.[28]

Based on changes of this dummy variable over time, episodes of (reverse) privatization can be identified. The following transition matrix provides an overview of the share of municipalities which did or did not switch between in-house and no in-house provision for the two episodes, 2003 to 2009 and 2009 to 2015.

[26] This dataset was produced by Remondis. It is based on publicly available information and business knowledge of Remondis.
[27] So-called "Zweckverband" according to German law.
[28] This definition centers around the requirement of a competitive tender. Given the focus of this paper, i.e., the impact of local competition, this seems to us to be the most relevant delineation line. If one seeks an answer to the question of the role of state institutions in the economy, private-public partnerships and commercial offers by public firms also potentially qualify as the public provision of commercial services.

Table 1: Switching events in percent, 2003/2009 and 2009/2015

	No in-house provision in 2009	In-house provision in 2009
No in-house provision in 2003	78.3%	8.5% reverse privatization
In-house provision in 2003	1.5% privatization	11.8%
	No in-house provision in 2015	**In-house provision in 2015**
No in-house provision in 2009	75.9%	4.7% reverse privatization
In-house provision in 2009	0.0% privatization	19.4%

Source: The authors.

As can be seen in the dark gray cells, switching occurred more often during the first episode than during the second, namely 10 percent and 5 percent, respectively. Across both episodes, switching occurred predominantly from "no in-house provision" to "in-house provision," that is, reverse privatization. Switching from "in-house provision" to "no in-house provision," that is, privatization, is a rather rare event and occurs mostly in the first episode. In absolute terms, we observe 178 privatization events between 2003 and 2009 and five between 2009 and 2015. The low number of privatization events prevents a robust analysis thereof. In comparison, the number of reverse privatization events is above 1,400 across the two episodes. As a result, in 2015 24 percent of all municipalities were using in-house services for waste collection while in 2003 only 13 percent were relying on in-house services.[29]

3.2. Indicators of local competition and close-by public activity

Based on geo-coordinates and population data, we construct variables summarizing the competitive environment in the solid waste collection industry. In line with the practice of the German Competition Authority[30] for each company, or the group to which it belongs, we calculate market shares among the privately supplied municipalities in a 100km circle around the midpoint of each municipality, not taking into account the target county. The HHI and concentration ratios of the three largest providers (CR3) are calculated based on these market shares.

In order to measure the regional effects of close-by public activity we calculate the share of municipal provision in the neighborhood, based on a 25km circle around the target municipality. For this calculation we again exclude the county to which the municipality belongs as the decision for private or public provision is taken at county-level in some counties. We restrict the radius to 25km because in those neighboring municipalities informal information flows between municipal decision-makers are more likely than in a wider 100km radius.[31]

[29] Please note that this statistic is conservative with respect to the involvement of public entities as it excludes municipal enterprises participating in a competitive tender and private-public-partnerships. Absolute numbers of switching events are given in the appendix.
[30] See, for instance, (Sulo / Cleanaway, 2006), (Remondis/RWE Umwelt, 2005), (Rethmann / Entsorgungs-Service Anhalt-Mitte GmbH / Tönsmeier, 2004).
[31] In the appendix we offer a sensitivity with a 100km radius and find the results to be substantially unchanged. In fact, the coefficient of the municipal share is in this variant positive and statistically significant during both episodes (in the baseline model it is statistically significant during the second episode only).

Additionally, in order to measure public activities at other stages of the value chain, a variable is constructed that measures the distance to the next municipal waste incinerator plant. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety provides a list with all waste incinerator plants in Germany. This information is complemented and cross-checked by data from ITAD (the trade organization of waste incinerator plants). All sites are geocoded using Google Maps. We also collect information on whether the incinerator plant is in municipal hands or privately held, as of today. Entry and exit, and change in ownership is considered as far as public information is available.[32] We then calculate for each municipality the distance to the next municipal waste incinerator plant. Based on the distance, we derive a proximity measure based on the following formula:

$$Proximity = \frac{Max(Distance) - Distance}{Max(Distance)}$$

If the incinerator is situated in the center of a municipality, distance to it is zero, and the proximity measure takes on the value of 1. If the distance from the center of the municipality to the waste incinerator plant is 215km (the maximum observed distance), the proximity measure takes on the value 0. Thus, the proximity measure is just a re-scaled version of distance, taking values between 0 and 1.

3.3. Other explanatory factors

In line with the related literature, we allocate the other explanatory variables to the following categories: economic efficiency, fiscal constraints, and political processes and ideological attitudes.

Most of the public statistics are available only on a more aggregate county ("Landkreise") level, though. Furthermore, there have been some instances where smaller municipalities have merged into larger units while counties' boundaries are more stable over time. Accordingly, the other explanatory factors have been collected on a county-level and have been merged with the municipality data, that is, municipalities of the same county are associated with the same other explanatory factors.[33] The data are collected for the years 2003, 2009, and 2015. For the regression analysis, however, only the values for the years 2003 and 2009 are used as we deploy lagged explanatory variables to exclude reverse causality problems.

Economic efficiency

The German Federal Statistical Agency, Destatis, provides information on population, population density, area, and geo-coordinates for each municipality. We use the number of population and population density as relevant measures. Population and population density are relevant variables to control for efficiency differences in public versus private service provision: If economies of scale are an important factor in the waste collection industry, population and population density partly proxies for cost differences between private and public suppliers (Bel and Fageda, 2009). Specifically, in the literature it is conjectured that private suppliers seem to be better suited to using economies of scale across municipal borders, which gives them a principal cost advantage in less populated areas. Hence,

[32] Most of the investment in new incinerator capacity was induced by the phasing out of landfills in 2005. After this date, unsorted waste from households could no longer be brought to landfills, but instead had to be treated differently. Accordingly, during the period 2004 to 2009 significant additional incinerator capacity was brought into the market. See Energie Brainpool, p.21, https://www.energybrainpool.com/fileadmin/download/Studien/Studie_2017-02-09_ITAD_Beitrag-TAB-zur-Energiewende_Energy-Brainpool.pdf]

[33] On average, each county exhibits 26 municipalities in the data set in 2015.

one would expect that this cost disadvantage of public provision allows public provision to become competitive only in sufficiently densely populated municipalities whereas rural municipalities are more cost efficiently served by private suppliers.

Fiscal constraints

We use the per-capital tax revenue for the years 2003, 2009, and 2015 at county-level to measure the fiscal constraints a municipality faces. Municipalities with a lower per-capita tax revenue are potentially more constrained and, hence, may have stronger incentives to privatize and lower incentives to insource private activity.

Furthermore, per-capita public debt levels are introduced as a measure of fiscal constraints. Municipalities with a higher debt level per-capita are potentially more constrained and, hence, may have stronger incentives to privatize and lower incentives to insource private activity. However, due to a break in the methodology data after 2009 is not directly comparable to data prior to that date. For the regression analysis this is unproblematic, though, as we only use the values for the years 2003 and 2009.

The different tax treatments shown towards public and private providers complicate this picture. A potential advantage for providing services in-house is different tax treatment. Whereas private providers are subject to the German value-added tax, municipal providers are not taxed under certain conditions. Furthermore, a municipality often also runs deficits when providing certain services, for instance, public swimming pools. If the same municipal provider is active in loss-making activities and profitable activities like refuse collection, the profits in one activity can be reduced by losses in other activities. Private providers, in principle, can also claim those losses, but they are usually not engaged in activities which inherently do not generate sufficient profits. As the situation regarding tax advantages did not change substantially[34] during the observation period we consider them covered by the broader fiscal measures described above: more financially constrained municipalities will value those tax advantages higher.

Political processes and ideological attitudes

Two variables are available to measure differences in the political processes and ideological attitudes across municipalities and over time – the unemployment rate and leftist parties' vote shares.

Regarding the first variable, the unemployment rate at county-level is used as a measure of the social and economic pressure on local politicians. A high unemployment rate may trigger a political debate on insourcing economic activity in order to increase local employment. The data is available at county-level for the years 2003, 2009, and 2015 from Destatis.

Regarding the second variable, results from the federal elections at county-level are deployed as a measure of ideological attitudes. The federal elections took place in September 2002, 2009, and 2013. The election outcome is matched to the municipal data set for the years 2003, 2009, and 2015, respectively. From those results we generate a summary variable containing the sum of the leftist parties' vote shares: Social Democrats ("SPD"), Green Party ("die Grünen"), and the Socialist Party ("Die Linke"). While those results do not give direct information about who governs a certain municipality it does give a general tendency about the political leanings of the citizens in a certain

[34] In 2007 VAT rates were increased from 16% to 19%.

municipality. The expectation is that in municipalities with a higher leftist party share insourcing occurs more frequently.

3.4. Summary statistics

The following table provides the descriptive statistics of the variables included in the regression analysis.

Table 2: Explanatory variables, summary statistics, 2003 to 2009

	Average	Standard Deviation	Minimum*	Maximum
Population (number of residents)	6,416.2	43,173.8	4.0	3,442,675
Population density (Population/sq. km)	173.7	264.2	0.9	4,283.6
Concentration ratio 3	64.2	12.1	28.3	100.0
HHI of private suppliers	1,909.8	750.4	617.1	9,951.3
Municipal share (in %)	29.5	30.4	6.6	100.0
Proximity	0.7	0.2	0.01	1.0
Vote share of leftist parties (in %)	46.8	10.8	19.4	76.7
Unemployment rate (in %)	9.8	5.6	2.2	27.3
Per-capita tax revenue (in Euro)	520.5	221.0	140.7	2,315.1
Per-capita debt in '000 Euro	1.4	0.7	0.1	3.9

Source: The authors, based on municipality data set and public regional statistics. For the regression results only values for the years 2003 and 2009 are used. *Lowest value above zero.

Table 3 shows the development of these factors over time. It has to be noted that changes over time with respect to population and proximity to next municipal incinerator is partially driven by mergers of municipalities. The share of leftist parties is declining over the observation period; the same trend can be observed for the unemployment rate. The average per-capita debt of municipalities is stable between 2003 and 2009 and increasing significantly in 2015; the tax revenue per capita is increasing more steadily over time.

Regarding concentration, the average is slightly declining from 2003 to 2009 and increasing thereafter. Note that this is a simple average, that is, not weighted by population.[35] The share of municipalities offering the services in-house is increasing over time.

Table 3: Explanatory variables, averages, 2003, 2009, and 2015

	2003	2009	2015
Population (number of residents)	6181.5	6671.5	7185.6

[35] Population weighted averages are for concentration ratio 3 67.01% (2003), 62.91% (2009) and 66.84% (2015) and for HHI 2,202.3 (2003), 1,853.0 (2009), and 2,242.2 (2015).

Population density (Population/sq. km)	169.6	178.1	185.1
Concentration ratio 3	64.97	63.38	65.88
HHI of private suppliers	1962.4	1852.7	2147.1
Municipal share (in %)	27.36	31.88	36.32
Proximity	0.687	0.706	0.722
Vote share of leftist parties (in %)	49.89	43.37	38.90
Unemployment rate (in %)	11.64	7.805	5.465
Per-capita tax revenue (in Euro)	461.0	585.3	847.1
Per-capita debt in '000 Euro	1.390	1.391	1.503

Source: The authors, based on municipality data set and public regional statistics.

4 Empirical assessment

In the empirical assessment, we investigate switching events to identify the motives for in-house provision. In particular, we explore differences in the characteristics of municipalities which took the decision to switch to the public provision of solid waste collection services. This is first done by a visual analysis; thereafter the data is analyzed within a logit model framework. The analysis differentiates between switching events occurring between 2003 and 2009 (the "first episode of reverse privatization") and between 2009 and 2015 (the "second episode of reverse privatization").

4.1 Visual analysis

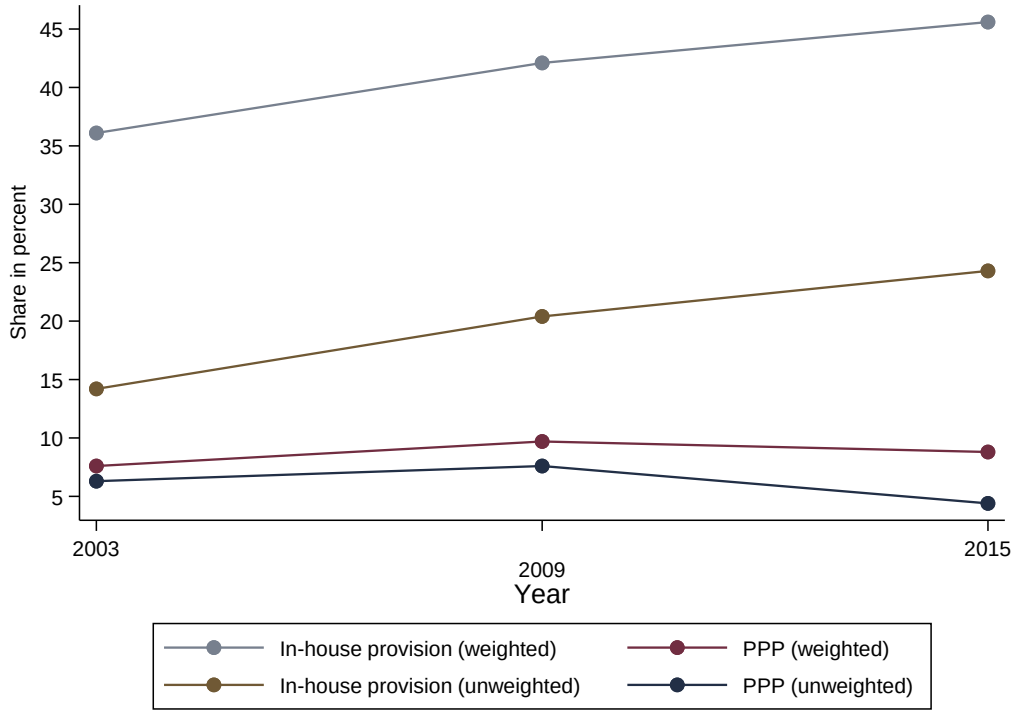
Figure 1 shows the share of municipalities which provide waste collection services in-house. The shares are given for the years 2003, 2009, and 2015. Figure 1 also shows the share of municipalities which provide waste collection services through a private-public partnership company. Both shares are calculated unweighted, that is, based on the number of municipalities, and weighted by population.

Figure 1 offers several insights. First, comparing the share of municipalities with in-house provision unweighted and weighted by population, the latter is substantially higher than the former. Hence, larger municipalities are overrepresented in the group of municipalities delivering the services in-house. This result is consistent with the findings of Böckers et al. (2017) for the year 2015.

Second, the share of municipalities with in-house provisions is increasing over time, that is we observe reverse privatization in the data. As one can see, the share of in-house provision increased from 36.1 percent in 2003 to 42.1 percent in 2009 and 45.6 percent in 2015 (based on the population weighted shares). The increase is more pronounced during the first episode of reverse privatization.

Finally, we also depict the share of private public partnerships as they are a mixed form of private and public provision. The share of private public partnerships is slightly increasing from 2003 to 2009 but is stable/slightly declining from 2009 to 2015. Also, for private-public partnerships the population weighted share is larger than the unweighted share, that is, private-public partnerships are more common in larger municipalities.

Figure 1: Municipal and Private-Public Partnership ("PPP") share at federal level, 2003, 2009, and 2015

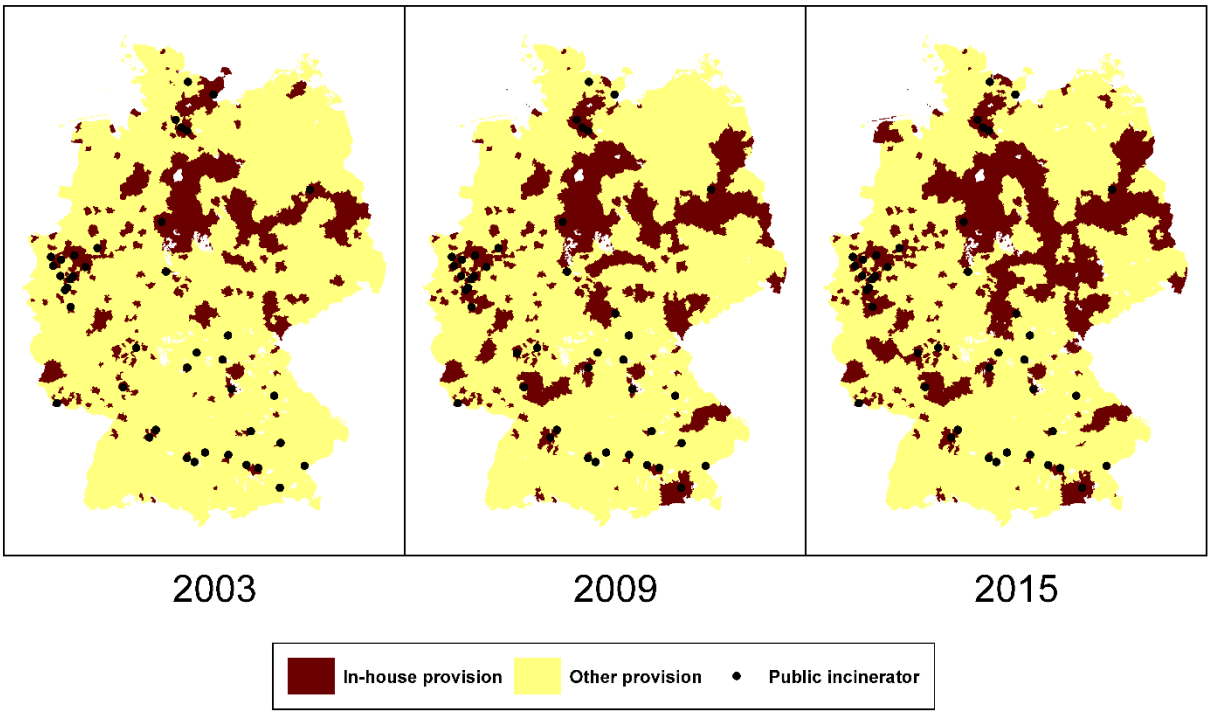


Source: The authors, based on the municipality data set.

Figure 2 offers a regional view of the evolution of reverse privatization. The red areas represent municipalities which provide solid waste collection in-house; yellow areas are the regions which are served by private firms, private-public partnerships, or public firms acting commercially.

We also depict the location of incinerators in public ownership. This is due to the hypothesis that publicly owned incinerators also trigger the public collection of solid waste: steering waste to the public incinerator may be more easily feasible in the case of public waste collection.

Figure 2: In-house provision of solid waste collection in Germany, 2003, 2009, and 2015



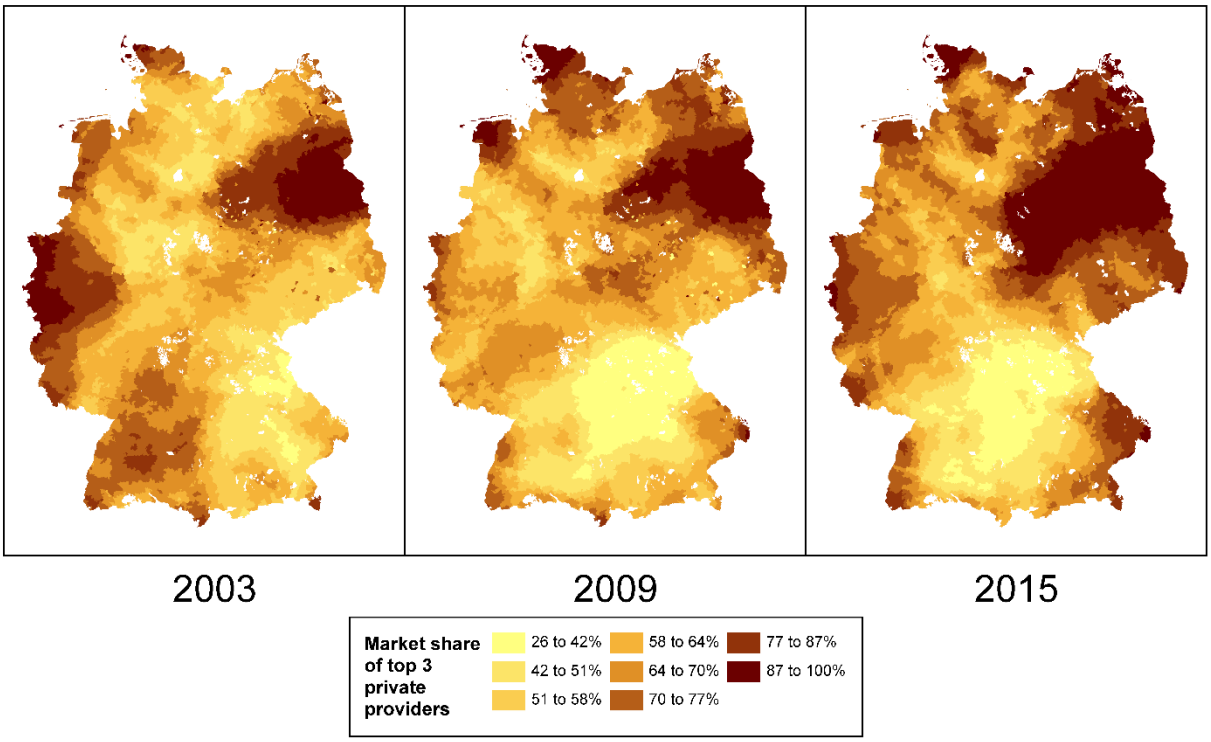
Source: The authors based on the municipality data set and publicly available information on public incinerators.

As can be seen in Figure 2, the area covered in red is increasing over time, that is, the phenomenon of reverse privatization is recognizable in the regional data. Notably, the increase of regions served in-house exhibits the characteristic of regional correlation: the red-marked areas are locally clustered and extension occurs around existing clusters. This is in line with the hypothesis of the existence of local contagion effects. While local clustering is more pronounced in the eastern part of Germany, that is, the Neue Bundesländer, the phenomenon is observable across Germany.

Figure 2 also offers some first indications that the proximity of public incinerators is correlated with regions being reversed privatized. This is, for instance, the case in the Ruhr Valley (in the West) and the region around Hamburg (in the North). Here, the proximity of a large number of publicly owned incinerators coincides with a large fraction of the market being served by public waste collection. For the southern parts of Germany this coincidence is less obvious.

Figure 3 shows the development of regional market concentration. As explained before, for each municipality we calculated a local measure of concentration, that is, the sum of the market shares of the three largest private suppliers (CR3) based on a 100km catchment area. As can be seen, concentration increased over time, with the exception of the Ruhr Valley from 2003 to 2009. The most pronounced increase of concentration occurred in the Neuen Bundesländer, a region which also experienced a substantial wave of reverse privatization. The graphs look substantially the same if produced based on HHI statistics (see appendix).

Figure 3: Market concentration (CR3) for solid waste collection in Germany, 2003, 2009, and 2015



Source: The authors, based on the municipality data set.

Moving from visual to statistical analysis Table 4 offers a t-test to assess the differences between municipalities which did reverse privatization, that is, switched to in-house provision, and municipalities which did not switch to in-house provision, that is, did not switch at all or switched to another alternative to in-house provision.

As one can see in Table 4, municipalities which do reverse privatization exhibit in comparison to non-switching municipalities a larger population, are more densely populated, vote share of leftist parties, and the unemployment rate is larger, both tax revenue and per-capita debt is lower, concentration measured by CR3 and HHI is higher, the share of public provision by neighboring municipalities is higher, and the proximity to the next municipal incinerator is roughly the same.

Table 4: Comparative analysis for municipalities which switched compared to non-switching municipalities: Averages, and t-test of differences of lagged values

	No switch to in-house (I)	Switch to in-house (II)	Difference (II-I)	T-test of difference	P-values (two-sided test)
Population (number of residents)	4964.1	6006.4	1042.3	2.226	0.026
Population density (Population/sq. km)	168.6	202.5	33.9	5.393	0.000
Concentration ratio 3	62.9	64.8	1.9	6.182	0.000
HHI of private suppliers	1853.0	1891.3	38.2	1.935	0.053
Municipal share (in %)	26.5	31.7	5.2	6.687	0.000

Proximity	0.71	0.69	-0.02	-3.438	0.001
Vote share of leftist parties (in %)	44.7	46.9	2.2	8.013	0.000
Unemployment rate (in %)	8.9	10.7	1.8	12.725	0.000
Per-capita tax revenue (in Euro)	542.2	471.2	-71.0	-12.223	0.000
Per-capita debt in '000 Euro	1.44	1.36	-0.08	-4.144	0.000

Source: The authors, based on the municipality data set and publicly available information.

A few points are worth noting before turning to regression results. First, the vote shares of leftist parties and the unemployment rates are potentially highly correlated (also reflected in the common trend over time, see Table 3). Municipalities which exhibit high unemployment rates, one can assume, tend to vote for left parties and vice versa. Given that both characteristics are more pronounced in municipalities which do switch to in-house provision separating the two effects is hardly feasible.

Second, both the per-capita debt indicator and the tax revenue per-capita are lower for municipalities which do switch to in-house provision. This seems to be counterintuitive at first glance, but the relationship between tax revenues and debt per capita is not very close in the data sample. One reason for this is that per-capita debt and tax revenues for eastern Germany municipalities often come hand in hand. When looking at individual states and changes over time, however, typically a negative relationship between per-capita debt and tax revenues is visible.

4.2 Regression analysis

The model

In the following regression analysis, the switching behavior of municipalities over the time span 2003 to 2015 is analyzed within a logit model framework. In analyzing reversed privatization, the sample is restricted to municipalities which originally contracted out and switched to in-house provision.

We assume a panel logit model of the following form

$$Pr(RP_{it} = 1|x_{it-6}) = \frac{\exp(x_{it-6}\beta)}{1 + \exp(x_{it-6}\beta)}$$

with $t=\{2003, 2009, 2015\}$ and i representing individual municipalities. Within that framework reverse privatization, $RP=\{0,1\}$, during a particular episode is measured at the end of the episode and explained by the observed variables (represented by the vector x) at the beginning of the episode. For example, switches to in-house provision between 2003 and 2009 (first episode) are explained by the level of the explanatory variables in 2003. With this approach we exclude reverse causality from affecting our results. This is in line with the approach recommended by Bel and Fageda (2007, p.528), spotting low explanatory power of static models which link the mode of service provision in a year with the value of some explanatory variable of the same year. Following standard practice, the coefficients of the explanatory variables are estimated via a maximum likelihood estimator.

The results

Table 7 shows the results for seven variations of the model, with model seven as our baseline model. The number of factors we are controlling for is increasing over the variants. All model variations include time fixed effects for episode 1 and episode 2 and state fixed effects for the 16 German Länder. Hence, identification comes via within-state variation and non-common time variation. The different regressions are run over the same sample, that is, the sample is restricted to observations for which all explanatory variables are available.

In the first variant we included those explanatory variables for which the literature identified robust relationships, that is, population/efficiency-related measures. In variants 2 to 4 we include factors of central interest to this paper, that is, variables related to local competition and close-by public activity. Political variables and fiscal constraints-related variables are included in the variants 5 to 7.[36]

Table 5: Reverse privatization, variations of the model, 2003 to 2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7) Base line
Population (number of residents)	-0.0000633	-0.000177	-0.0000491	0.000115	0.000600	0.000505	0.000395
	(0.00150)	(0.00149)	(0.00147)	(0.00144)	(0.00148)	(0.00149)	(0.00152)
Population density (Population/ sq. km)	0.000771***	0.000758***	0.000710***	0.000596***	0.000679***	0.000682***	0.000770***
	(0.000112)	(0.000113)	(0.000115)	(0.000117)	(0.000119)	(0.000119)	(0.000123)
Concentration ratio 3		0.0148***	0.0151***	0.0173***	0.0150***	0.0156***	0.0164***
		(0.00289)	(0.00290)	(0.00301)	(0.00313)	(0.00312)	(0.00318)
Municipal share (in %)			0.00198**	0.00112	0.00242**	0.00260***	0.00263***
			(0.000965)	(0.000967)	(0.000974)	(0.000982)	(0.000985)
Proximity				1.308***	1.648***	1.784***	1.807***
				(0.234)	(0.256)	(0.257)	(0.257)
Vote share of leftist parties (in %)					-0.0555***	-0.0590***	-0.0574***

[36] The variable "public debts" is not included in the pooled estimation. In the appendix results per episode are shown including this variable. The results regarding competition and contagion effect-related variables do not change substantially. The impact of public debt on the probability to switch to in-house provision is estimated to be negative in the first episode but positive in the second, and statistically significant.

					(0.00631)	(0.00655)	(0.00649)
Unemployment rate (in %)						0.0281**	0.0150
						(0.0140)	(0.0148)
Per-capita tax revenue (in Euro)							-0.000814***
							(0.000301)
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	19546	19544	19544	19542	19542	19542	19542

Source: The authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

We make the following observations: First, with respect to population/efficiency-related variables, the population number itself is not influential for the decision of a municipality to switch to in-house provision during the two episodes analyzed here; population density, however, is. More densely populated municipalities are more likely to switch to in-house provisions. It should be noted, however, that population and population density are positively correlated, and therefore it is difficult to identify separate effects for those variables. When excluding population density, the coefficient on population size becomes positive.[37]

In this context it has to be noted that these more densely populated municipalities, which do switch, are not metropolitan regions but rather more densely populated smaller/mid-sized municipalities: the average population size of municipalities carrying out reverse privatization is just over 6,000 inhabitants; whereas the average size of the municipality, which has already been served by in-house provision, is more than twice as large. Very large city states, like Berlin, Bremen, and Hamburg, already started out with in-house service provision, and hence could not be included in the analysis.

Second, regarding the variables related to local competition and close-by public activity, all three variables – the concentration measure, the municipal share in the neighborhood, and the proximity to a municipal incinerator – show a positive coefficient. The municipal share is statistically significant if the variable "proximity to municipal incinerator" is not included (variant 3) or if political and fiscal constraints variables are also included (variant 5 to 7). The other two competition-related variables are statistically significant throughout all variants (with and without political and financial distress variables); the estimated coefficients are stable across variations of the model.

Third, we observe that the political and fiscal constraints-related variables are also often statistically significant and, hence, we keep them in our baseline regression, variant 7, as proxies for changes in political orientation and fiscal constraints. The unemployment rate and tax revenue per capita exhibit a reasonable coefficient: a higher unemployment rate implies reverse privatization as does lower tax

[37] Equally, when we define reverse privatization to include switches to private-public partnerships population density loses significance and population size gains significance (see appendix).

revenues. The results for the vote share of leftist parties, however, are counterintuitive, though. Typically, one would expect reverse privatization to be initiated by leftist parties. The sign and significance of the unemployment rate also depends on whether one includes or excludes the vote share of leftist parties, indicating some multi-correlation issues with respect to these variables. The central variables of interest – on local competition and close-by public activity – are by-and-large unaffected by this.

Table 6 shows the results for reversed privatization across both episodes (column 1), and for the first (column 2), and for the second episode (column 3).

Table 6: Reverse privatization, pooled data (2003 to 2015), episode 1 (2003 to 2009) and episode 2 (2009 to 2015)

	Pooled data (2003-2015)	Episode 1 (2003-2009)	Episode 2 (2009-2015)
Population (number of residents)	0.000395	0.000987	-0.000829
	(0.00152)	(0.00181)	(0.00273)
Population density (Population/sq. km)	0.000770***	0.000610***	0.000635***
	(0.000123)	(0.000151)	(0.000194)
Concentration ratio 3	0.0164***	-0.000675	0.0381***
	(0.00318)	(0.00417)	(0.00662)
Municipal share (in %)	0.00263***	0.00156	0.00457***
	(0.000985)	(0.00132)	(0.00150)
Proximity	1.807***	2.798***	0.561
	(0.257)	(0.307)	(0.526)
Vote share of leftist parties (in %)	-0.0574***	-0.0619***	-0.0766***
	(0.00649)	(0.00695)	(0.0161)
Unemployment rate (in %)	0.0150	0.0270	0.123***
	(0.0148)	(0.0211)	(0.0297)
Per-capita tax revenue (in Euro)	-0.000814***	-0.0000451	0.000471
	(0.000301)	(0.000411)	(0.000389)
N	19542	9752	8952
State fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	One cross-section	One cross-section

Source: The authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Regarding the competition variables, it can be observed that the municipal share and the concentration measure, CR3, are specifically influential for reverse privatization during the second episode. The

proximity to a municipal incinerator explains switching, in particular during the first episode. In the appendix we provide a variant that also includes per-capita debt levels as an alternative measure of fiscal constraints. The variables of interest – on local competition and close-by public activity – are stable to its inclusion. We also provide a variant considering private-public partnerships to be a form of in-house provision (see appendix). Again, the coefficients of the variables of interest, competition, and close-by public activity – are by-and-large unchanged. The proximity to a public incinerator gains more relevance. In addition, the unemployment rate gains significance, that is, reverse privatization (here, including a switch to private-public partnerships) is induced by higher unemployment rates.

The estimated marginal effects of the variables of interest—the predicted increase in the probability of insourcing in response to a change of one of the variables—are economically reasonable and relevant: a one percentage point increase in the municipal share leads to a 1.9 percentage point increase; a one percentage point in CR3 leads to a 1.1 percentage point increase in the probability of reverse privatization; increasing proximity by 0.1 corresponds to a 1.2 percentage point increase in the probability of reverse privatization. All marginal effects are calculated at the respective sample averages (see appendix for details).

5 Discussion

In this paper, we assess evidence and explore factors influencing the process of reverse privatization in the German solid waste collection sector over the years 2003 to 2015. Indeed, we find evidence of reverse privatization in the data set, a phenomenon observed in the academic literature so far mostly in the US and Canada, [38] and to some extent in the Netherlands.[39]

The extent of this trend is substantial. The population weighted share of in-house provision increased over the observation period by around 10 percentage points to 45.6 percent in 2015. More than 1,000 municipalities (8.5% of all analyzed municipalities) switched during the first episode, 2003 to 2009, from "no in-house provision" to "in-house provision," that is, carried out reverse privatization; during the second episode (2009 to 2015) the respective numbers are more than 500 and 4.7 percent. On the contrary, switching from "in-house provision" to "no in-house provision," that is, privatization, is a rather rare event and occurs only five times in the second episode.

Regarding the motives of reverse privatization, an interesting picture emerges from our empirical analysis. Regarding population/efficiency-related factors, we find reverse privatization, both during the first (2003 to 2009) and second episode (2009 to 2015), in more densely populated areas. An explanation for this relationship is that private suppliers are better suited to using economies of scale across municipal borders, which gives them a principal cost advantage in less-populated areas. This cost advantage of private provision allows public provision to become competitive only in sufficiently densely populated municipalities whereas rural municipalities are more cost efficiently served by private suppliers. This finding is in line with results in the literature (Kitchen (1976), Dijkgraf et al (2003), Bel and Fageda (2009)) which typically find economies of scale in the provision of solid waste collection up to some population level. Assuming that private firms are better at exploiting those economies of scale[40] reverse privatization is more attractive for less populated municipalities.[41]

At the same time, the competitive environment plays a major role. In-house provision becomes more likely in municipalities which operate in local markets with a high market concentration of private suppliers. This is consistent with the argument that municipalities take their decision to insource strategically, that is, in response to the outside options available in the market. A result also found by Hefetz and Warner (2004), who show for public services in the US that the lack of private suppliers is an impediment of reverse privatization ("contracting back-in").[42] The strategic behavior of a municipality therefore has the potential to restrain the market behavior of private firms. In a companion paper, we argue that one should consider more systematically the option of in-house provision when assessing the competitive situation in the waste collection industry and other service sectors where the municipality has the option to take back service provision in-house.[43]

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[38] See, for instance, Hefetz and Warner (2004) which analyzes contracting back-in in the US. Bel and Fageda (2007) FN18 states: "Recent studies show that reverse privatization may be an emerging issue in countries like the US […] and Canada […]. As of now, such a phenomenon does not seem to exist in the European Union."

[39] Gradus et al. (2014) find some evidence of an increasing number of reverse privatization in the Dutch market for the period 2005 to 2010, in comparison to earlier periods.

[40] Several papers find significant cost advantages of private provision of those services. See literature cited in Dijkgraf et al. (2003), p.555. Sorensen (2007) shows that, besides economies of scale, dispersed public ownership in the form of inter-municipal cooperation can also be a cause of inefficiency.

[41] The work by Ohlsson (2003) is of interest in this context as the author shows that private firms are chosen specifically when costs of collection are high.

[42] Warner et al. (2012, p.321) also analyze reverse privatization for US services during the period 2002 to 2007. In their regression model measures of market concentration are not statistically significant. However, dual sourcing, i.e., parallel public and private provision, has the expected impact on reverse privatization, indicating that dual sourcing works as a competitive threat.

[43] Friederiszick et al. (2016)

According to our empirical findings, in-house provision is also induced by the level of close-by public activity, be it the public provision of solid waste collection in neighboring municipalities or in vertically-related markets, that is, refuse incineration. A result which was also found for the UK solid waste collection market Bivand and Szymanski (2000)[44] and in the Spanish solid waste collection market with respect to privatization Bel and Miralles (2003) and Bel et al. (2013). This result points toward local learning between municipalities offering the service in-house. The impact of the proximity to a public incinerator again indicates a commercial strategy behind insourcing, that is, securing sufficient supply to potentially underutilized public incinerators.

The results on local competition and close-by public activity point to the possibility of a dynamic effect. As more municipalities switch to in-house provision, the likelihood of other municipalities switching may increase as well. First, this increases the municipal share in local markets, which increases the likelihood of further reverse privatization. Second, there is also a positive correlation between the municipal share and the concentration ratio. This correlation could arise, if with rising levels of municipal in-house provision smaller private sector providers find it even more difficult to compete than large providers and therefore exit the market. This increase in private sector concentration makes switching back to in-house provision even more attractive for municipalities. This could give rise to a "reverse privatization spiral" with an equilibrium consisting of a high municipal share and only a few large national private suppliers being able to compete whereas small local players exit the market. While an efficient outcome of such cyclicality seems to us at least questionable,[45] the optimal policy response to break cyclical behavior is less clear: establishing a centralized (i.e., national not local) decision process is the most natural answer to this problem but it requires abandoning the benefits of decentralization, that is, local representation and competition of systems.

[44] See also the discussion of potential contagion effects in Dijkgraf et al. 2003, page 556.

[45] As we cannot assess the deeper reasons behind the contagion effects, we cannot draw any robust conclusion on the efficiency aspect of cyclicality.

6 Literature

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Appendix

Appendix 1 – Switching events, absolute numbers

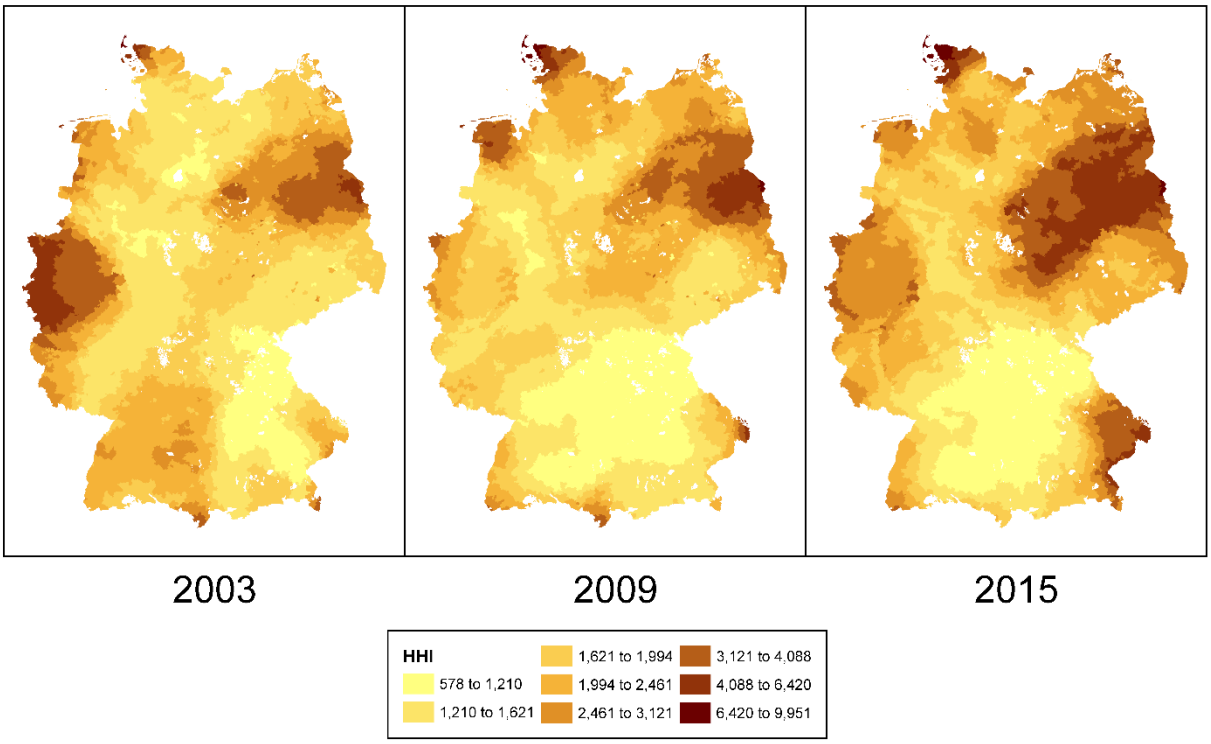
Table 7: Number of switching events, 2003/2009 and 2009/2015

	No in-house provision in 2009	In-house provision in 2009
No in-house provision in 2003	9,523	1,029 reverse privatization
In-house provision in 2003	178 privatization	1,433
	No in-house provision in 2015	**In-house provision in 2015**
No in-house provision in 2009	8,470	528 reverse privatization
In-house provision in 2009	5 privatization	2,162

Source: The authors.

Appendix 2 – Visual and regression analysis, based on HHI

Figure 4: Market concentration (HHI) for solid waste collection in Germany, 2003, 2009, and 2015



Source: The authors, based on the municipality data set.

Table 8: Reverse privatization, pooled data (2003 to 2015), episode 1 (2003 to 2009) and episode 2 (2009 to 2015) with HHI

	Pooled data (2003-2015)	Episode 1 (2003-2009)	Episode 2 (2009-2015)
Population (number of residents)	0.000487	0.00104	-0.00132
	(0.00154)	(0.00180)	(0.00264)
Population density (Population/sq. km)	0.000786***	0.000615***	0.000616***
	(0.000122)	(0.000151)	(0.000194)
HHI of private suppliers	0.0000803*	-0.0000693	0.0000731
	(0.0000422)	(0.0000619)	(0.0000620)
Municipal share (in %)	0.00248**	0.00143	0.00486***
	(0.000986)	(0.00132)	(0.00151)
Proximity	1.733***	2.796***	0.188
	(0.257)	(0.308)	(0.553)
Vote share of leftist parties (in %)	-0.0581***	-0.0623***	-0.0653***
	(0.00649)	(0.00699)	(0.0165)

Unemployment rate (in %)	0.0111	0.0262	0.153***
	(0.0148)	(0.0211)	(0.0276)
Per-capita tax revenue (in Euro)	-0.000757**	-0.0000506	0.000669*
	(0.000301)	(0.000412)	(0.000389)
N	19542	9752	8952
State fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	One cross-section	One cross-section

Source: The Authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Appendix 3 – Variant with public debt

Table 9: Reverse privatization, pooled data (2003 to 2015), episode 1 (2003 to 2009) and episode 2 (2009 to 2015) with debt per capita

	Baseline 2003-2015	2003-2009 With tax revenue	2003-2009 With debt	2003-2009 With tax revenue and debt	2009-2015 With tax revenue	2009-2015 With debt	2009-2015 With tax revenue and debt
Population (number of residents)	0.000395	0.000987	0.00316*	0.00311	-0.000829	-0.00100	-0.00105
	(0.00152)	(0.00181)	(0.00192)	(0.00196)	(0.00273)	(0.00298)	(0.00286)
Population density (Population/sq. km)	0.000770***	0.000610***	0.000481***	0.000489***	0.000635***	0.000805***	0.000725***
	(0.000123)	(0.000151)	(0.000146)	(0.000155)	(0.000194)	(0.000188)	(0.000195)
Concentration ratio 3	0.0164***	-0.000675	0.00960**	0.00961**	0.0381***	0.0377***	0.0370***
	(0.00318)	(0.00417)	(0.00411)	(0.00411)	(0.00662)	(0.00668)	(0.00676)
Municipal share (in %)	0.00263***	0.00156	0.00213	0.00215	0.00457***	0.00486***	0.00481***
	(0.000985)	(0.00132)	(0.00136)	(0.00136)	(0.00150)	(0.00145)	(0.00145)
Proximity	1.807***	2.798***	2.042***	2.048***	0.561	1.143**	1.123**
	(0.257)	(0.307)	(0.336)	(0.335)	(0.526)	(0.509)	(0.512)
Vote share of leftist parties (in %)	-0.0574***	-0.0619***	-0.0598***	-0.0597***	-0.0766***	-0.0730***	-0.0733***
	(0.00649)	(0.00695)	(0.00682)	(0.00688)	(0.0161)	(0.0154)	(0.0153)
Unemployment rate (in %)	0.0150	0.0270	0.0484**	0.0476**	0.123***	0.107***	0.115***
	(0.0148)	(0.0211)	(0.0195)	(0.0201)	(0.0297)	(0.0288)	(0.0296)
Per-capita tax revenue (in Euro)	-0.000814***	-0.0000451		-0.0000897	0.000471		0.000448
	(0.000301)	(0.000411)		(0.000404)	(0.000389)		(0.000414)
Per-capita debt (in 000)			-1.114***	-1.115***		0.511***	0.509***
			(0.121)	(0.122)		(0.142)	(0.142)
N	19542	9752	9743	9743	8952	8952	8952

State effects	**fixed**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	**fixed**	Yes	One cross-section	One cross-section	One cross-section	One cross-section	One cross-section	One cross-section

Source: The Authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Appendix 4 – Variant with 100 km radius

Table 10: Reverse privatization, pooled data (2003 to 2015), episode 1 (2003 to 2009) and episode 2 (2009 to 2015)

	Pooled data (2003-2015)	Episode 1 (2003-2009)	Episode 2 (2009-2015)
Population (number of residents)	0.000368	0.000949	-0.00118
	(0.00154)	(0.00188)	(0.00268)
Population density (Population/sq. km)	0.000830***	0.000679***	0.000732***
	(0.000123)	(0.000150)	(0.000190)
Concentration ratio 3	0.0171***	-0.00102	0.0389***
	(0.00326)	(0.00433)	(0.00692)
Municipal share (in %) 100km radius	0.0171***	0.0254***	0.0123***
	(0.00308)	(0.00503)	(0.00455)
Proximity	1.421***	2.349***	0.290
	(0.262)	(0.311)	(0.540)
Vote share of leftist parties (in %)	-0.0590***	-0.0646***	-0.0749***
	(0.00655)	(0.00687)	(0.0160)
Unemployment rate (in %)	0.00765	0.0134	0.121***
	(0.0145)	(0.0205)	(0.0298)
Per-capita tax revenue (in Euro)	-0.000830***	-0.000304	0.000507
	(0.000302)	(0.000432)	(0.000401)
N	19542	9752	8952
State fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	One cross-section	One cross-section

Source: The Authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Appendix 5 – Variant with private-public partnership categorized as public (in-house) provision

Table 11: Reverse privatization, pooled data (2003 to 2015), episode 1 (2003 to 2009) and episode 2 (2009 to 2015)

	Pooled data (2003-2015)	Episode 1 (2003-2009)	Episode 2 (2009-2015)
Population (number of residents)	0.0114***	0.0101***	0.0154**
	(0.00379)	(0.00333)	(0.00602)
Population density (Population/sq. km)	0.000337**	0.000318**	-0.000103
	(0.000132)	(0.000151)	(0.000234)
Concentration ratio 3	0.0197***	-0.00450	0.0254***
	(0.00289)	(0.00396)	(0.00528)
Municipal share (in %)	0.00424***	-0.00119	0.00967***
	(0.000913)	(0.00116)	(0.00128)
Proximity	3.796***	5.059***	2.898***
	(0.257)	(0.323)	(0.442)
Vote share of leftist parties (in %)	-0.0611***	-0.0569***	-0.0773***
	(0.00616)	(0.00631)	(0.0138)
Unemployment rate (in %)	0.179***	0.165***	0.388***
	(0.0113)	(0.0154)	(0.0230)
Per-capita tax revenue (in Euro)	-0.000575**	0.000915***	0.000171
	(0.000227)	(0.000342)	(0.000411)
N	19542	10546	8952
State fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	One cross-section	One cross-section

Source: The Authors. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Appendix 6 – Estimated marginal effects

Table 12: Estimated marginal effects, baseline model

	Marginal effect	Std. Err.
Population (number of residents)	0.0000271	0.0001046
Population density (Population/sq. km)	0.0000529	8.48E-06
Concentration ratio 3	0.0011279	0.0002199
Municipal share (in %)	0.0001806	0.0000677
Proximity	0.1241805	0.0177176
Vote share of leftist parties (in %)	-0.003947	0.0004412
Unemployment rate (in %)	0.0010311	0.0010178
Per-capita tax revenue (in Euro)	-0.0000559	0.0000206

Source: The authors.

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