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**Competition and Regulation in Electricity and Natural Gas
Markets in Germany**

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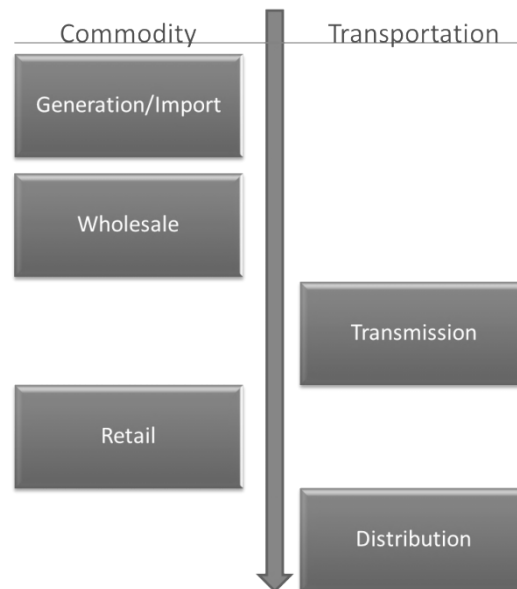
Abbreviations

BNetzA	German Regulation Authority, Bundesnetzagentur
DC	Distribution Charge
DSO	Distribution System Operator
EC	European Commission
EEX	European Energy Exchange
EnWG	Energiewirtschaftsgesetz, German Energy Industry Act
EU	European Union
HHI	Herfindahl-Hirschman-Index
kWh	Kilowatt hour
NGI	Natural Gas Importer
OTC	Over-the-Counter trading
TSO	Transmission System Operator
USO	Universal Service Obligation

1 INTRODUCTION

Fifteen years after the liberalization of the European energy markets, these are still in focus of the current European directives and regulations. Increasing electricity and natural gas prices, insufficient competition, low efficiency gains, challenging climate policy targets and imperfect regulation of networks are the subject of numerous sociopolitical debates within Europe. Various policy instruments have been implemented to solve the remaining problems. Much of these efforts have been put into production, wholesale and transmission stages, while retail and distribution of electricity and gas have also been targeted by policy instruments but have not received a great deal of attention yet. Besides, the theoretical and empirical studies also have mainly addressed the issues in production, wholesale and transmission, but only a small number of studies were carried out considering distribution and retail stages from an industrial organizational perspective. Due to different markets structures among the European end consumer markets and lack of data, empirical investigations are rarely possible and therefore their number is limited. This thesis tries to bridge this gap by analyzing particular competition and regulation issues at the distribution and the retail stages by using firm level data from different sources for German electricity and natural gas markets for household customers.

Figure 1: Electricity / natural gas market stages



In general, electricity and natural gas markets include on the one hand the generation (production) and supply of the commodity and on the other hand it's transmission (transportation) and distribution to end consumers using the network. In contrast to generation and supply stages, which have been liberalized, the networks, as natural monopolies, have to be ex-ante regulated. Different regulation schemes

are implemented across European countries. Germany had first implemented a cost-based regulation of the network charge and then switched to an incentive regulation, which put a certain cap on the revenue of the network operators. The energy markets can also be separated into five vertically integrated market stages: generation, wholesale, transmission, retail (downstream) and distribution. The majority of markets in European countries are dominated by few large energy producers and suppliers. The German market structure is not an exception at the wholesale stage but is unique with regard to downstream markets, i.e. the markets for end-consumers. The uniqueness of these markets is a result of a historically built supply structure. To serve customers with electricity the downstream market has been divided into about 850 geographically separated sub markets. Private firms and municipalities were allowed to set up local energy suppliers and build electricity networks. In return, these firms were protected by the German Energy Industry Act (Energiewirtschaftsgesetz, EnWG) to act as monopolists in their local market until the liberalization process in Europe began. That has resulted in a market structure with about 850 former downstream monopolists serving customers with natural gas or electricity in their local sub market. Furthermore, in most of the sub markets these downstream incumbents also have operated the distribution network. At the present time, nearly fifteen years after the starting point of the European liberalization, the geographically distinct sub markets in Germany are still dominated by the former monopolists. Beside the fact that the majority of these dominant firms was, and still is, vertically integrated, this market structure with a huge number of sub markets and different ownership relations allows the empirical analyses of competition and regulation issues that are not only of interest in Germany but also for further development of market liberalization within Europe.

This thesis aims at considering particular issues that come along with the liberalization of the energy markets for household customers. In particular the following four distinct questions are in focus of the theoretical and empirical investigations²:

- A) Are there any differences in electricity pricing strategy between firms with different ownership structure, in particular, public vs. private and ownership concentration?
- B) Do the former monopolists in electricity markets affect the entry decision of potential newcomers with a strategic pricing?
- C) Are vertically integrated natural gas importers able to affect market entry in their downstream markets?
- D) What are the appropriate regulation schemes for vertically integrated electricity providers and network operators?

The first issue is a well-known research question that considers the performance variation among firms with different ownership structure and owners. There exists a large number of analyses that consider the performance differences between public

² The analyses A,B and D are based on joint research with Tobias Veith, and C with Jürgen Weigand.

and private firms and most of the empirical investigations show that public firms are less efficient and have worse performance, in terms of profits, than private firms. The argumentation follows the Principal Agent theory. In contrast to private firms, the literature suggests, first, there is a higher degree of information asymmetry between managers and the owners in a public firm, and, second, the elected representatives would rather follow their political objectives than profit maximization. This results in less efficient public firms compared with their private counterparts. On the other hand, the question is how ownership concentration affects firms' behavior, which is in close connection with the Corporate Governance literature. Following the literature, owners with less involvement in a firm, in contrast to owners with high ownership shares, have difficulties exerting strategic influence and should therefore rather seek short-term performance objectives with their investments. The short term performance can be achieved, for example, with a price increase for customers with lower willingness to switch their supplier. The hypotheses suggested by the theoretical literature are tested empirically employing retail electricity prices for household customers and cost-based regulated distribution charges for electricity grid access, which reflect the costs, and, thus the efficiency of the network operators. The pricing strategies of the former monopolists are tested with explanatory variables for the owner type, ownership concentration and numerous control variables. Based on that data set for about 600 former monopolists, the results show that public or private ownership has no impact on the pricing strategy of energy suppliers. Furthermore, efficiency differences, in term of distribution charges, are not explained by the owner type. Instead, a high ownership concentration leads to low electricity prices, regardless of the owner type. However, the regulated distribution charges are not affected by the ownership concentration. This indicates the effectiveness of cost-based regulation and at the same time strengthens the hypothesis on firms' strategy depending on the ownership concentration.

The second topic takes again the pricing behavior of former monopolist into consideration but the focus is on strategic pricing that can potentially prevent the market entry of competitors. Following the 'Limit Pricing' theory, in certain situations it might be profitable for a monopolist to lower the price to a threshold that makes market entry for a competitor unprofitable. In particular, incumbents' pricing for the standard contract that has a market share of more than 50%, could affect market entry decision. This contract is the most expensive electricity contract and is a "fallback" for customers who decide to switch to an alternative contract. They automatically return to the standard contract either if their new provider leaves the market, or if their contract is cancelled by the supplier and customers have not decided which supplier to switch to (§§ 36 – 38, EnWG). In addition, customers that have not switched their contract after the markets have been liberalized are served under this contract. Beside the standard contract the incumbents' offer "competitive" contracts at lower price and compete with newcomers for customers who are willing to switch. With this contract type on average 40 percent of the customers are served. Thus, the average market share of the former monopolists' is still about 90 percent. Newcomers that enter the market primarily try to poach customers that are severed

under the expensive standard contract. In this analysis a theoretical model is used to derive the optimal price-setting behavior of a price-discriminating incumbent provider. The model shows that under certain circumstances reducing the standard contract price could increase the incumbent's profit and at the same time prevent market entry. The theoretical findings are then analyzed empirically employing data for German retail electricity submarkets using a simultaneous equation approach. The results show that 'Limit Pricing' can be profitable. In particular, for customers with low consumption and relatively high switching costs the results show that the standard contract price can affect market entry whereas for high consumption level customers the hypothesis can be rejected. Beside that, the analysis shows the importance of effective regulation of the distribution charges. As the distribution charges can be considered as input costs for firms serving customers, the empirical results show that high distribution charges can also prevent market entry.

In contrast to residential electricity markets, the entry of newcomers into residential gas markets is not frequently observed. One key explanation for this fact can be seen in difficulties in purchasing gas on the wholesale market due to a lack of market liquidity. This lack of liquidity has two causes: First, for newcomers natural gas imports to Germany are de facto unrealizable due to pipeline capacity constraints at the border. These pipelines are operated by gas importing firms, which maintain contracts with foreign gas producers. Second, about 90 percent of total consumption is imported by the 5 major importing firms, which maintain long term contracts with retail incumbents. Furthermore, two of those namely, E.ON and RWE, are extensively forward integrated with retail downstream incumbents in distinct sub markets. Due to potential abuse of the market power in the wholesale and end consumer markets, the Federal Cartel Office prohibited further forward integration of natural gas importers (NGI) from 2005/2006 to 2010 and limited long term contracts.³ The Authority argued that the very few dominant gas importing companies, which are already extensively integrated and also own and operate the gas pipelines, could have an incentive to foreclose existing competitors or prevent potential market entry. This part of the thesis aims at investigating the effects of vertical integration between gas importers and retail incumbents on market entry of newcomers. To preserve retail subsidiaries' profits, natural gas importers may wish to deter market entry, since in markets for household customers entry induces business stealing rather than market expansion. To analyze possible vertical integration issues empirically we employ cross sectional data (for September 2009) for about 500 sub markets for household customers in Germany. For this purpose ownership and market entry data were merged, and market and consumer characteristics were taken into account. However, the estimation results do not show clear evidence that market entry of newcomers is restricted by vertical integration. Thus, the decision of the Federal Cartel Office to repeal the regulation of vertical integration in 2010 was appropriate.

³ Long term contracts with a length of more than 4 years were also prohibited from 2006 until 2010.

A further issue of vertical integration, in particular ownership integration between monopolistic network operator and retail incumbent, is the potential discrimination of retail competitors to access the monopolistic network. The literature on vertical integration in markets with an upstream monopolist suggests that the integrated upstream firm might engage in price and non-price discrimination of downstream competitors. Potential 'raising rivals' costs' in terms of distribution charges for the network access and non-price discrimination, for example by delaying the customers switching processes might appear. To prevent price discrimination the distribution charges are regulated ex-ante. However, non-price discrimination still remains an issue although a certain type of regulation, the so called 'legal unbundling', has been implemented in Germany in 2007. The law requires that integrated firms with a certain number of customers (100,000) have to be separated legally and operationally. Several studies provide policy recommendations derived either from case study approaches or based on theoretical modeling which addresses the unbundling issue. Since the vertical structures of German firms vary from fully integrated, legally unbundled to fully separated electricity suppliers without a common owner, empirical investigations of effects driven by different regulation regimes are possible. Thus, our data allows the analysis of differences that are caused by vertical structure. First, a theoretical model has been developed that helps deriving hypotheses for the empirical analyses. Then, following the theoretical model, the impact of vertical integration of retail incumbent and network operator on retail prices and upstream charges is analyzed empirically. The results show significantly higher prices in markets with vertically integrated firms compared to markets with fully separated firms. This finding could indicate non-price discrimination. Furthermore, the results show no evidence that the introduced legal unbundling eliminates the incentives for non-price discrimination because the prices do not differ from prices in the markets under vertical integration.

The distinct studies in this thesis are presented separately. Each study contains a comprehensive introduction into the specific research question. A market description, including a report of current policy on regulation and market structure with specific focus on the research question, follows the introduction. To derive hypotheses for the empirical analyses either findings in current literature have been used or theoretical models have been developed. Prior to a description of the empirical methods applied in the studies, comprehensive descriptive statistics for the employed data are reported. In the following section, the empirical results are presented and discussed. The final section in each of the studies summarizes the main results and derives policy implications. A summary of the main findings in the conducted analyses is provided in the last part of the thesis.

2 THE IMPACT OF OWNERSHIP ON PRICE-SETTING IN RETAIL SUBMARKETS FOR ELECTRICITY⁴

⁴ Based on joint research with Tobias Veith

2.1 Introduction

Energy markets in Europe have been liberalized during the 1990s. Since this time, new competitors try to enter energy markets and challenge former public monopolists in production and, in particular, in retail energy provision markets. Additionally, also former regional retail monopolists enter the markets of other former regional retail monopolists trying to increase competition apart from their home markets. As competition for private customers develops very hesitantly and, therefore, most customers stay with the former monopolists in Continental Europe, regional governments seek to re-increase their shares in former monopolists. So-called re-municipalization describes the repurchase of formally (partially) privatized public companies, the repurchase of grids or licenses (or the startup of public companies). According to a survey by the Institute for Public Finances and Public Management of the University of Leipzig (2009) more than 20% of the municipalities in Germany plan such a step. Proponents further justify this trend with the objective of a cheaper and safer energy provision as well as the objective of providing more renewable energy.

With more than 850 regionally separated submarkets, Germany provides a micro picture of European energy markets. While public ownership in energy providers is an ongoing topic in political discussions, there seems to be no empirical evidence on the impact of the ownership structure on different stages of the supply chain for the end-consumer. In this paper, we investigate whether public ownership of the utility provider has an impact on the energy price. We focus on standard contracts, as the majority of household customers is still served with this contract type (in Germany on average 51 percent of all households following the regulator Bundesnetzagentur, 2010).⁵

Only a few papers empirically investigate the impact of ownership in energy markets. In particular, the importance of ownership of individual energy providers has been mostly ignored. We pursue the classical theoretical literature and discuss two explanatory attempts about the impact of public ownership vs. private ownership, from which we derive hypotheses on their impact on the business' behavior and, therewith, the price-setting for household customers.

Following the Principal Agent argumentation for public enterprises, the management is, to a far extent, better informed about the circumstances of the business than the owners and their political representatives. Besides business objectives, managers follow own objectives, which might be in conflict with those of the owners and, thus, reduce efficiency. In contrast to the private companies, in public companies the

⁵ Besides the standard contract, the utility provider also offers alternative (lower priced) contracts in order to keep customers which are ready to switch. Since the liberalization in 1998, following the 2008 report of the German energy regulator (Bundesnetzagentur, 2009) only about 6 percent of all household customers have chosen an alternative energy provider, the rest of households is still provided by the incumbent.

multiplicity of objectives of elected representatives additionally influences the Principal Agent problem: First, managers are more informed than public representatives and, second, elected representatives follow a set of multiple objectives, which provides more degrees of freedom in decisions for managers of public energy companies. As private energy demand is highly price-inelastic (the majority of households has not switched its contracts more than ten years after the liberalization), energy providers can pass on inefficiencies to customers.

On the other hand, the question of how ownership concentration has an impact on the behavior of a company is in close connection with the Corporate Governance literature. Following this strand of literature, one should expect that owners with a high involvement are able to enforce their interests over-proportionally in contrast to owners with less involvement and seek, above all, long-term business objectives due to their interest in having a say. In contrast, owners with less involvement have difficulties exerting strategic influence and should therefore rather seek short-term performance objectives with their investments. Transferring these expectations to the particular situation of standard contracts in retail energy markets, companies with a lower ownership concentration should choose higher retail prices ignoring more customers switching to competitive contracts. On the other hand, providers with a higher ownership concentration choose lower retail prices internalizing customers' switching behavior in their price choice.

Energy providers have to pay distribution grid operators a regulated charge, the distribution charge, for getting access to retail energy consumers. According to the regulator, this fee determines one fourth of the standard contract price. We approach the analysis of wholesale and retail price influences estimating a two-equation system. To investigate the relevance of indirect effects of distribution grid ownership on end-consumer prices, we choose a simultaneous estimation approach in which we take the distribution charge as an endogenous variable in the price equation. Distribution charges are explained by multiple grid and regional characteristics and the ownership structure of the grid owner.

In doing so, we find that the end-consumer price and also the distribution charge do not significantly differ due to public or private ownership. In contrast, using ownership concentration instead of measuring ownership shares, we find that a higher ownership concentration promotes lower prices for end-consumers whereas the distribution charge does not react to ownership concentration. This shows that regulation effectively mitigates ownership influence on the distribution charge.

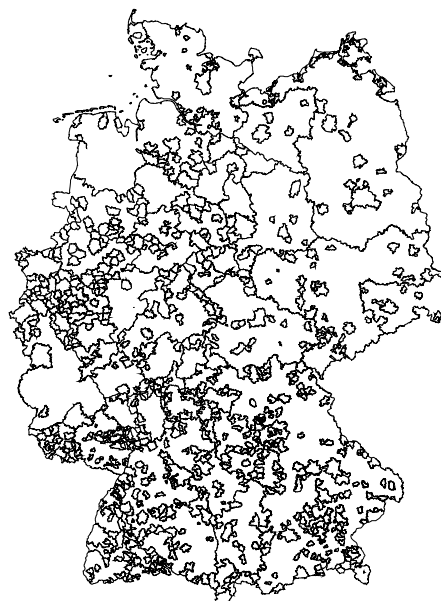
The paper is organized as follows. The next section describes the German electricity sector with a specific focus on regional distribution markets, the average composition of the standard contract price and regional differences. In Section 3, we consider the existing literature and derive hypotheses on the impact of the participation structure and the participation concentration on the retail and the wholesale price. Prior to a

multivariate analysis, we provide a comprehensive overview over the data used in section 4. As coherences concerning proprietary rights in the German energy economy have, to our knowledge, not been scientifically investigated yet, we consider the ownership situation and the relation of the retail incumbent and the grid operator in this section. Afterwards, in section 5, the results of several multivariate estimation models are considered and compared to each other. Section 6 summarizes the main results and derives policy implications.

2.2 Electricity market in Germany

Electricity market can be divided into five vertically interrelated market stages: production, wholesale, transmission, distribution and delivery to the consumer (for bulk purchasers and small consumers). About 80 percent of the capacity of electricity generation in Germany is controlled by the four compound companies E.On, EnBW, RWE and Vattenfall.⁶ The remaining 20 percent are power plants of municipal utilities and private energy producers. While the transmission grid is also controlled by four transmission grid operators, there are about 850 regional distribution grids which are controlled by local grid operators, usually by municipal utilities and regional energy providers.⁷ Each of these distribution grids determines a regional submarket with one grid operator each, in which energy suppliers provide electricity with different contract conditions for household consumers. Figure 2 depicts the geographical distribution of the regional submarkets in Germany. Western German markets are heavily subdivided with a number of submarkets in the Rhine-Ruhr metropolitan area. The Eastern German markets, however, are characterized by geographically significantly larger submarkets.

Figure 2: Local electricity markets for household customers in Germany



⁶ Bundeskartellamt, Sector Inquiry Energy Production and Wholesale Trade (2011).

⁷ Transportation grids were initially integrated into the business of the four compound companies. However, they have sold their transmission business.

Providers, which do not produce energy themselves or have to cover peak demands are able to purchase electricity on the energy exchange EEX in Leipzig, where a variety of products, such as short-term, day ahead, futures etc., are offered. In addition, over-the-counter (OTC) trading allows long-term bilateral contracts between producers and suppliers. The major part of the energy demand is based on bilateral contracts with the stock exchange price as the underlying. Only about 15 percent of the energy needed was traded on the EEX in 2008 (Ockenfels et al., 2008) but the number increased substantially in the last couple of years. In the following, we focus on the last two stages of the value chain, energy distribution and household supply. On average, about 40 suppliers provide energy contracts to household customers in a regionally delineated market. This high number of alternative providers should, however, not be considered as evidence for a high intensity of competition as the switching rate to alternative suppliers after the liberalization until the period under consideration (2008) was still very low with 6 percent on average across all regional markets (Bundesnetzagentur, 2009).

In order to deliver energy to end consumers, energy providers use the regional distribution grid of monopolistic grid providers. These are, however, often vertically integrated into the former, regional and monopolistic energy providers.⁸ To avoid possible distribution charge discrimination, the so-called distribution charge, is regulated.⁹ Furthermore, vertically integrated businesses with more than 100.000 customers are obliged to divide their grid activity and their energy provision activity into two legally separated partial businesses. Energy companies with less than 100.000 customers are allowed to be vertically integrated.

Standard contracts are successive contracts for the former, monopolistic contracts, through which household customers were supplied prior to the liberalization. They have to be offered due to legal guidelines by the largest energy provider of a region to those customers whose current energy provider left the market unexpectedly (substitute provision, §38 Energiewirtschaftsgesetz (EnWG), the German Energy Act) or who, after the liberalization, have neither changed their energy provider nor their contract. Compared to alternative contracts of standard contract providers and, in particular of competitors, according to Bundesnetzagentur (2010) the standard contract is usually the most expensive contract.¹⁰ Standard contract providers argue that this contract type is more expensive than competitive contracts due to the risk of substitutive energy provision. However, it is often neglected that the substitute provision is limited to 3 months (§ 38 (1) EnWG) and only mandatory if this is economically reasonable for the standard contract provider. Therewith, the risk of the standard contract provider is significantly limited and comparable to the risk of a new energy provider, which does not have regional market knowledge when entering the

⁸ About 75 percent of the former monopolists are even completely vertically integrated with the regional distribution grid operators.

⁹ Since 2009, grid access is organized by incentive regulation (c.f. Cullmann, 2011).

¹⁰ We do not consider contracts for electricity from renewable energy, which may be more expensive than standard contracts.

market. Therefore, it can be assumed that high prices for this universal service obligation are for the most part a consequence of low switching rates of German households.¹¹

The price of the standard contract is made up of several components, which are determined by legal guidelines, the amount of the distribution charge and by the energy provider. The standard contract provider determines a portion of the price which is about 34 percent; this is attributable to energy procurement and production and, on the other hand, is dependent on sales-oriented measures. About 27 percent of the price is determined by the amount of the distribution charge, while the amount of the distribution charge is itself dependent on a variety of cost drivers, such as network quality, network length and other network related and regional factors. The remaining 39 percent are split up in taxes and duties and legal contributions.¹²

In the following, we focus on the standard contract and its particular conditions and try to link its price setting to the ownership structure of the standard contract provider.

2.3 Derivation of hypotheses

The economic and business literature presents several explanations regarding the impact of public and private ownership on the behavior of a dependent company. On the one hand, conflicting aims exist between owners and managers. On the other hand, private and public owners follow different demands regarding monitoring and controlling. While representatives of public property are elected and have to balance a set of multiple, sometimes diverging objectives, private owners have oftentimes more elaborate knowledge about the branch.

Our investigation follows the two strands of argumentation on Principal Agent theory and Corporate Governance theory.

2.3.1 Principal Agent theory

Public energy companies are oftentimes organized within municipal cross-compounds. Profits from energy business are therefore used for subsidizing other, less profitable public firms or business units. In order to provide sufficient financial means for the support of other public plants, the primary objective of a public energy provider should be profit maximization, similarly to private energy providers.¹³

¹¹ According to the annual report of the regulator, in 2008, still 51 percent of all household customers (volume-weighted) were served via the standard contract and have, consequently, not yet changed their energy provider.

¹² Information taken from the Bundesnetzagentur Annual Report 2008 (BNetzA, 2009).

¹³ As public plants are not allowed to pursue profit maximization objectives in Germany, public energy providers are commonly organized as municipal utilities, which also provide other public services besides energy provision such as public transport systems.

Therefore, *ceteris paribus*, one should expect public energy providers with an identical price-setting behavior as private energy providers.

However, differences exist regarding the exertion of ownership rights and duties. In German energy markets, owners of suppliers are usually not involved in the operational energy provision activity of their company. Public owners assign managers to develop and implement business strategies. Due to their stronger integration into these activities and their proximity to the strategic and operative core business, managers often have more detailed knowledge of the business situation than company owners. For this reason, there is an information asymmetry between owners and managers of a business, which is referenced to in the literature as the “classical” Principal Agent problem (Tirole, 1995; Mas-Colell et al., 1995). As owners only supervise their managers to a limited extent and are not able to exercise their management task themselves, a residual space for decision-making presents itself to managers, which they can use to pursue own objectives (Shleifer and Vishny, 1997). These own objectives are not necessarily identical with the owner’s objectives, but might possibly even lead to inefficiencies, which may cause higher costs (Furubotn and Pejovich, 1972) and have, correspondingly, an impact on the price-setting.¹⁴

Private energy companies usually have several owners who themselves control the management or have it be controlled by representative supervisory bodies. Even though private owners may pursue very heterogeneous objectives, capital markets channel their interests by (at least to some extent) enabling the trade of shares (Dixit, 1997). Provided that the control task is passed on, owners look for adequately qualified representatives and audit personnel, who are acquainted with a manager’s task and who are able to work out incentive systems necessary for managers, to govern and to control them. With the expert knowledge of these supervisors, a far-reaching, efficient implementation of the owner’s objectives is achieved.

Contrary to private companies, public property is often represented by elected representatives. Consequently, efficient conduct of public companies is only one objective out of a complex set of multiple objectives. Thus, politicians have to balance a magnitude of alternative, sometimes diverging objectives. As their perspective does not only focus on energy related governance and control duties but has to bring them together with regional public governance and control objectives, public energy company strategies and objectives diverge to some extent from private energy company strategies and objectives. However, this divergence might be in the interest of the “owners” of energy companies, the regional population, as they optimize total regional welfare not only energy company profits. Therefore, besides information asymmetries between owners and managers, energy company objectives are part of a larger set of objectives to be optimized under public

¹⁴ Due to high switching costs and different customer preferences for specific businesses, no “pure” Bertrand-competition exists in German energy markets.

governance. If elections lead to an efficient depiction of the opinion of the electorate, politicians should pursue the interest of the majority of voters (Wittmann, 1995).

In consequence, diverging objectives of political decision makers limit the proprietary control of the management of public companies. This provides more degrees of freedom for managers of public energy companies. As a result, Shirley et al. (2000) conclude that public companies suffer from potential cost disadvantages compared to private companies, as decision makers in public businesses do not necessarily exploit their scope of action in the public interest. If public energy providers alike private energy providers pursue the objectives of maximizing profits, similar efficiency could be expected for public as for private companies. However, due to existing inelastic demand in German energy markets, public energy providers may compensate higher costs at least partially with higher end-consumer prices. As a result of this discussion, former public incumbents should, *ceteris paribus*, demand higher energy prices than comparable, non-public providers. Thus, the Principal Agent problem is more pronounced in public companies than in comparable private companies.

Hypothesis 1a: *More degrees of freedom in decisions for managers of public companies provide additional cost inefficiencies for public energy providers compared to private energy providers as former incumbents can pass on higher costs to customers due to inelastic retail energy demand. In consequence, higher retail prices are expected for public providers than for private providers.*

While hypothesis 1a depicts the well-known Principal Agent problem of public companies compared to private companies, it is necessary to consider counter-arguments which might challenge this Principal Agent argument. For example Fiorio et al. (2007) take more detailed energy sector-specific information into account. They argue that market players and the informed public are aware of production and transport technologies and the associated costs. For example, electricity wholesale prices are most widely predefined by the so called Merit Order¹⁵ at the energy exchange and legal guidelines for energy supply regarding renewable energies. The majority of traded energy is turned over in long-term, bilateral deals. Only a relatively small part (approximately 15 percent) of the daily energy demand in Germany was covered by the trade at the European Energy Exchange EEX in Leipzig in 2008 (Ockenfels et al., 2008). Furthermore, the distribution charge is regulated. Price-quantity-combinations can therefore only to a limited extent be adjusted in the short-term; this is the reason why the managers' of public and private energy companies individual scope of action is very limited. Due to given product- and transport-technological prerequisites, and due to legally regulated public availability of key business figures, no significant efficiency loss of public energy providers should be expected compared to private energy providers following this theory. The sector-

¹⁵ Merit order pricing is determined by short-run marginal costs of electricity generation.

specifically founded concretion of the Principal Agent theory in energy economics therefore leads to the following counter-hypothesis:

Hypothesis 1b: *Production technologies and regulated transport prices inhibit a manager-induced deviation from given business objectives. Connected with the high transparency in production and transport technologies resulting from this, public and private companies are similarly efficient. Therefore, there is no significant difference in retail prices or distribution charges between public and private energy providers.*

2.3.2 Corporate governance and ownership concentration

The Corporate Governance literature is closely related to the classical Principal Agent theory.¹⁶ We focus particularly on the ownership structure and its impact on price-setting, in which organizational influences are of minor interest. Owners provide managers with financial and non-financial means, which allows managers to implement business activities. Without further contractual guidance, the management would be able to use the given financial means for non-entrepreneurial objectives as well (Shleifer and Vishny, 1997). Besides corresponding incentive mechanisms, further contractual conditions limit the scope of actions compared to firm owners. Furthermore, contractual pre-requirements regulate the owners' control rights and the opportunity to intervene in strategic and operational decision making.

Shleifer and Vishny (1986) point to the fact that these rights to intervene and control are probably only exercised insufficiently. For example, shareholders with little involvement might have an interest in free-riding concerning strategic decision-making. In contrast, larger owners and family owners are represented in supervisory bodies personally or by representatives. This constellation enables larger shareholders to enforce their interests relatively too strong in business objectives and also in backflows from provided financial means (Vickers and Yarrow, 1991; Shleifer and Vishny, 1997; Dyck, 2001). Franks and Mayer (2001) confirm these theoretical findings also for a German sample of 171 industrial and commercial firms.

On the other hand, owners with lower participation can sell their shares more easily. Therefore, owners with smaller involvements orient themselves by rather short-term performance objectives and seek a higher short-term profit distribution (Holl, 1975; Hill and Smell, 1989). Opposed to this, larger owners seek a long-term, high income return.

Summarizing both of these argumentation strands, we should observe rather long-term business strategies for companies with a high ownership concentration. Translating this into the customer relationship issue, companies with higher

¹⁶ In this paper, we consider the „classical“ Corporate Governance issue, which mainly comprises the meaning of ownership structure and legal certainty for investors (see e.g. Shleifer and Vishny, 1997 and the literature in this line). More recent strands of literature also take into account the organizational principal-agent relationship which results from the ownership structure.

ownership concentration should seek long-term customer loyalty objectives. Customers with experience in switching do not (voluntarily) return to standard contracts anymore due to poor contract conditions of this contract type. Combining this observation of the Bundesnetzagentur report (2009) and the ownership objective-discussion in the literature, a higher ownership concentration should result in an over-proportional concentration of interests among larger owners and, therefore, lead to lower prices for standard contracts. Contrary to this, “smaller” owners pursue less long-term business objectives, but expect higher, short-term profits. For this reason, also a lower value is attached to customer loyalty with a lower ownership concentration and a higher willingness to switch is accepted with higher standard contract prices in order to make higher short-term profits.

Hypothesis 2: *Companies with a high ownership concentration set lower prices for standard contracts to bind customers. Contrarily, in companies with a lower ownership concentration, short-term profit objectives prevail; therefore, customer-loyalty is neglected, which should favor higher prices.*

2.4 Data and descriptive analysis

In the following, we will provide a description of our data set with a particular focus on ownership structures. Key to our discussion is the differentiation of public and private ownership. After the ownership structure, we consider the dependent variables and examine regional effects, before introducing further control variables.

2.4.1 Data sources

For our investigation, we use data from various sources. We take into account impact factors on consumer prices and distribution charges, which basically comprise three groups: ownership integration up to the ultimate owners, network characteristics and conditions of demand and regional factors connected to that. Available information is collected for August 2008 and aggregated onto the level of the distribution grid.¹⁷

The commercial credit agency Creditreform provided business information, which enables the detailed consideration of the ownership structure. Based on ownership shares the calculated share of the ultimate owner can be determined. We focus on standard contract providers and analyze to which extent their shares are in private or in public (mostly regionally public) ownership. Owners may be involved via several intermediate owners in an energy provider. This should have an impact on the possibilities to control and enforce individual objectives of the owner on the owned companies. Regarding all companies, the largest owner was for the most part directly invested in the standard contract provider, i.e. on average it was connected via less than one intermediate owner (0.4 intermediates) with the standard contract provider.¹⁸ For the largest owner of the grid operator, we also find participation via less than one intermediate owner (0.6 intermediates).¹⁹

We consider the standard contract price for a quantity of 4,000 kWh per year, the typical demand of a household of 3-4 people. Household characteristics were provided on zip code level and come into play weighted by the number of households in our computation of adjacent submarkets as, usually, market borders are not identical with the borders of zip code areas.

Information on grid characteristics or the composition of the distribution charge was provided by E'net. The distribution charge is composed of a fixed component as well as a component which is variable depending on the quantity of energy passed through the distribution grid. Grid characteristics contain details about the length of

¹⁷ Demand characteristics had to be statistically aggregated on the grid level using the number of households as the transition parameter as they can only be provided on the level of zip code areas.

¹⁸ When taking into account those municipal utilities as ultimate owners, which are directly integrated into the municipal organization, the average number of intermediates drops to 0.20.

¹⁹ When taking into account the integration into the municipal organization, it is connected via 0.48 intermediates to the grid operator.

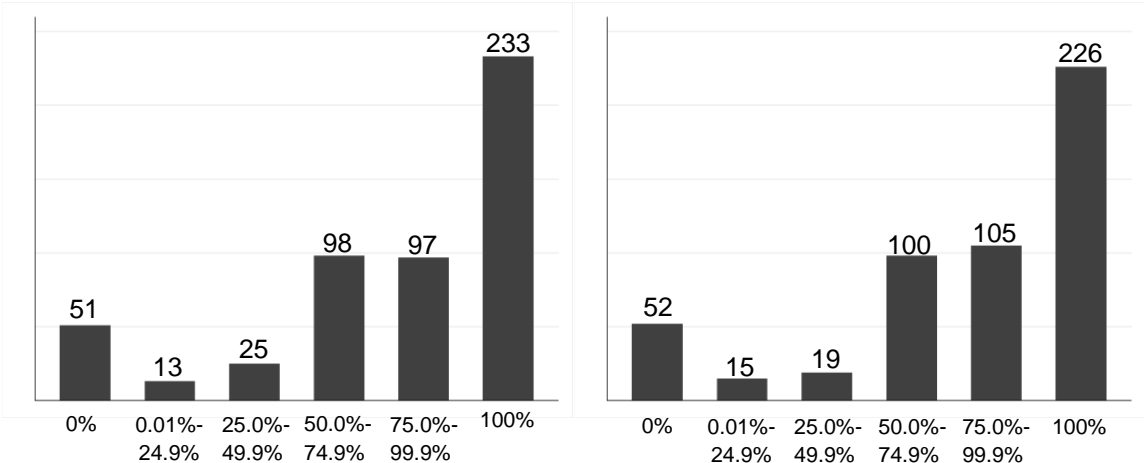
the distribution grid in the regional market and the number of tapping points as well as the quantity of energy passed through the grid on a regional basis. Tapping points are exit points of the regional grid and therefore describe households, businesses and public customers.

In the following, we introduce the key variables of the multivariate analysis and discuss them with respect to their main features. Further information is provided in the appendix.

2.5 Descriptive discussion of the ownership structure

In order to give a comprehensive overview of the meaning of public ownership for price-setting, we compare various parameters. After calculating ownership shares across all intermediate owners to the ultimate owner, several category values and continuous variables were formed. On the one hand, we use participation as a continuous variable, which describes the precise ownership share of the ultimate owner in the standard contract provider or the grid operator. Therewith, it is possible to derive insights into quantity effects of the ownership variables and concentration effects with the Herfindahl-Hirschman-Index (HHI) or the linear and the squared ownership share in the multivariate analysis.²⁰ Besides linear effects, also threshold effects could be assumed. For example, the 50-percent-value forms the threshold for the decision majority, whereas crossing the 75 percent ownership-threshold value allows (depending on the legal form) the decision on the strategic direction of a company.²¹

Figure 3: Number of standard contract providers with public involvement (left) and number of grid operators with public involvement (right).



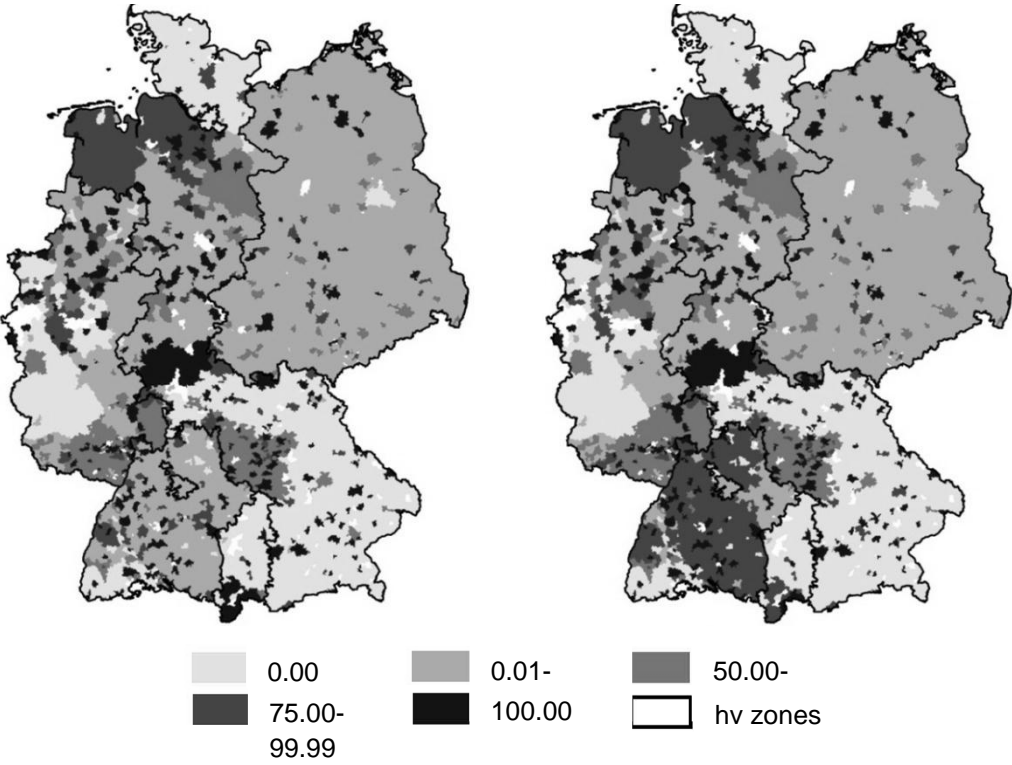
²⁰ See e.g. Lehmann et al., 2007

²¹ Please note that alternative approaches exist to calculate the ultimate owners' shares in a company (see e.g. Bortolotti et al., 2007). For this reason we compared our multivariate analysis using 50 percent majority ownership shares calculated from the owned to the ultimate owner, but find no essential differences to what is provided here.

Figure 3 shows the number of standard contract providers and grid operators dependent on the share of public involvement which is displayed in categories. For standard contract providers as well as for grid operators, a major share of companies was fully publicly owned. 233 and 239 companies, respectively, had a mixed ownership structure with private as well as public shareholders. Compared with the continuous measure (not depicted here), no concentration at the class thresholds is observable for the ownership share between 0 percent and 100 percent. Rather, a group of companies exists with a very low public ownership share. After the 50-percent-ownership threshold, the number of companies rises again. The majority of standard contract providers and grid operators, however, were entirely publicly owned. This distribution shows that public investors have very little interest in minority shareholding. Municipalities and regional unions rather actively try to have their say in business events and therefore participate in the majority of companies with an ownership share of over 50 percent. The largest group of communities is even interested in total control of the direction of energy businesses in their home region.

The consideration of regional differences (Figure 4) shows a high compliance of the share of public involvement regarding the standard contract provider (left graphic) and the grid operator (right graphic). This is basically due to the fact that at the time of the inquiry, the majority of standard contract providers and grid operators was fully vertically integrated (approximately 75 percent). Among the remaining, separated energy providers in 17.9 percent standard contract providers held a share in the grid operator and in 1.4 percent of the cases the grid operator was involved in the standard contract provider. Comparing Figures 2 and 3, a 100-percent-involvement

Figure 4: Share of public involvement in the standard contract provider (left) and share of public involvement in the grid operator (right) (percent).



especially occurred in smaller grid areas and is strongly scattered across Germany.²²

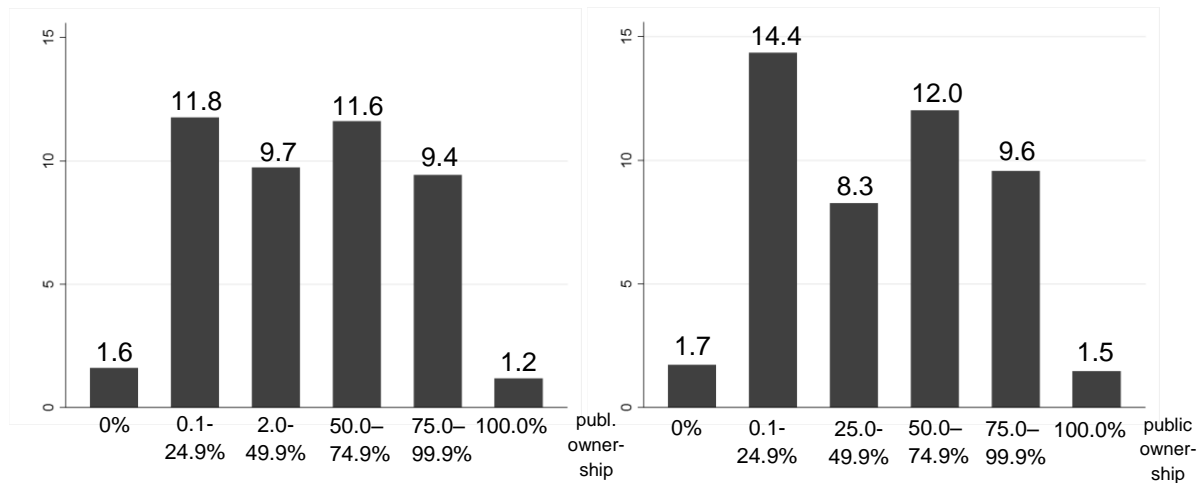
Figure 4 shows significant differences between Eastern and Western Germany. In Eastern Germany, the public involvement in energy companies is, with a few exceptions, under 50 percent, which is particularly due to the situation of the former German Democratic Republic (GDR). The founding and dissolution of the GDR led to two structural breaks: While in the course of the founding of regional energy markets, 15 energy combinations were joined (Blättchen, 1999), the decentralization following the reunification was connected with an extensive re-organization of regional energy markets, in which particularly the privatization of energy markets was in the center of attention. Therefore, a comparatively low public involvement in energy companies in East Germany is observable after the turnaround (Birke et al., 2000).

For Western Germany, there is, however, a more mixed picture with less public involvement in large parts of Bavaria, Schleswig-Holstein, the Saarland and the North of Rhineland-Palatinate. Compared to that, there was a very high public involvement of grid operators connected with a strong unbundling with regard to laws concerning one's property of standard contract providers and grid operators in Baden-Wurtemberg.

While we have so far depicted the public involvement in dependent companies, in the following, the connection of public involvement and ownership concentration will be considered. Figure 5 shows the average number of owners for different shares of public involvement in the standard contract provider (left graphic) and the grid operator (right graphic). For entirely public or entirely private ownership, the number of owners is limited to 1 or 2, for mean involvement, there are, however, a variety of owners with 10 owners on average. The aberration value with regard to minority involvement among grid operators,

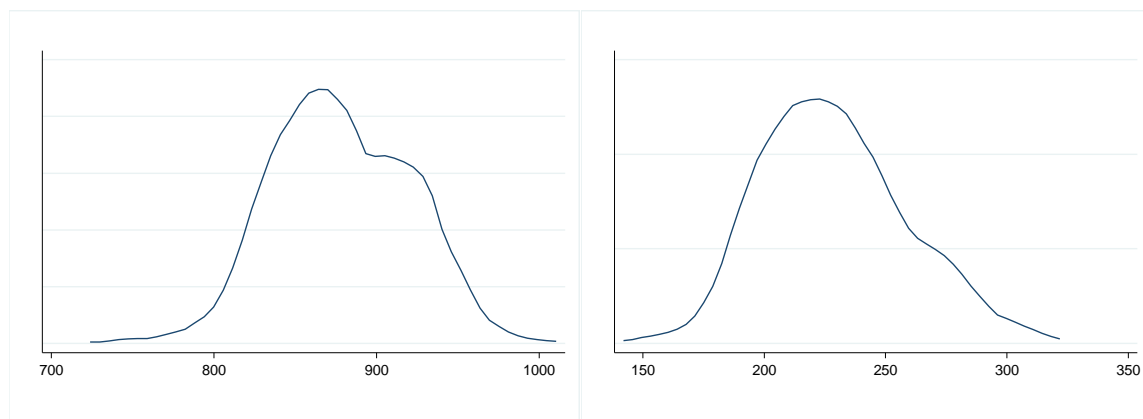
²² The size of the distribution grid is related to the geographical area, not the number of citizens. Therefore, we cannot conclude that standard contract providers and grid operators in larger grid areas measured in terms of surface area must be vertically separated due to legal guidelines.

Figure 5: Number of owners with given public involvement in the standard contract provider (left graphic) and the grid operator (right graphic)



(between 0 and 25 percent) is attributable to three grid operators which own a variety of very small shareholders. The observation of all grid operators mitigates the depicted effect, which results in a mean of 14.4 shareholders involved in a company with a public minority involvement. Neglecting the three aberration companies, the number of owners fluctuated among the standard contract providers as well as among the grid operators at around 10, while particularly among grid operators, a majority of municipal minority involvements with very small shares is striking.

Figure 6: Core density estimation of the price of the standard contract (left) and the distribution charge (right)



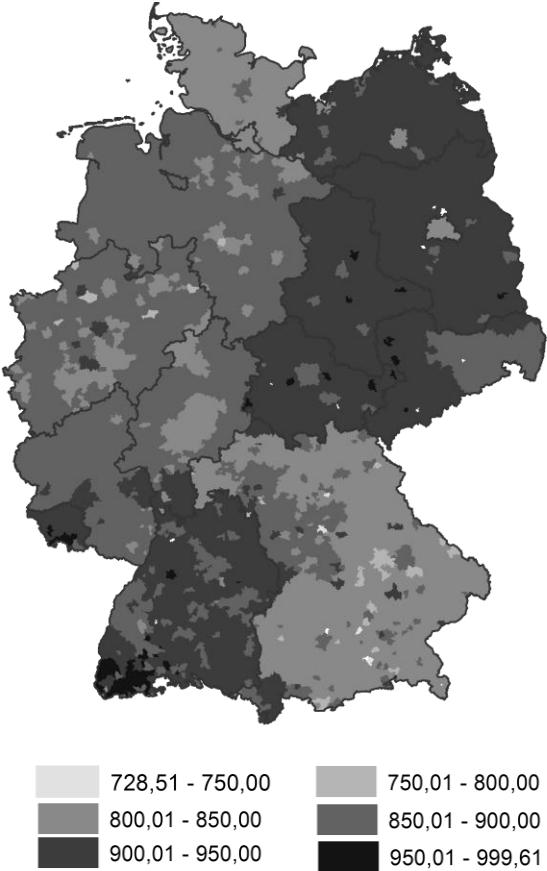
2.6 Descriptive consideration of the dependent variables

The distribution of standard contract prices for 4000 kWh contracts and the distribution of the distribution charge for 4000 kWh are depicted in Figure 6. The graphics show core density estimations based on the Epanechnikov-Core (optimal range for the estimation of the price 9.99, optimal range for the estimation of the distribution charge 6.96). While prices scatter relatively normally distributed around

the arithmetic mean of 877 Euros, a slightly right skewed distribution of the distribution charges is found (arithmetic mean of 229 Euros).

More detailed information about regional differences are provided in Figure 7. The darker shaded the area, the higher the price in the respective grid area. In Eastern Germany, i.e. the former Vattenfall region,²³ and in vast parts of South-Western Germany, i.e. the EnBW region, the standard contract prices were relatively high, while particularly in South-Eastern Germany, rather low prices can be observed. Striking is the conformity of significant differences in prices at the borders of high voltage grids. One reason for higher prices in the former Vattenfall-region are higher distribution charges. In the 1990s, older distribution and transportation lines were replaced, which, prior to the end of the former GDR had been neglected with regard to maintenance and re-investments (Birke et al., 2000). Costs resulting from this are depreciated over years and, therefore, added to the distribution charge. Taking into account the high share of the distribution charge in the price of the standard contract, grid investments are reflected in higher prices for household customers in Eastern Germany.

Figure 7: Price for standard contract provision in various grid regions (in Euro per 4000kWh contract)



²³ The Vattenfall-grid was sold to the Belgian company Elia and a financial investor in March 2010.

2.6.1 Further control variables for the multivariate analysis

In the following, the control variables of the multivariate analysis are introduced and discussed. The variables are summarized in Table 1.

Table 1: Descriptive statistics of the control variables of the multivariate analysis

Variables	Mean	Standard Deviation	Min.	Max.
buying power (m.)	100.8	79.7	0.236	490.9
inhabitants (k)	115.5	336.1	0.858	3,410.0
area (km ²)	551.5	2,326.2	1.3	21,781.4
supply intensity	27.7	214.8	0.003	3,034.3
grid density	1,254.1	969.8	0.640	9,008.6
work (MWh)	286,906.2	848,954.1	24.2	7,420,265
EnBW	0.152	0.359	0	1
E.ON	0.403	0.491	0	1
RWE	0.218	0.413	0	1
Vattenfall	0.196	0.398	0	1

As a measure for wealth in a distribution grid region we use the buying power of the region. In regions with a higher buying power, we expect standard contract prices to be higher.

The number of inhabitants and the surface area of a grid region are measures for regional concentration. We use both variables individually, as “inhabitants per area” can only partially proxy economies of scale in our opinion. On the one hand, “inhabitants per area” neglects that not individuals, but households, demand energy. On the other hand, with this measure, entrepreneurial energy consumers, which also obtain energy via the regional distribution grid, are not taken into account. In order to approximate economies of scale, we therefore use the measure “grid density”, which puts the number of tapping points in a grid region into relation to the area supplied (not the entire grid region). In doing so, we obtain a very precise approximation of the number of energy consumers in relation to the area in which grid access is available. If rather than the area supplied, the total area of a distribution grid region is assumed, this would lead to an under-prediction of demand in rural areas with a high inhabitants concentration.

The variable chosen here for proxying economies of scale, however, neglects differences in the grid load factor as does the variable “inhabitants per area”. In regions with a high inhabitants density, energy withdrawal from the distribution grid is often lower than in regions which are more entrepreneurially coined. To take into account the grid load factor, we have introduced the variable “supply intensity” as a mean value for the work per tapping point in the distribution grid. Economies of scale,

measured by grid density and supply density in the grid region, should both have a cost reducing effect on the distribution charge. Therefore, we expect for both of these variables negative coefficients in the distribution charge equation.

2.7 Econometric model

As follows from the previous sections, the price for consumer contracts is determined by several factors. Those are, on the one hand, cost and demand dependent and, on the other hand, particularly the ownership structure. As explained above, the distribution charge determines a mean amount of about 27 percent of the standard contract price. The distribution charge, however, depends itself on various factors which mainly come from the structure of the grid. Therefore, it has to be checked, what indirect impact these factors have on the distribution charge and, consequently, on the standard contract price.

Furthermore, there are latent variables (for instance the aggregate demand of a region or the owner relationship between grid operators and standard contract providers) which might influence the estimate of the distribution charge as well as the standard contract price. We therefore assume a two-equation system, in which we first estimate the distribution charge on several potential influencing variables, and, subsequently, the standard contract price on its potential factors of influence where the distribution charge is considered as endogenous in the price equation:

$$\log(dc_i) = \alpha^{dc} + \text{property}_i^{dc} \cdot \beta_{prop,i}^{dc} + \text{grid factors}_i \cdot \beta_{grid,i} + \beta_{hv\ zone} \cdot hv\ zone_i + \epsilon_i^{dc} \quad (1)$$

$$\log(\text{price}_i) = \alpha^p + \text{property}_i^p \cdot \beta_{prop,i}^p + \text{demand}_i \cdot \beta_{demand,i} + \beta_{dc,i} \cdot \log(dc_i) + \epsilon_i^p \quad (2)$$

The first equation is for the determination of the impact factors of the distribution charge.²⁴ The vector *property* includes variables for the participation share of different owners in the grid operator and in the standard contract provider and for ownership concentration. For considering the hypothesis derived from the Corporate Governance literature, we also take into account an influence of higher order in estimations with continuous share variables. If we find a significant influence of higher order, this points to the fact that the estimation of the participation structure is not necessarily due to a participation effect, but rather a concentration effect. As a measure for ownership concentration, we use the Herfindahl-Hirschman-Index (HHI), calculated on the basis of the squared and aggregated shares independent of the type of ownership. Accordingly, the highest concentration exists with only one shareholder. *grid factors* are a vector for characterizing the distribution grid. It includes variables which describe the length and regional coverage of the grid and

²⁴ Structural and regional explanatory variables have been included in the distribution charge equation, as they affect grid access but should have no direct impact, however, on standard contract provision.

the grid work load. Furthermore, we control for differences between high-voltage zones.

The demand for energy should have a significant impact on the standard contract price. Unfortunately, we have no contract demand-information. We therefore approximate demand distinctions between regions with information on the buying power of each region and the number of inhabitants as influence factors of regional consumption. In the simultaneous estimation, $\log(dc_i)$ corresponds to the value estimated in the distribution charge equation. When specifying the price estimation, it has to be taken into account, that no information on production or trade is publically available. This cost component is therefore absorbed by the error term. A summary of the variables is depicted in Table 2 in the appendix.

Equations (1) and (2) are initially estimated separately. Thereby, we assume the distribution charge as an exogenous variable in the price-equation and neglect cross-effects of latent variables and the ownership structure. Taking into account, however, that the bulk of the retail price is determined by the distribution charge and, once again, that latent variables affect both the distribution grid equation and the retail price equation, there should exist an indirect effect of the explanatory variables of the distribution charge on the end consumer price. The separate consideration of both equations neglects the resulting correlation of the exogenous variables of both equations. By taking into account the impact of indirect effects, we contrast the independent estimation model with a simultaneous estimation approach, in which the distribution charge flows as an exogenous variable into the retail price equation. Initially, the distribution charge and the retail price are estimated for all endogenous explanation variables. This approach corresponds to the first step of a classical, instrument variable estimation (IV, 2SLS). Based on the error terms of both estimations, the variance-covariance matrix is subsequently determined and, in a third step, the price equation is estimated with the GLS method allowing for the estimation results of the first two steps.

2.8 Estimation results and discussion

Tables 4 to 6 in the appendix show the results of the various model specifications. The left column in each case contains the results of the independent estimations of the distribution charge and the price equations, the right column shows those of the simultaneous estimation. Comparing the independent and the simultaneous estimation approach provides very similar coefficients with both approaches in particular for the ownership variables. A difference between both estimation approaches only appears with regard to the distribution charge: While the independent estimation shows a price increase of about 14 percent when the distribution charge increases by 1, a change of about 25 percent is observable when

endogenizing the distribution charge.²⁵ With regard to considering the participation effect on price setting, no difference between the two estimation approaches is observable. Table 4 shows a significantly positive coherence for a mean public share in the standard contract provider. Minority shares below 25 percent and companies, which are completely publically owned, do not differ from the reference category “no public participation”. t -tests and χ^2 -tests for differences between positive coefficients of a mean public participation have neither led to significant differences. **Hypothesis 1a**, which states that companies with a higher public ownership share demand higher prices compared to private companies, has therefore to be rejected on the basis of the owner-category estimation.

Making, however, use of a steady share variable instead of classes brings us to a concave relation between the share of public ownership and the standard contract price (Table 5), which is also confirmed with the application of the HHI (Table 6). With the continuous variable, no positive effect of the share of public ownership on the standard contract price becomes apparent. Due to efficient regulation, the public share in the grid operator has no significant impact on the distribution charge. As about 75 percent of the grid operators and standard contract providers were fully vertically integrated in 2008, and as the distribution charge determines about 27 percent of the standard contract price, these estimation results point to no differences in efficiency between public and private standard contract providers. We therefore reject hypothesis 1a in favor of the counter-hypothesis 1b that the specific market structure and the complex information availability in energy markets “regulate” the additional Principal Agent challenge for public companies known from the literature.

As it has already been assessed in the discussion of the first hypothesis regarding the Principal Agent theory, there is an influence of higher order of the share variables on the price, not, however, on the distribution charge. Using the HHI instead of the continuous share variables, the results are confirmed: A higher ownership concentration, either of public or private owners, leads to significantly lower prices for household customers. A group of few, large owners or individual owners choose rather low prices. However, also no significant effect of ownership concentration on the distribution charge becomes apparent either. These results confirm the explanation approaches of the Corporate Governance literature: Individual owners pursue a long-term oriented strategy with their companies, and try to deter customers from switching. On the other hand, companies with a lower ownership concentration choose higher prices in favor of short-term profit, whereby they risk customers switching to alternative providers. Summarizing, **Hypothesis 2** cannot be rejected on the basis of our estimation results.

Besides the ownership structure, standard contract prices are mainly determined by demand factors. Indeed, for all estimations, higher prices in regions with a higher

²⁵With the endogenization, the actual distribution charge is not taken into account anymore, but is instrumented by the variables which only appear in the distribution charge equation.

number of inhabitants exist; buying power in a region has, however, no significant impact on the price-setting behavior.²⁶ For the distribution charge, the regional parameters show for the most part the effects known from the literature: We find positive coefficients for the served area and the intensity of supply and a negative effect regarding the amount of energy put through the distribution grid (Salies, 2008). On the other hand, the number of tapping points has no significant effect on the distribution charge.

While our dataset covers a broad range of information about German retail energy markets there are data missing which focus our analysis on the particular aspects of ownership and pricing and ignore other aspects. E.g., we have no detailed access to size characteristics, in particular of energy providers. Thus, an issue which cannot be considered in depth is the price-size relationship. This particularly means that we only have control variables for the distribution charge equation such as the number of tapping points or regional area size but no direct control measures for firm size such as revenues or employees.²⁷

2.9 Conclusion

In this paper, we have considered the impact of public participation in former monopolistic electricity providers on the prices which most of German households pay for electricity supply and the distribution charge which energy providers pay to access household customers. Against the background of the current, regional-political debate about re-municipalization of former public companies, we have pursued the question which direct effect of public ownership on prices, and, thereby, on household customers exists. For this reason, we have combined data sets, which, on the one hand, give information on contracts and the distribution grids, and, on the other hand, permit a comprehensive view of the ownership structure in German energy markets for household customers.

As most customers are served by the high-price contract of former monopolists, these providers still keep a significant market share with only one contract in their home markets even ten years after the liberalization. Customer hysteresis hampers upcoming competition and thus the entry of new providers. Due to the almost balanced ownership structure between public and private shares in electricity companies with a significant market share, we can investigate whether the effect resulting from public ownership is used rather for the attainment of consumer-oriented (lower) prices, which in the long run hampers competition, or for the attainment of entrepreneurial objectives (with possibly higher prices), which supports customers switching to competitive contracts.

²⁶ Further variables, for instance about the average household size in a grid region, had to be excluded from the estimations as these variables are strongly positively correlated with the buying-power variables.

²⁷ More information on the relationship of size and price choice could be found in Cullmann (2011) where the impact of firm heterogeneity in the context of electricity distribution is analyzed.

Our descriptive analysis shows a strong concentration of ownership when public owners are predominantly involved in a business. Often, public investors even participate as full owners without intermediate owners in former monopolists (and grid operators). When there are private and public owners at the same time, public participation usually takes place with shares in an intermediate owner, which should lead to an even stronger Principal Agent problem. On the other hand, companies, which are completely privately owned, oftentimes also have only one direct owner. Thus, ownership strategies of public and private owners do not really differ based on these findings.

Turning to the price-setting resulting from ownership, we identify a non-linear impact of participation with higher standard contract prices for lower ownership concentration. Individual owners of standard contract providers better understand the market situation of their company and have a greater interest in maintaining their established customer group, i.e. they seek to keep their dominant position in the market for end consumers. The classical Corporate Governance literature argues that a lower ownership concentration or also the situation of less dominant and many small owners lead to free riding of the (smaller) owners (Shleifer and Vishny, 1986, 1995; Vickers and Yarrow, 1991; Dyck, 1999). In consequence, with lower ownership concentration short-term profits with higher standard contract prices are given preference compared to long-term customer loyalty strategies. Distribution charges are not affected by ownership concentration, which is mainly attributable to the target-aiming regulation.

These results contradict the standard opinion of differences in ownership types: While proponents of more public engagement in local energy supply repeatedly put forward that customers benefit from lower prices, we find no significant price differences between public and private ownership. Instead, we find that ownership concentration is a key aspect in price setting. Keeping in mind the particular contract type under consideration, which is the successor of the former monopolistic contract, our results suggest the following policy implications: Supporting a higher ownership concentration leads to a reduction in standard contract prices. As most customers are still served by this particular contract type, customers directly benefit from this policy. Such an implication does not contradict the objective of more competition as competition could only be increased if customers want it to be increased. If prices are sufficiently low from a customer welfare perspective, which is predominantly followed by the European Commission, no stronger competition is required.

2.10 References

- Anderson, R. C. and Reeb, D. M. (2003), Founding-Family Ownership and Firm Performance: Evidence from the S&P 500, *Journal of Finance* 58 (3), 1301-1327.
- Birke, A., Hensel, V., Hirschfeld, O. and Lenk, T. (2000), Die ostdeutsche Elektrizitätswirtschaft zwischen Volkseigentum und Wettbewerb. Universität Leipzig - Institut für Finanzen Arbeitspapier 22.
- Bortolotti, B., Cambini, C., Rondi, L. and Spiegel, Y. (2007), Capital Structure and Regulation: Does Ownership Matter?, CEPR Working Paper.
- Blättchen, K. (1999), "Die Transformation der Elektrizitätswirtschaft im Osten Deutschlands", GERAG Verlag.
- Bundesnetzagentur (2009), Jahresbericht 2008.
- Conway, P. and Nicoletti, G. (2006), Product market regulation in non-manufacturing sectors in OECD countries: measurement and highlights, OECD Economics Department Working Paper.
- Cullmann, A. (2011), Benchmarking and Firm Heterogeneity: A Latent Class Analysis for German Electricity Distribution Companies, *Empirical Economics*, forthcoming.
- Dixit, A. (1997), Power of Incentives in Private versus Public Organizations, *American Economic Review* 87, 378-382.
- Dyck, A. (2001), Privatization and Corporate Governance. *The World Bank Research Observer*, vol. 16, no. 1.
- Franks, J. R. and Mayer, C. (2001), Ownership and Control of German Corporations, *Review of Financial Studies* 14 (4), 943-977.
- Fiorio, C.V., Florio, M. and Doronzo, R. (2007), The Electricity Industry Reform Paradigm in the European Union: Testing the Impact on Consumers, Working Paper University of Milan.
- Furubotn, E. and Pejovich, S. (1972), Property Rights and Economic Theory: A Survey of Recent Literature, *Journal of Economic Literature*, Vol. 10, No. 4.
- Holl, P. (1975); Effect of control type on the performance of the firm in the UK. *The Journal of Industrial Economics* 23(4): 257-271.
- Hill, C.W.L. and Snell, S.A. (1989), Effects of ownership structure and control on corporate productivity. *Academy of Management Journal* 32(1): 25-46.
- Institut für Öffentliche Finanzen and Public Management der Universität Leipzig (2009), Stadtwerke – Perspektiven vor dem Hintergrund der Interdependenz von Daseinsvorsorge und Wettbewerb im Fokus eines regulierten Marktumfeldes, Studie, Herausgeber: Commerzbank AG.

Kansalliskirjasto, K. (2007), The Effect of Family Ownership on Firm Performance: Empirical Evidence from Norway, Working Paper Lappeenranta University of Technology – School of Business.

Lehmann, E., Warning, S., and Weigand, J. (2004), Governance Structures, Multidimensional Efficiency and Firm Profitability, *Journal of Management and Governance*, no. 3 (2004): 279-304.

Ockenfels, A., Grimm, V., Zöttl, G. (2008), Strommarktdesign – Preisbildungsmechanismus im Auktionsverfahren für Stromstundenkontrakte an der EEX.

Praetorius, B. (2009), Trends in der Energiewirtschaft: Kooperationen und (Re-) Kommunalisierung von Infrastrukturen, *Kommunales Infrastruktur-Management Berlin*.

Mas-Colell, A., Whinston, M. and Green, J. (1995), *Microeconomic theory*. Oxford Univ. Press. New York.

Salies, E. (2008), Mergers in the GB electricity market: effects on retail charges. *Applied Economics*, 40 (11), 1483–90.

Shirley, M. and Walsh, P. (2000), Public versus Private Ownership: The Current State of the Debate. The World Bank.

Tirole, J. (1995), *Industrieökonomik*. Oldenbourg. München, Wien.

Tollison, R.D. (1982), Rent-seeking: A survey. *Kyklos* 35 (4): 575-602.

Tullock, G. (1967), The Welfare costs of tariffs, monopolies and theft. *Economic Inquiry*, Volume 5, Issue 3, Pages 224 – 232.

Shleifer, A., and Vishny, R. (1986), Large Shareholders and Corporate Control. *The Journal of Political Economy* 94(3), 461-488.

Shleifer, A., and Vishny, R. (1997), A Survey of Corporate Governance. *Journal of Finance*, 52(2): 737-783.

Vickers, J. and Yarrow, G. (1991), Economic Perspectives on Privatization. *The Journal of Economic Perspectives*, Vol. 5, No. 2.

Wintrobe, R. (1987), The Market for Corporate Control and the Market for Political Control. *Journal of Law, Economics, and Organization* vol. 3, no. 2.

Wittmann, D. (1995), *The Myth of Democratic Failure: Why Political Institutions are Efficient*, University of Chicago Press.

2.11 Appendix

Table 2: Description of the variables

Variable	Description
price	Standard contract price for yearly consumption of 4000 kWh in Euro
distr. charge	Distribution charge for yearly consumption of 4000 kWh in Euro
pp (m)	Cumulated purchasing power of households in the distribution area in m Euro
inhabitants	Number inhabitants in the distribution area
provider HHI	Herfindahl-Hirschman-Index of public and private ownership shares in the standard contract provider
provider share ≤ 0.25	Bivariate variable: Aggregated share of all public owners in the standard contract provider below or equal 0.25
$0.25 < \text{provider share} \leq 0.5$	Bivariate variable: Aggregated share of all public owners in the standard contract provider between 0.25 and 0.5
$0.5 < \text{provider share} \leq 0.75$	Bivariate Variable: Aggregated share of all public owners in the standard contract provider between 0.5 and 0.75
$0.75 < \text{provider share} < 1$	Bivariate Variable: Aggregated share of all public owners in the standard contract provider between 0.75 and 1
provider share = 1	Bivariate Variable: Aggregated share of all public owners in the standard contract provider equals 1
provider share	Continuous variable: Aggregated share of all public owners in the standard contract provider
provider share (squared)	Continuous variable: Aggregated share of all public owners in the standard contract provider, squared
Area	Distribution area in squared kilometers
supply intensity	Average quantity of electricity extracted from tapping points in a distribution grid area
grid density	Number of tapping points in a distribution grid area
Work	Total quantity of electricity supplied in a distribution grid area
EnBW	Bivariate Variable: EnBW high voltage zone
E.ON	Bivariate Variable: E.ON high voltage zone
RWE	Bivariate Variable: RWE high voltage zone
Vattenfall	Bivariate Variable: Vattenfall high voltage zone
grid operator HHI	Herfindahl-Hirschman-Index aggregated on public and private shares in the grid operator
grid op. share ≤ 0.25	Bivariate variable: Aggregated share of all public owners in the distribution grid operator below or equal 0.25
$0.25 < \text{grid op. share} \leq 0.5$	Bivariate variable: Aggregated share of all public owners in the distribution grid operator between 0.25 and 0.5
$0.5 < \text{grid op. share} \leq 0.75$	Bivariate Variable: Aggregated share of all public owners in the distribution grid operator between 0.5 and 0.75
$0.75 < \text{grid op. share} < 1$	Bivariate Variable: Aggregated share of all public owners in the distribution grid operator between 0.75 and 1
grid op. share = 1	Bivariate Variable: Aggregated share of all public owners in the distribution grid operator equals 1
grid op. share	Continuous variable: Aggregated share of all public owners in the distribution grid operator
grid op. share (squared)	Continuous variable: Aggregated share of all public owners in the distribution grid operator, squared

Table 3: Descriptive statistics based on dependent estimations

	Mean	Std.dev.	Minimum	Maximum
log (price)	6.777	0.048	60.6	60.9
log (distr. charge)	5.423	0.130	50.0	50.8
log (pp (m))	4.322	0.832	-10.4	60.2
log (inhabitants)	10.3	10.4	60.9	150.0
provider HHI	0.823	0.218	0.299	1
provider share \leq 0.25	0.025	0.157	0	1
0.25 < provider share \leq 0.5	0.049	0.215	0	1
0.5 < provider share \leq 0.75	0.191	0.393	0	1
0.75 < provider share < 1	0.189	0.392	0	1
provider share = 1	0.449	0.498	0	1
provider share	0.750	0.326	0	1
provider share (squared)	0.669	0.369	0	1
log (area)	4.208	10.6	0.262	91.0
log (supply intensity)	82.8	5520.1	0.003	56970.3
log (grid density)	1254.5	9710.1	0.640	90080.6
log (work)	11.2	10.8	30.2	200.6
EnBW	0.152	0.359	0	1
E.ON	0.403	0.491	0	1
RWE	0.218	0.413	0	1
Vattenfall	0.196	0.398	0	1
grid operator HHI	0.823	0.217	0	1
Grid op. share \leq 0.25	0.029	0.168	0	1
0.25 < grid op. share \leq 0.5	0.039	0.194	0	1
0.5 < grid op. share \leq 0.75	0.193	0.395	0	1
0.75 < grid op. share < 1	0.202	0.402	0	1
grid op. share = 1	0.438	0.497	0	1
grid op. share	0.749	0.329	0	1
grid op. share (squared)	0.669	0.368	0	1

Table 4: Estimation results based on threshold values

	independent estimations			dependent estimations		
log(price)						
log(distr. charge)	0.143	***	(0.014)	0.243	***	(0.030)
log(pp (m.))	-0.004		(0.003)	-0.001		(0.003)
log(inhabitants)	0.004	**	(0.002)	0.005	***	(0.002)
provider share ≤ 0.25	0.024		(0.016)	0.016		(0.014)
0.25 < provider share ≤ 0.5	0.043	***	(0.011)	0.036	***	(0.011)
0.5 < provider share ≤ 0.75	0.037	***	(0.009)	0.032	***	(0.008)
0.75 < provider share < 1	0.031	***	(0.008)	0.028	***	(0.008)
provider share = 1	0.016	**	(0.008)	0.014	**	(0.007)
constant term	5.956	***	(0.082)	5.391	***	(0.170)
log(distr. charge)						
log(area)	0.016	***	(0.006)	0.016	***	(0.006)
log(supply intensity)	0.005	**	(0.009)	0.022	***	(0.008)
log(grid density)	-0.035		(0.007)	0.007		(0.007)
log(work)	-0.035	***	(0.007)	-0.036	***	(0.007)
EnBW	0.003		(0.032)	0.023		(0.030)
E.on	0.041		(0.031)	0.016		(0.028)
RWE	0.038		(0.032)	0.028		(0.029)
Vatenfall	0.185	***	(0.033)	0.184	***	(0.030)
grid op. share ≤ 0.25	0.034		(0.037)	0.036		(0.035)
0.25 < grid op. share ≤ 0.5	0.013		(0.030)	0.015		(0.030)
0.5 < grid op. share ≤ 0.75	-0.017		(0.021)	-0.017		(0.020)
0.75 < grid op. share < 1	-0.004		(0.020)	0.000		(0.019)
grid op. share = 1	-0.004		(0.018)	-0.001		(0.017)
constant term	5.626	***	(0.066)	5.632	***	(0.053)
observations		517			517	
F-Test/Chi2-Test (1st eq.)		19.67 (8)			128.65 (8)	
F-Test/Chi2-Test (2nd eq.)		16.42 (13)			226.95 (13)	
R2 (1st eq.)		0.228			0.159	
R2 (2nd eq.)		0.290			0.276	

Table 5: Estimation results based on continuous share variable

	independent estimations			dependent estimations		
log(price)						
log(distr. charge)	0.146	***	(0.014)	0.253	***	(0.030)
log(pp (m))	-0.004		(0.003)	-0.001		(0.003)
log(inhabitants)	0.004	***	(0.001)	0.006	***	(0.002)
provider share	0.137	***	(0.025)	0.129	***	(0.024)
provider share (squared)	-0.123	***	(0.021)	-0.115	***	(0.022)
constant term	5.936	***	(0.080)	5.336	***	(0.174)
log(distr. charge)						
log(area)	0.017	***	(0.006)	0.016	***	(0.006)
log(supply intensity)	0.018	**	(0.009)	0.020	***	(0.008)
log(grid density)	0.003		(0.007)	0.005		(0.007)
log(work)	-0.033	***	(0.007)	-0.034	***	(0.007)
EnBW	0.007		(0.032)	0.029		(0.029)
E.on	0.044		(0.031)	0.017		(0.028)
RWE	0.041		(0.032)	0.030		(0.029)
Vatenfall	0.190	***	(0.033)	0.188	***	(0.029)
grid op. share	-0.083		(0.066)	-0.085		(0.060)
grid op. share (squared)	0.073		(0.059)	0.078		(0.054)
constant term	5.618	***	(0.066)	5.625	***	(0.052)
observations		517			517	
F-Test/Chi2-Test (1st eq.)		31.64 (5)			126.39 (5)	
F-Test/Chi2-Test (2nd eq.)		20.37 (10)			224.32 (10)	
R2 (1st eq.)		0.228			0.151	
R2 (2nd eq.)		0.288			0.271	

Table 6: Estimation results based on ownership share HHI

	independent estimations			dependent estimations		
log(price)						
log(distr. charge)	0.146	***	(0.014)	0.248	***	(0.030)
log(pp (m))	-0.001		(0.002)	0.001		(0.003)
log(inhabitants)	0.004	**	(0.001)	0.005	***	(0.002)
provider HHI	-0.054	***	(0.009)	-0.051	***	(0.009)
constant term	6.002	***	(0.082)	5.421	***	(0.176)
log(distr. charge)						
log(area)	0.018	***	(0.006)	0.016	***	(0.006)
log(supply intensity)	0.018	**	(0.009)	0.019	**	(0.008)
log(grid density)	0.003		(0.007)	0.005		(0.007)
log(work)	-0.034	***	(0.007)	-0.034	***	(0.007)
EnBW	0.005		(0.031)	0.029		(0.029)
E.on	0.043		(0.031)	0.018		(0.028)
RWE	0.039		(0.031)	0.030		(0.029)
Vatenfall	0.189	***	(0.032)	0.190	***	(0.029)
grid operator HHI	0.029		(0.025)	0.033		(0.024)
constant term	5.587	***	(0.076)	5.585	***	(0.060)
observations	517			517		
F-Test/Chi2-Test (1st eq.)	41.11 (4)			125.13 (4)		
F-Test/Chi2-Test (2nd eq.)	22.62 (9)			224.15 (9)		
R2 (1st eq.)	0.229			0.157		
R2 (2nd eq.)	0.288			0.271		

*, **, *** represent significance at the 10, 5 and 1 percent significance levels, respectively.

3 STRATEGIC PRICING, MARKET ENTRY AND COMPETITION: EVIDENCE FROM GERMAN ELECTRICITY SUBMARKETS²⁸

²⁸ Based on joint research with Tobias Veith.

3.1 Introduction

Electricity markets in Europe were liberalized during the 1990s. Since then new entrants are allowed to enter the market and offer energy contracts to customers of former national or regional monopolists. However, particularly in Germany only a very low number of residential customers have switched to an alternative provider. Following the “Monitoringbericht 2008”, an annual survey by the German regulator Bundesnetzagentur, only 6.4 percent of all German households switched to an alternative provider, 34 percent switched to an alternative incumbent contract and about 60 percent stayed with incumbents’ standard contracts.

The largest retail provider - that is the former monopolist in each local submarket, is obliged to offer a particular contract type, namely the standard contract, due to universal service obligations (USOs). As the retail markets are not regulated each incumbent can individually determine its standard contract price. The prices for standard contracts are higher than for alternative contracts offered in the markets. Additionally, incumbents offer alternative contracts to customers who are more willing to switch. Thus, they charge higher prices from customers with high switching costs while they offer low-price contracts to those customers who are willing to switch their contract or supplier. This behavior is a form of third degree price discrimination (see e.g. Schmalensee (1981)). As customers in the standard contract seem to be highly price-insensitive we analyze the hypothesis that standard contract price adjustments could be used as a strategic instrument to affect competition in terms of number of competitors or contracts in retail markets.

We adopt the idea of limit pricing models as introduced in Bain (1949) and extended in Dixit (1979) and rearrange it to the framework observed in German retail energy markets for household customers. In a simple theoretical model of market deterrence we first show that the level of the standard contract price might have an impact on the number of contracts in the market. However, this is possible only if the incumbent, as a first mover, can commit itself to a price strategy. Thus, if the strategy of the price leader is binding, market deterrence might occur.

Using data for numerous German geographically separated electricity submarkets we test the theoretical outcome. We determine the impact factors of distribution charges and standard contract prices separately and analyze how the difference in standard contract prices and distribution charge, known as the price-cost markup influences the number of competitors, the number of contracts with prices below the standard contract price and the number of contracts per provider in about 850 local markets. We conduct this analysis for three alternative user groups (demanding 1500, 2800 and 4000 kWh per year) as proposed in Salies and Waddams Price (2004) or Salies (2008). Note that the distribution charges are cost-based regulated, thus, the only strategic instrument is the incumbent’s retail price.

We find that the **number of contracts** in a local market is on average positively affected by the price-cost markup of the standard contract. However, we do not observe a clear evidence for market deterrence, as the number of entrants is negatively affected by the price-cost markup only for high consumption level (4000 kWh). Thus, our empirical results provide evidence for the standard contract price being an additional strategic instrument to affect the number of contracts, and thus, the extent of price discrimination, but not for market entry.

The paper is organized as follows: We first give an overview of the existing literature. Next we present our theoretical model based on the situation observed for Germany followed by the discussion on the outcomes of the model. In section 4 we describe the data and derive the estimation model. Section 5 provides the estimation results and their discussion. The last section concludes the paper.

3.2 Related literature

Electricity markets are in the focus of multiple strands of literature. While there is a non-exhaustive range of literature on wholesale competition, production and the challenges of transmission, we mainly concentrate on the description of retail competition and entry barriers.

Only a few empirical studies consider the effects of market liberalization on incumbents' market power. For example, Salies and Waddams Price (2004) analyze how competition in UK retail energy markets is affected by the market power of single providers. They find that prices are determined not only by customer characteristics and cost factors but particularly also by incumbency.

Salies (2008) takes up these results and analyzes which factors affect competition and thus contracts offered to private customers. He finds that providers first differentiate between rural and urban customers as prices are significantly lower in more densely populated areas. Concerning grid characteristics he identifies underground cables to be a "price-reducer" since underground cables are less affected by climate impact factors. Moreover, Salies shows that transmission charges on both higher voltage and distributional level also positively affect retail prices. Finally, he identifies significantly higher prices for incumbents.²⁹

The theoretical literature distinguishes between vertical and horizontal market entry deterrence. A vertically integrated provider controls an essential input (distribution

²⁹ A further central aspect of this paper is the analysis of the correlation of vertical integration and incumbent prices. The author finds vertical integration aspects to be of less importance than regional aspects. We want to address this research question in a subsequent paper for German electricity markets where we use data for the incumbent operators and compare price differences of standard contracts with regard to vertical integration with grid owners, the four high-voltage companies and municipal firm alliances.

network) for downstream competitors and is also involved in downstream competition. Because of this exceptional position it is able to influence downstream prices or quality aspects of goods by altering characteristics of the essential input. The issue of vertical foreclosure is extensively discussed in Rey and Tirole (2003). As providers have to pay a network access charge it could be used to foreclose downstream competitors as is shown in Stiglitz (1979). To prevent such an abuse network (distribution) charges are regulated and have to be paid by all downstream supplying firms regardless of their vertical relations with distribution network operators.

In contrast to vertical foreclosure horizontal foreclosure means a firm's strategic pricing that can force competitors out of a market or used to deter entry. One particular theory in this context is the limit-pricing theory which focuses on a monopolist who chooses a lower price under the threat of entry than in a closed-market situation. Bain (1949) argues that a price chosen sufficiently low prevents new providers from market entry. Despite the criticism as it could not really be proven in reality (since the prices adjust after the market entry and a monopolist's price choice is flexible in itself), further theoretical studies provide alternative ideas how price reduction could be used as an instrument to deter market entry (Dixit, 1979, 1980, Spence, 1977 and Milgrom and Roberts, 1982b). Pricing strategies to foreclose competitors in a market are examined mainly under the umbrella of predatory pricing (see e.g. Milgrom and Roberts, 1982a). In this context the predator reduces its price to drive competitors out of the market. In the short run prices could be chosen even below marginal costs, thus inducing losses that could be recouped after competitors have left the market. However, predation falls under the treatment of national and EU antitrust law.

Klemperer (1987) shows that in markets with high switching costs the incumbent can lower the output and deter market. He too suggests that the larger the consumer base in the pre-entry period the less likely is an aggressive behavior of the incumbent to attract new customers and compete with the entrant when price discrimination between new and old costumers is not possible. To deter market entry the incumbent could "limit over-price" in the pre-entry period and then compete with the entrant in the second period. This behavior might weaken market entry incentives.

Our theoretical model refers to the idea of limit pricing in retail markets, where the price is not regulated, the former monopolists are the current incumbents in their local markets, and distribution charges for the electricity grid are the same for all firms as they are regulated. The assumption in our model is that the incumbent move first by setting a binding price for its standard contract. The potential entrants observe the prices and decide whether to enter or not. In contrast to Klemperer (1987) we assume that the incumbent is able to discriminate between customers with low and high switching costs but we do not model the switching costs explicitly. Furthermore, the assumption of price competition might be appropriate as the total market demand is assumed to be (at least in the short run) inelastic in the electricity markets for

household customers and new customers do not enter the market (market expansion does not occur due to market entry). We want to show that limit-pricing can be rational for former monopolists in the electricity markets and test this hypothesis using cross-sectional data for household customers in Germany. As suggested in the literature on market entry, for example in Bresnahan and Reiss (1990), we too assume that a market can accommodate a certain number of newcomers that enter as long as the expected profits are non-negative.

3.3 Market description

The German electricity market is much more geographically decentralized than other European electricity markets. In the production and high voltage transmission system four transmission system operators (TSOs) exist which are active in their regionally separated high voltage areas. At the low voltage level, there are about 850 regionally separated markets for household electricity provision.³⁰ These are delineated by the geographical area supplied by only one distribution operator. In each market only one distribution operator and one downstream incumbent is active. The definition of the relevant market for household customers is applied by the German Competition Authority in cases of market power abuse. We follow another market definition for our empirical analysis, which is described in the Data section. Figures 1 and 2 provide an overview of regional separation.³¹ Figure 8 displays the four highest voltage areas of E.On³², EnBW, RWE and Vattenfall Europe.³³ The E.On area is the largest, the EnBW the smallest of the four regions. The TSOs keep about 85 percent of the electricity production capacities in Germany (in 2008). Moreover, long-run supply-agreements and over the counter trade with regional energy providers exist and, thus, only about one fifth of electricity trade takes place at the European Energy Exchange (EEX) in Leipzig.

On the distribution level local grid operators were mainly integrated with retail energy providers but were forced to disentangle production, distribution and retail into legally separated companies by the introduction of legal unbundling in 2007 to prevent discrimination against the entrants.³⁴

All in all, former monopolistic energy providers still keep the absolute majority of customers in their home markets mainly in standard contracts but also in newly

³⁰ See the Monitoringbericht 2008.

³¹ Data for the graphs are provided by E'net.

³² Recently E.on sold its transmission grid to TenneT (in 2010). As we employ Data from 2008 we consider E.on as the owner of the Grid.

³³ Note that there are also transmission regions close to the German border which are operated either by foreign transmission grid providers or by smaller providers.

³⁴ The obligation to separate the grid from other activities, such as retail or production, applies only for firms with more than 100.000 customers. Firms which do not reach this threshold are allowed to remain within the same company.

installed, more competitive contracts. On average more than 40 additional providers are active in each electricity market with a market share of less than 10 percent of all retail customers.³⁵ Switching away from incumbent to a competitor is still very rare. Figure 9 displays the 850 separated distribution areas. Two equally large regions exist, one in North-Eastern Germany and one in Bavaria. The first mainly covers the less densely populated area in Germany. In contrast, the most-densely populated area, the Rhine-Ruhr area in Western Germany, is separated into a multitude of very small distribution areas. For the access to one of these local markets electricity providers have to pay a cost-based regulated distribution charge.³⁶ This distribution charge is a two-part tariff composed of two fixed-part elements which are a fixed annual charge and a metering charge. The variable charge depends on the amount of consumed energy.³⁷ Distribution charges are market specific and the same for all suppliers.

Competitors that entered the market are mostly newcomers that were not active in electricity markets before the liberalization. Beside the newcomers, a few former monopolists decided to expand in new geographically separated markets and also low-cost suppliers that have been set up mostly by the four major electricity producing companies, entered particular markets. Electricity contracts for household customers are mostly equipped with specific characteristics. For example, customers can choose contracts with different shares of renewable energy or contract duration. Additionally, there are contracts with particular bonus schemes or price reductions. Product differentiation is one of the crucial factors to relax intense price competition. However, all of these contract characteristics only slightly affect provision costs.³⁸ In contrast to these recent types of differentiation, the standard contracts

³⁵ Note that these alternative providers are much more successful with regard to industrial customers.

³⁶ Regulation changed in 2009 from cost-based regulation to revenue-cap regulation.

³⁷ Since 2009 the distribution charges are incentive based regulated (revenue cap). In our empirical analysis, however, we employ cost-based regulated distribution charges from 2008.

³⁸ We do not have any production cost information for our analysis below. Therefore, we have introduced contract dummies and, alternatively, company dummies to cover (among others) production or procurement costs. These dummies were of no significance for prices offered to customers. Also with other estimation model specifications we find only a low number of dummies being significant which, in our opinion, is a sign for strong similarities among providers taking into account the range of other variables used in our study.

Figure 8: Regional separation of the German Electricity Transmission Market³⁹

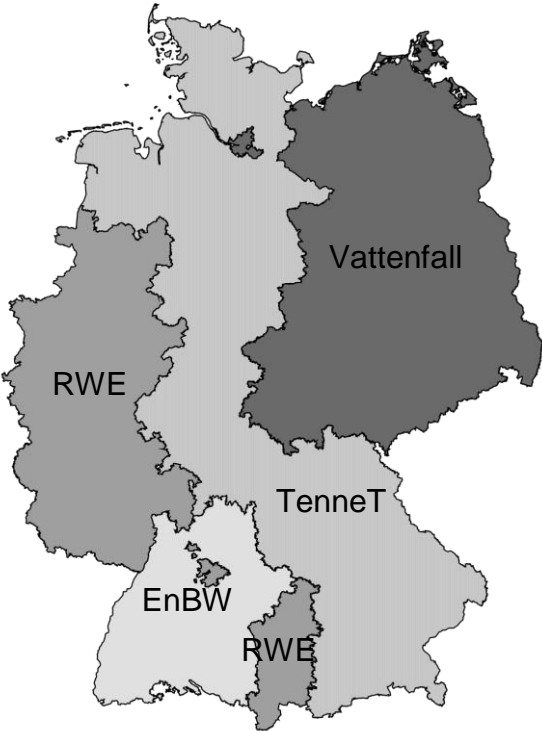
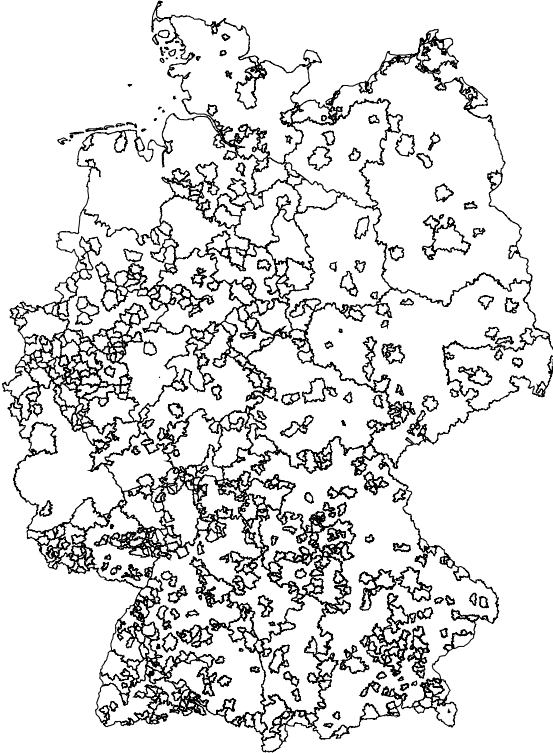


Figure 9: Regional separation of the German Electricity Distribution Market



³⁹ The maps in this thesis are generated using Acxiom, Creditreform, GfK GeoMarketing, Verivox and Enet information.

have significantly less (or no) “add-on” characteristics but are offered at a higher price. By law these have to be offered by the energy provider which serves the majority of household customers in a region. It could be interpreted as a “fall-back” option for customers who have switched to an alternative contract. They automatically return to the standard contract either if their new provider leaves the market or if their contract is deleted and customers in this contract have not decided where to switch (§§ 36 – 38, Energiewirtschaftsgesetz (EnWG)). However, as already mentioned above, the *Monitoringbericht* of the German Regulation Authority, Bundesnetzagentur, reports that about 60 percent of all German households have not switched yet (c.f. Monitoringbericht 2008). Note that in all German retail markets former monopolists are still the providers of standard contracts. Nevertheless, they are also allowed to offer alternative contracts. These contracts are much more similar to those of new competitors but they are also a successful instrument for binding potential “switchers” as most switching households stay with their incumbent providers (34 percent).

3.4 Theoretical model

In the following, we consider sequential price competition with differentiated products and the threat of potential market entry in a three stage game. Differentiated contracts for electricity supply are offered by the dominant provider and one alternative competitor. We assume that the dominant provider offers two types of contracts, a standard contract at price p_{st} and a competitive contract at price p_1 for customers with low switching costs that are willing to switch.⁴⁰ The competitor offers one contract at price p_2 . We assume that one further (potential) competitor will enter the market with only one contract at a price p_3 if its expected profits are larger than zero. The timing of the game is as follows: first, the incumbent determines the price for the standard contract. Then the competitor and the potential entrant observe this price and the potential competitor decides to enter the market or not. Finally, all providers choose their competitive contract prices simultaneously. With these assumptions, we follow the Limit Pricing theory with fully informed firms maximizing their profits given that the strategy of the price leader (incumbent) is binding. Thus, the incumbent can commit itself to a price for its standard contract and the competitors consider this price strategy as credible. If for example the price leader decreases its price for the standard contract (in contracts to alternative contracts) then an immediate increase is not profitable since a number of customers could prompt switching to another contract or other electricity supplier.⁴¹

⁴⁰ Note that we do not model the switching costs explicitly. The heterogeneity in the switching costs is implicitly captured in the demand and price functions of the offered contracts.

⁴¹ Since the standard contract can be switched monthly, incumbents seldom adjust prices because in that case customers have to be informed about the price change. Thus, compared with other contracts

Customers are of mass 1 and individually ask for an identical quantity of electricity.⁴² All customers who have not yet switched are in the standard contract st . For reasons of simplicity we assume that customers switch to an alternative contract if the net utility increase of switching is sufficiently large. The demand for contract $i \in \{1, 2, 3, st\}$ is then defined as function of contract prices in the market. We keep the usual price-demand assumptions:

$$N_i = N_i(p_i) \text{ with } \frac{\partial N_i}{\partial p_i} < 0, \quad i = 1, 2, 3, st$$

Prices are strategic complements, $\frac{\partial p_i}{\partial p_{-i}} \geq 0$, and cross-price effects are positive regardless of other contracts. The absolute own-price effect on demand is larger than the cross-price effect:

$$\frac{\partial N_i}{\partial p_{-i}} > 0, \quad \left| \frac{\partial N_i}{\partial p_{-i}} \right| < \left| \frac{\partial N_i}{\partial p_i} \right| \quad i, -i = 1, 2, 3, st; \quad i \neq -i$$

We first analyse the situation without strategic intervention of the incumbent and then show that under particular conditions it could be profitable for an incumbent to offer a standard contract at a lower price to keep a competitor out of the market.

3.4.1 Optimal pricing with market entry

We solve the game by backward induction and start where the potential competitor decides to enter the market. The profit functions are then:

$$\begin{aligned} \pi_1 &= (p_{st} - dc - c_1)(1 - N) + (p_1 - dc - c_1)N_1 - F_1 \\ \pi_2 &= (p_2 - dc - c_2)N_2 - F_2 \\ \pi_3 &= (p_3 - dc - c_3)N_3 - F_3 \end{aligned} \tag{1}$$

with $N = N_1 + N_2 + N_3$. Thus, N is defined as the total number of customers who have “switched” from the standard contract to competitive contracts. All providers bear marginal costs c_i , fixed costs F_i , $i = 1, 2, 3$, and an identical, regulated per-unit distribution charge dc . We further assume that $F_2 < F_3$ to ensure that the potential entrant is the one targeted by the standard contract, as the entry condition must hold. The rationale for this assumption is that first the higher-cost competitors are affected by incumbent’s pricing behaviour

with longer contract duration, we observe rare price adjustments for the standard contract. Usually, the majority of the incumbents announce their price adjustments simultaneously. This could mitigate switching effects because of the announcements in the popular press and customers perception that prices are affected in the whole industry and therefore switching to another supplier is not beneficial.

⁴² We assume total market demand to be price inelastic in the short run.

Beginning with the last stage, the optimal prices are determined by the FOC of the profit functions with respect to competitive prices. Thus, we obtain the implicit price reaction functions for the competitive contracts

$$\frac{\partial \pi_1}{\partial p_1} = N_1(p_{st}, \cdot) - (p_{st} - dc - c_1) \frac{\partial N(p_{st}, \cdot)}{\partial p_1} + (p_1 - dc - c_1) \frac{\partial N_1(p_{st}, \cdot)}{\partial p_1} = 0 \quad (2.1)$$

$$\frac{\partial \pi_i}{\partial p_i} = N_i(p_{st}, \cdot) + (p_i - dc - c_i) \frac{\partial N_i(p_{st}, \cdot)}{\partial p_i} = 0 \quad (2.2)$$

$i = 2, 3$.

Thus, we get the best response functions for the competitors' contracts and for the incumbent's competitive contract as

$$p_i^R = p_i^R(p_{st}, p_1, p_{-i}, c_i, dc), \quad i, -i = 2, 3, \quad i \neq -i \quad \text{and} \quad p_1^R = p_1^R(p_{st}, p_2, p_3, c_1, dc).$$

In the second stage the potential competitor observes the standard contract price p_{st}^* . It only enters the market if the zero condition holds:

$$\pi_3(p_{st}, p_1(p_{st}), p_2(p_{st}), p_3(p_{st})) \geq 0.$$

Finally, given the implicit price reaction functions of the last stage and the entry decision of the potential customer we implicitly derive the optimal standard contract price:

$$\frac{\partial \pi_1}{\partial p_{st}} = 1 - N - (p_{st} - dc - c_1) \frac{\partial N}{\partial p_{st}} + (p_1^R - dc - c_1) \frac{\partial N_1}{\partial p_{st}} + N_1 \frac{\partial p_1^R}{\partial p_{st}} = 0 \quad (3)$$

The incumbent takes into account the (direct) price effect, the first two terms, and, additionally, an (indirect) price effect on its competitive contract price, the last term. Note that the incumbent uses its competitive contract to prevent customers from switching to an alternative provider. The higher the standard contract price the more customers choose an alternative contract. A higher demand for alternative contracts raises the prices for these contracts. The magnitude of this price effects depends on

$\frac{\partial p_1^R}{\partial p_{st}}$. If, for example, customers with standard contracts have high switching costs

then the incumbent can raise the standard contract price without having a high impact on its competitive price. Thus, the higher the difference between the switching costs the bigger the gap between prices paid by different customer groups with different switching costs.⁴³ When choosing its standard contract price the incumbent has to deal with this trade-off between the standard contract price effect and the

⁴³ This result reflects the theoretical findings of Varian (1980) in a sale model.

indirect effect on its own competitive contract. From (3) one can derive the equilibrium standard contract price as $p_{st}^* \equiv p_{st}^*(dc, c_1, c_2, c_3)$ which only depends on the (exogenously given) distribution charge and the variable costs of electricity provision.

3.4.2 Optimal pricing with entry deterrence

As mentioned above, we assume that competitors consider the standard contract price set by the incumbent in the first stage as binding. Depending on the price elasticity the loss caused by a standard contract price reduction is lower than the loss of a lower demand if a new competitor enters the market. In this scenario, the alternative standard contract price $p_{st}^A (< p_{st}^*)$ has to satisfy the following foreclosure condition: $\pi_3(p_{st}^A, p_1^A, p_2^A, p_3^A) < 0$. A indicates the case of market deterrence.

If provider 3 stays out of the market the remaining profit functions are as follows:

$$\begin{aligned}\pi_1^A &= (p_{st}^A - dc - c_1)(1 - N^A) + (p_1^A - dc - c_1)N_1^A - F_1 \\ \pi_2^A &= (p_2^A - dc - c_2)N_2^A - F_2\end{aligned}\tag{4}$$

with $N^A = N_1^A + N_2^A$, $p_{st}^A < p_{st}^*$.

Thus, the new price reaction functions for the competitive contracts are $p_1^{AR} = p_1^{AR}(p_{st}^A, p_2^A, c_1, dc)$ for the competitive incumbent contract and $p_2^{AR} = p_2^{AR}(p_{st}^A, p_1^A, c_2, dc)$ for the competitor's contract. In case of only two competitive contracts in the market and low standard contract price the demand for each contract is higher: $N > N^A$, $N_i^A \geq N_i$, $i = 1, 2$.

Provider 3 would enter the market if its resulting profit just equals the profit from its outside option:

$$\pi_3^A = (p_3^A - dc - c_3)N_3^A - F_3 = 0\tag{5}$$

By assuming continuous price reaction functions we calculate the threshold standard contract price as the standard contract price with entry minus the standard contract price change due to the price reaction of potential competitor's contract:

$$p_{st}^A = p_{st}^* - \frac{(p_3^* - p_3^A)}{\partial p_3^R / \partial p_{st}}\tag{6}$$

Rearranging the threshold condition in (5) and replacing it into (6) yields:

$$p_{st}^* - p_{st}^A = \frac{p_3^*}{\partial p_3^R / \partial p_{st}} - \left(\frac{(dc + c_3)N_3^A + F_3}{(\partial p_3^R / \partial p_{st})N_3^A} \right) \quad (7)$$

The gap between the optimal standard contract price with three providers and the optimal standard contract price for entry deterrence depends mainly on two factors: first, the competitor's price reaction function and, second, the competitor's marginal and fixed costs. The higher the cross-price effect and the higher the marginal costs, the lower the relevant effort for the incumbent. Obviously, the price-cost margin is lower with market deterrence than with market entry: $\frac{p_{st}^* - dc - c_1}{p_{st}^*} > \frac{p_{st}^A - dc - c_1}{p_{st}^A}$.

From the incumbent's perspective a price deviation is only profitable if $\Delta^A = \pi_1^A - \pi_1^* > 0$, i.e. if the foreclosure profit exceeds the equilibrium profit with two competitors. Subtracting the profit in the static equilibrium situation from the one in the foreclosure situation and rearranging terms yields:

$$\begin{aligned} \Delta_1^A = & (p_1^A N_1^A - p_1^* N_1) + (p_{st}^* N - p_{st}^A N^A) - (p_{st}^* - p_{st}^A) \\ & - (dc + c_1) \left((N - N_1) - (N^A - N_1^A) \right) \end{aligned} \quad (8)$$

The sign of the first term is undetermined due to the price effect. As prices are strategic complements the competitive contract price increases with increasing standard contract price. On the other hand, with one contract less, the demand for each of the other contracts is higher. Therefore, except for the standard contract, the competitive contract price could be set higher than in case of market entry. As without further specification it is unclear which of the two effects outweighs the other no clear-cut answer concerning the sign of the first term could be deduced. The second and the third term represent the revenue effect, the last term is the increase in costs due to the demand effect, which are all positive. Thus, if the demand-driven revenue effect is sufficiently high, the incumbent could be better off choosing a lower standard contract price. This can be one equilibrium solution in which the standard contract price is low enough to deter further market entry. Note that we do not model the market demand explicitly by introducing the elasticities and switching costs. Thus, further equilibrium solutions are possible.

In a nutshell, we have shown, first, that market entry could be affected by the price or the price-cost margin of the incumbent and, second, that it might be even profitable for the incumbent to use its standard contract strategically.

Hypothesis: *The price-cost margin or the price for the standard contract could affect the number of competitors in the market. Thus, the lower the price-cost margin the fewer competitors are in the market.*⁴⁴

⁴⁴ We analyse also the impact of the price-cost margin on the number of contracts offered in the market and the average number of contracts per provider as an indicator for product differentiation.

3.5 Empirical analysis

In our econometric model we control for alternative impact factors on the standard contract price and also on the distribution charges. We have kept the theoretical model as simple as possible and assumed that each competitor offers only one contract. We relax this assumption in the empirical part of the paper and estimate along with the number of entrants, the number of competitive contracts. Exogenous variables are the absolute price-cost margin (or the markup),⁴⁵ $p_{st} - dc$, of the standard contract as well as additional instruments and control variables. According to our model the markup would determine the number of contracts or competitors. Due to lack of variables, such as firms' demand or costs we are not able to identify how an incumbent uses its standard contract price to influence competition by using a structural form derived by our theoretical model.⁴⁶ Therefore, we apply a reduced form model to analyze whether the price markup affects the number of contracts and competitors or does not. If we find an effect statistically different from zero it means that incumbent providers are in a position where they can affect competition in terms of the number of competitors (or contracts) in the market.

As it has been frequently shown in the literature on entry barriers to an essential facility that the distribution charges might act as a foreclosure instrument, therefore we did not focus on distribution charge regulation in our theoretical model. Nevertheless, we take distribution charges into account in the econometric analysis since these are regulated on a cost basis that in turn might be influenced by grid owners. As we observe huge variations between distribution charges among the market areas, we are in particular interested in network and market characteristics which influence operators' costs and, thus, determine the distribution charges.

3.5.1 Econometric model

Distribution charges are two-part tariffs which consist of a fixed fee for serving a particular customer and a variable fee for the quantity of electricity transmitted to a household. For firms that offer differentiated contracts the marginal costs remain nearly the same as long as the wholesale electricity price is unaffected by the downstream contracts. If that is not necessarily the case, suppliers can hedge their risks by trading future contracts. Thus, purchasing costs for electricity should not be affected by the contract terms. If our assumptions are applicable, we should observe a higher number of contracts (per firm) in markets with a higher standard contract

⁴⁵ We observe the distribution charges, which varies across the distinct markets. However, we have no data on marginal costs for electricity.

⁴⁶ To account for firm heterogeneity, for example in costs, we introduced firm dummies. The results of the estimation, however, remained unaffected (see also footnote 14).

price-distribution charge margin since differentiation allows for increasing profits due to heterogeneous customer characteristics and relaxed price competition. The higher the markup the more contracts can be offered. In contrast, a low markup cannot accommodate more variation in contracts and prices as the standard contract price is considered to be the highest in the market. We analyze both the impact of the incumbents' behavior on the number of providers and on the number of offered contracts with prices below the standard contract price to see whether additional idiosyncratic elements in the decision to enter a market and to offer an additional contract exist.

A competitors' decision to enter a particular (sub) market is not only driven by the strategic behavior of the incumbent but should also be affected by cost-related aspects (with regard to both prices and distribution charges) and customer characteristics (with regard to prices). As with most of empirical literature on market entry that use cross-section data, we assume that a market can accommodate a certain number of entrants.⁴⁷ This is the equilibrium number of competitors that given the equilibrium price and demand can enter without incur any losses. As discussed in detail in section 3 the suppliers' behavior might be driven by the customers' price-sensitivity, procurement and production costs and by the strategic interaction of competitors. Thus, we formulate the market supply equation as follows:

$$y_i = f(\text{markup}_i, dc_i, \text{customers}_i) \quad (9)$$

where y_i stands for a) **the number of providers**, b) **the number of contracts** with prices below the standard contract price for each region and c) **the number of contracts per provider** with prices below the standard contract price. markup_i is the difference between the standard contract price charged by the incumbent in market i and the distribution charge in this market:

$$\text{markup}_i = p_i^{st} - dc_i \quad (10)$$

customers_i is a vector of customer characteristics. These customer characteristics are control variables which are dedicated to regional aspects like the number of multi-apartment houses or average household size. All variables are based on the zip-code area i as price information is available on this aggregation level.

We break down the markup into two explanatory equations::

$$p_i^{st} = g(\text{customers}_i, dc_i) \quad (11)$$

$$dc_i = h(\text{grid}_i) \quad (12)$$

⁴⁷ For example, Bresnahan and Reiss (1990), Berry and Valdfogel (1999), Abraham et al. (2007), and Ferrari and Verboven (2010).

The price of the standard contract is explained by customer characteristics and market characteristics, for example market density, and market specific distribution charges. As distribution charges are cost-based regulated, grid characteristics, $grid_i$, such as grid length, meter points or grid losses, are employed meter points to proxy the grid costs c_{grid} . For the empirical implementation of the equation system 9 to 12 we assume the following log-log structure:

$$\begin{aligned}
 \log(y_i) &= \alpha_1 + \beta_{markup}^1 \log(markup_i) + \beta_{dc}^1 \log(dc_i) + customers_i' \beta_{cust}^1 + \varepsilon_1 \\
 \log(p_i^{st}) &= \alpha_2 + customers_i' \beta_{cust}^2 + grid_i' \beta_{grid}^2 + \varepsilon_2 \\
 \log(dc_i) &= \alpha_3 + grid_i' \beta_{grid}^3 + \varepsilon_3
 \end{aligned} \tag{13}$$

α 's represent fixed effects while β 's are coefficient vectors of the variables in the equations. $\log(markup_i)$ and $\log(dc_i)$ in the first equation are constructed using the procedure proposed in Zellner and Theil (1962) where $\log(markup_i)$ is the difference of the standard contract price equation and the distribution charge equation. $\log(dc_i)$ is instrumented using the distribution charge equation only.

Distribution charges and, expectedly, standard contract prices are cost-oriented and thus differ among local markets. It is thus inevitable to use a measure which is comparable across multiple regions. The log-log specification excludes level effects which might stem from other regional influences not covered by other control variables.

β_{markup} and β_{dc} represent the influence of strategic variables. If we find β_{markup} being significantly positive we know that the markup of the standard contract positively affects the number of entrants and contracts (which corresponds to the hypothesis), i.e. the higher the standard contract price over the distribution charge the more contracts or providers are active in a market. If we additionally find β_{dc} being significantly negative, distribution charges could also be used as an instrument for blocking entry as commonly mentioned in the literature (see e.g. Laffont and Tirole (2000)). Note that distribution charges are cost-based regulated. Price sensitivity could only be proxied through the coefficients of the customer characteristics. For our analysis we have employed alternative variables like purchasing power, share of multi-apartment houses and the fluctuation rate as the sum of households moving to and from a region. Price-sensitivity is expected to be higher when purchasing power is lower, and the higher the share of multi-apartment houses the higher the fluctuation rate.

As we assume the competition equation depending on the other two equations, we estimate the equations simultaneously employing 3SLS approach, where we constrain the price difference in the competition equations as described above. Using this estimation method we allow for correlation between the error terms among the

equations as we assume that there exist certain market characteristics or shocks which affect all endogenous variables in the equations system.

3.5.2 Data selection

We employ data from multiple sources which provide information on offered contracts, grid characteristics and customer characteristics at the zip code level and which represents a cross-sectional dataset as of September 2008. Data on household contracts were obtained from the online price comparison platform Verivox, where customers who are willing to switch their supplier can compare the contracts offered by competitors.⁴⁸ Our cross-sectional data include all contracts offered by a particular provider with all contract conditions, for example tariffs (mainly two-part tariffs) and bonuses provided via the Verivox platform. Data on distribution network characteristics, for example, distribution areas, meter points and distribution charges are obtained from E'net, an information service provider specialized in energy markets. As we have no contract-specific demand data, we use information on customer characteristics on a regional level provided by Acxiom. The comprehensive dataset includes household size and status information, area and building characteristics and other socio-regional information which is calculated on a zip code level based on publicly available and private statistics.

In our study, the relevant geographic market equals the zip code area since entrants choose specific zip-code areas where they place their offer. In contrast, in case of market investigations according to German Competition Authority the geographical delineation equals the area supplied by one distribution network operator. As the zip code area does not necessarily equal the distribution area of one operator, we deviate from this market definition for empirical purposes because we observe market entries only in particular zip codes. Suppose that a network operator distributes the electricity in two zip codes 1 and 2. These zip codes are totally different in their market characteristics so that due to expected profits a firm decides to enter only in one zip code 1 but not in zip code 2. A problem occurs in cases where we observe two network operators in only one zip code. We omitted these zip codes in our empirical analyses to avoid assumptions on market characteristics at lower level than zip-codes.⁴⁹ Note that we are not interested on firms' individual pattern of entry but on the number of the entrants in a certain zip-code area.

⁴⁸ www.verivox.de, Verivox is the most established electricity comparison platform for all zip code regions in Germany.

⁴⁹ Although demand characteristics are entirely independent among zip-code areas, there might be factors that are correlated between zip-code areas that are located within a relevant market supplied by one incumbent (distribution network operator). For example, the distribution charges are the same for all entrants independent in which zip-code area they entered as long as the zip-code areas are located within the relevant market. Factors that we do not observe are captured in the error terms of

3.5.3 Data description

Table 7 provides an overview of the variables used in the econometric model. The last three columns indicate which equations the variables enter and which effect is expected either from empirical findings in the literature or from a theoretical point of view and from the findings of our model presented above. The dependent variable in the supply equation is the number of providers, the number of contracts offered at a price below the standard contract price or the number of contracts per provider offered at a price below the standard contract price. The standard contract price is the total per year price which has to be paid by a representative one-, two- or three-and-more-person household in this type of incumbent contract. To construct the distribution charge variable we sum up the fixed elements (monthly fixed fee, metering fee) and add the quantity dependent element times the average consumption level (1500 kWh for one-person households, 2800 kWh for two-person households and 4000 kWh for more-than-two-person households).

We expect a negative effect of the distribution charges on the number of competitors and a positive effect on standard contract price. Additionally, we expect a positive effect of the markup on the dependent variables in the supply equations as explained by the theoretical model. While we did not differentiate providers from contracts in the theoretical part, we expect the markup effect on providers to be lower as the decision to enter a market is driven by more extensive start-up expenditures and, thus, by fewer impacts of short-run related aspects than the decision to offer an additional contract.

We expect a positive impact of purchasing power on both the supply and the standard contract price equations because a higher purchasing power allows for higher prices and more product differentiation and consequently makes a region more attractive for competitors.

In contrast, our expectations concerning the share of houses with more than one apartment are ambiguous: We expect a negative impact on distribution costs since in areas with high density less access lines have to be installed. The fluctuation rate is the share of households per total households which have moved into the zip code area or left it during the last year. We use this measure as a proxy for movements across the borders of the distribution area as we do not have information on this aggregation level. Since customers who want to be served by a contract other than the standard contract have to announce their choice about six to eight weeks before they move, we expect many households with switching intentions to switch after they have moved. Consequently, with a high fluctuation rate the (short-run) demand for a

our equations. However, the error terms are assumed to be i.i.d.. As a relevant market is served by only one incumbent, introducing incumbent dummies to capture firm heterogeneity (as stated in footnote 14) we also capture the factors that are common for all zip-code area within the relevant market.

standard contract could be higher. Moreover, in regions with a higher fluctuation rate (e.g. around universities) we expect customers to be more flexible which might also affect their intention to switch to alternative contracts making these regions more attractive for competitors.

Table 7: Variables of the empirical model

Dependent Variables				
# providers	Number of providers	Supply Function Equations		
# contracts below standard contracts	Number of contracts with prices below the standard contract price			
# contracts/provider	Number of contracts per provider			
standard contract price	Standard contract price	Standard contract price equation		
distribution charge	Distribution charge to pay for supplying household consumers	Distribution charge equation		
Independent Variables				
		Supply Eq.'s	Std. Contract	Distribution Charge
Markup	Markup of standard contract price over distribution charge	+		
Customer Characteristics				
purchasing power/household	Purchasing power of households (single, double, family)	+	+	
share apartment buildings	Share of houses with more than 1 apartment in a region	-	-	-
fluctuation rate	Fluctuation rate (share of households moving to a region and leaving a region per total households)	+/-	+	
Grid Characteristics				
distribution area (lv)	Distribution area of low voltage grid (sq. km)	+	+	+
distribution area (lv)/area	Share distribution area of low voltage grid	+	+/-	-
share cable	Share of low voltage cable grid length per total low voltage distribution grid length (also including overhead lines)		-	-
# meter points lv	Number of meter points in low voltage grid		-	-
High Voltage Zones				
hv zone Vattenfall	High voltage zone of Vattenfall			
hv zone E.On	High voltage zone of E.ON			
hv zone RWE	High voltage zone of RWE			
hv zone EnBW	High voltage zone of EnBW			

Concerning grid characteristics we expect a positive impact from the total size of the distribution area on all dependent variables. With regard to the share of distribution area per total area we expect similar results as for population density. However, we use the grid-based measure instead of population density as supply areas are mostly larger than zip code regions. As distribution charges are paid for grid access, using

zip code regions-related measures might result in deterred coefficients. Similar to Salies (2008) and Salies and Waddams Price (2004), we anticipate a scope effect of underground lines since maintenance costs for cable lines are lower. Finally, we expect a negative effect of the number of meter points on distribution charges because the problem of voltage fluctuation on the distribution level could be reduced with more points.

We have selected information for three alternative user groups which are 1500 kWh, 2800 kWh and 4000 kWh per year since these usage levels are average consumption levels for one-, two- and more-than-two person households in Germany.⁵⁰ Prices are average total prices per usage group per year since not the technical composition of prices but only the total price to pay is relevant for customers since the annual electricity usage is (at least in the short run) constant.⁵¹ Customer information is selected per household (not per person). Summary statistics for the alternative customer groups are presented in Table 9 in the appendix.

Table 8 provides a short summary of the competition variables used in the analysis. Values are means per usage group across all zip-code areas. While the total number of contracts is highest for one-person households and decreases for family households, the number of contracts with prices below the standard contract price is lowest for one-person households but highest for two-person households. While the number of providers remains constant for all user groups, more contracts with prices below the standard contract price are offered to two-persons-households. In contrast, we observe that the absolute (and also the relative) markup of standard contract prices above distribution charges increases from the 1500 kWh to the 4000 kWh contract. In particular for energy distribution scale effects seem to exist (see also Salies, 2008) which are not passed on to customers.

Table 8: Means of competition variables

	1500 kWh	2800 kWh	4000 kWh
# contr. below standard contract	88.4	92.5	91.3
# providers	46.1	46.1	46.1
standard contract price (in euro)	385.9	644.4	882.9
incumbent's lowest price contract (in euro)	357.9	605.2	831.2
total lowest price contract lowest price (in euro)	286.2	524.7	706.8
Markup (in euro)	282.7	481.2	664.3

⁵⁰ We have compared average consumption levels from multiple sources, i.e. providers, associations and information portals who all offer similar recommendations and used the levels proposed by Verivox.

⁵¹ We focus on annual prices and ignore contract characteristics, such as electricity mix or prepayment.

Comparing the incumbents' competitive contract prices with those of the low price contracts of competitors we find incumbents' competitive prices to be only between 6.0 and 7.4 percent below the standard contract price whereas the lowest competitor's price is 18.5 to 26.7 percent below the standard contract price. Taking into account that less than 7 percent of all households have switched to an alternative provider but about 34 percent have switched to an alternative incumbent's contract these figures point to a high market power of the incumbent providers. The findings in Salies and Waddams Price (2004) also support these results of the impact of demand shares on prices.

Note that we exclude those zip-code areas for the econometrical analysis where more than one grid owner is active. These regions are crossover areas between alternative grids.

3.6 Estimation results and discussion

Estimation results are provided in Table 12 in the appendix. The first three columns show the results of the analysis when using the number of contracts with prices below the incumbent's standard contract as a dependent variable in the supply equation. Columns 3 to 6 represent the results with the number of providers offering at least one contract in a region as a dependent variable. Finally, the last three columns show the estimation results of the ratio of the number of contracts to the number of providers ratio as the dependent variable.^{52, 53}

Concerning the outcomes of the theoretical model and the expectations from the descriptive discussion we find mixed results: The coefficients for **markup** show the expected results only for the number of contracts. For the provider equations, however, they are ambiguous. The absolute markup coefficients are much lower for the provider equations and even insignificant for the 2800 kWh equation whereas the introduction of an additional contract is significantly affected by the markup. We interpret this result as an increasing scope for price discrimination. Higher markup allows the competitors to extend discrimination (and offer more contracts) and at the same time undercut the standard contract price.

As the incumbents use two-part tariffs it possible to target certain customer groups with different consumption levels, since a two-part tariff itself is an instrument for

⁵² As the large number of highly significant coefficients might be caused by potential overidentification problems due to the fact that our analysis is based on zip code level we conducted Hansen tests for overidentification, but the results reject the hypothesis of overidentification for our dataset.

⁵³ We mainly compare our findings with the results of Salies and Waddams Price (2004) and Salies (2008) as these papers are, to the best of our knowledge, most closely related to our models.

price discrimination. While the coefficient for 2800 kWh is statistically not significant, we confirm our hypothesis for 1500 kWh (one-person household). The lower the markup the lower is the number of competitors. Thus, setting a lower standard price for this customer group the incumbent can prevent market entry e.g. prevent competitors from offering attractive contracts to this group. The fact why this can happen is caused by switching behavior of customers that depend on their total consumption. According to the German Regulation Authority customers with high consumption are more likely to switch their supplier compared with customers with lower consumption (Bundesnetzagentur, 2010). The rationale is that the absolute savings increase with consumption whereas the absolute switching costs are likely to be nearly the same, i.e., the relative switching costs are lower for big households compared with small households. Therefore, the outcome of the theoretical model may apply as lower price for standard contract prevent customers' switching, so that the revenue driven effects are positive, and at the same time the lower price prevents market entry in this market segment. For some competitors, however, the low consumption group is not profitable, i.e. the expected profits from market entry are negative.

We observe the opposite scenario for big households with high consumption (4000 kWh). In this market segment entry is still profitable for competitors although the markup might be low. Usually incumbents offer additional competitive contracts for customers who are willing to switch the supplier. These are low priced contracts that have high cross-price effects with competitors' prices. In contrast to the case above, where the low consumption customers remain with the standard contract, the high consumption customers are likely to actively participate in supplier switching. This results in price discrimination between active and passive market participants as the price difference between "active" and "passive" customers can rise. Therefore, the profitability of market entry depends mainly on the incumbents' competitive prices for "active" customers.

Combining these findings with the significant results for distribution charge coefficient brings us to the following explanation: Following the literature on entry barriers access prices to an essential facility, the **distribution charges**, could be used as an instrument to foreclose providers, as, ceteris paribus, higher levels of distribution charges hinder a long-run oriented engagement of providers in a competitive market (see e.g. Laffont and Tirole, 2000). Thus, the increase of distribution charges is similar to the raise of downstream providers' costs (see e.g. Salop and Scheffman, 1983). These results show the importance of effective regulation regimes. In particular vertically integrated network operators have an incentive to discriminate against competitors. Thus, regulation has to prevent artificial cost movements between downstream and upstream (network). Tough regulation is also required in a price- (or revenue-) cap regulation regime for strategic access pricing in different markets, such as household or business customers that aim at preventing market entry (Riechmann, 2000). For example, in markets with (expected) lower competition intensity, charges might be lower than in markets which allow more

competition and at same time are profitable for the incumbent. Higher charges could prevent entry or raise the competitors' costs and create an advantage the retail incumbent. In that case the network can even cross-subsidize the low access charge in one market with higher charges in other markets as long as revenue-cap requirements are met.

Salies (2008) extensively discusses the effect of regional factors on prices. While he finds a significant negative effect of customer density in particular for smaller usage groups the impact of this measure loses significance in the case of higher energy consumption. Using **distribution area per total area** we find a negative effect of the related coefficients both in the standard contract price and distribution charge equations which corresponds to the results in the UK market and which might be due to the fact that the installation and maintenance of a distribution grid is more expensive in less covered regions. With regard to the total size of the **distribution area** we find a positive effect on distribution costs particularly for the contract equations since the transmission costs also increase with the total grid length. Concerning the **share of underground cables** we find a significant negative coefficient which in our opinion is mainly driven by lower maintenance costs and a lower impact of atmospheric conditions on underground circuits. We also observe a negative impact of the **number of meter points**. As already mentioned above, with a higher number of meter points voltage fluctuations on the total distribution grid might be reduced and thus lead to lower distribution costs.

The **share of apartment buildings** in a particular region consists of a cost and a demand component. First, scale effects with regard to energy provision might exist as households in apartment buildings can be served by one common distribution cable. Additionally, apartment buildings are mainly constructed in more densely populated areas. Salies' (2008) scale effect argument is thus also supported by our estimations. Second, as the income of households living in apartment buildings is probably lower than the income of households living in single-family houses electricity prices are of more relevance for these customers what raises low-price offers in these regions.

Additionally, we find that the higher the average **purchasing power per household** the lower the number of competitors in the relevant region. Concerning the **fluctuation rate** a highly significant positive impact on standard contract

Figure 10: Number of providers per zip code area

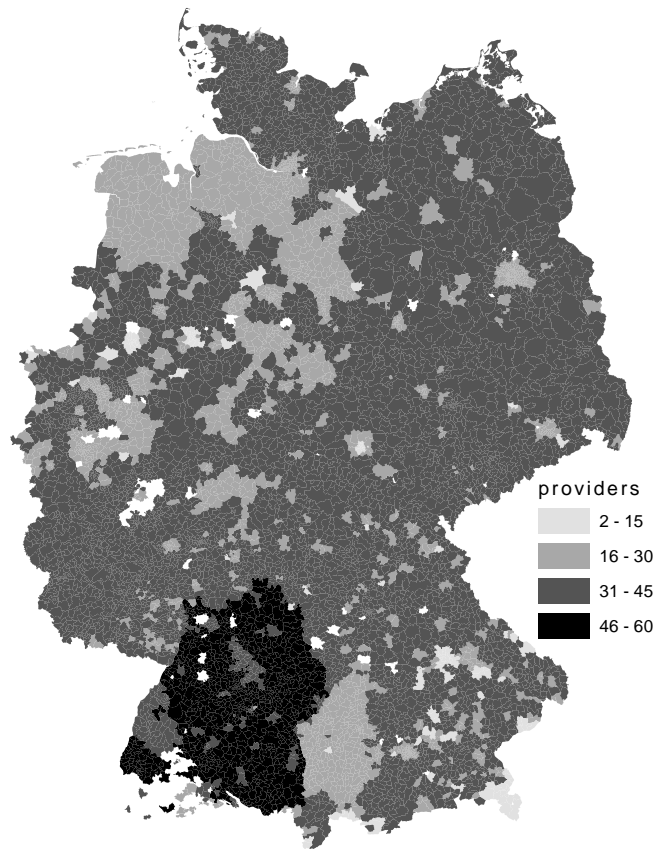
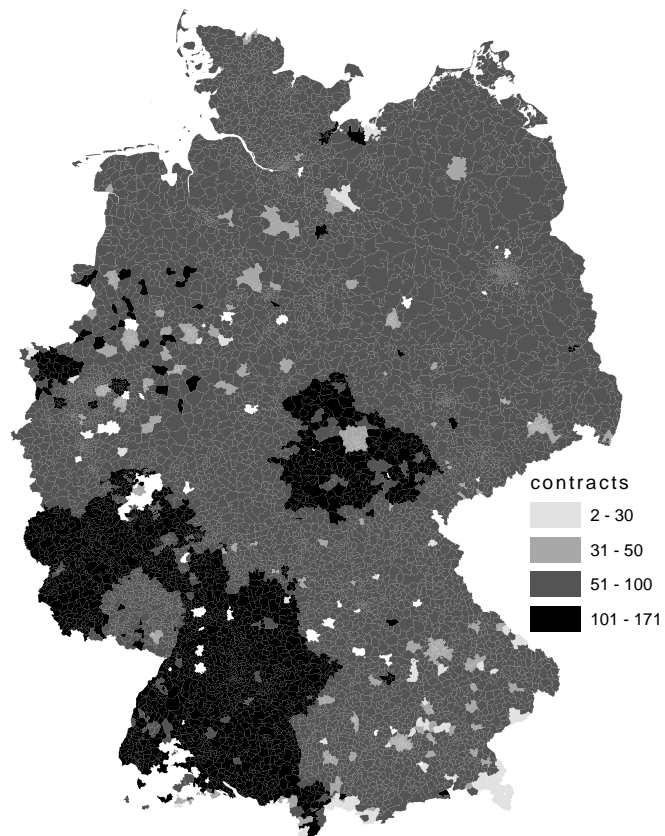


Figure 11: Number of contracts per zip code area



prices is deduced. As described above, switching from a standard contract lasts about six to eight weeks. Moving households, therefore, switch to an alternative provider after they have moved and mostly ignore the opportunity beforehand. Thus, the data support the argument that there might be an advantage for the standard contract providers particularly in regions with a higher fluctuation rate.

Concerning differences between **high voltage areas** as drivers for price and competition differences, significantly more providers and contracts exist in the EnBW area which is the smallest of the four high voltage areas in Germany. Taking a look at the effect on standard contract prices we find that they are also significantly higher in the EnBW area. In contrast, distribution charges are lower in the EnBW area in comparison to the three other areas. In summary, these findings support the hypothesis of a positive interrelation of the markup of standard contract prices over distribution charges with the number of competitors. Figures 4 and 5 provide graphical evidence for these results. The more shaded the region the higher the number of providers (Figure 10) or contracts (Figure 11).⁵⁴

In a nutshell, distribution charges are found to affect the number of competitors and the number of contracts. However, providers, for which distribution charges are no entry barrier, offer significantly more alternative contracts the higher the distribution charges. With regard to the markup of standard contract prices over distribution charges we find significantly positive effects on the number of contracts but not on the number of providers in a big household segment. Solely for one-person household small consumption, we cannot reject our hypothesis as the number of entrants decreases with decreasing standard contract price. In contrast to big households, small households are likely to be “passive” and remain with standard contract, thus, it could be profitable for the incumbent to lower the standard contract price to prevent switching and profitable market entry in this segment. Due to two-part tariffs it is possible to target specific customer groups, so that the standard contract price takes into account the relative high switching costs whereas the competitive contract price mainly accounts for competitors’ prices. Thus, the intense the competition the higher the price dispersion paid by “passive” and “active” customers per kWh.⁵⁵ In our opinion, to increase competition it is required to further decrease switching costs and reduce information asymmetries across customers for alternative contracts. This might help to reduce the share of “passive” customers and at the same time reduce the prices due to increased competition.

⁵⁴ Besides regional aspects there might be also ownership aspects which drive standard contract price differences among regions. As this interrelation is of particular interest for European markets with many public (local) owners and public private partnership relations we address the aspect of vertical integration and ownership with incumbents’ contract offers in subsequent companion study.

⁵⁵ This finding confirms the theoretical results derived by Varian (1980).

3.7 Conclusion

The electricity distribution grid access is known to be a target of regulation since this part of the electricity grid is a natural monopoly which should not be duplicated. Instead, it should be opened for all electricity suppliers to reach potential customers at a regulated access price. What is not in the focus of regulation are the retail prices. All “non-switchers” are served by the so called standard contract offered by former monopolists. As these customers seem to be highly price-insensitive these contracts are high-price contracts compared to other contracts in the market.

We show in a theoretical model that the standard contract price level can affect the entry decision of potential competitors in retail electricity markets. In the benchmark case where market entry occurs and the incumbent then competes, it asks for higher standard contract prices and higher competitive contract prices than competitors. With a lower standard contract price, customers are less willing to switch and, additionally, it becomes more difficult for competitors to undercut the standard contract price. Under particular demand conditions depending on price elasticity this pricing strategy could be profitable for the incumbent.

We test the theoretical findings employing data for German retail electricity competition for three different consumption levels (one-, two- and four-person households) which differ in their relative switching costs and the likelihood of switching suppliers. While doing so, we separate effects on distribution charges from those that apply to pricing decisions and those which are relevant for both. We find that the markup of standard contract price over distribution charges has a significantly positive effect mainly on the number of contracts. In contrast, the effect on the number of providers is ambiguous. For a customer group (one-person households), which compared to other groups have the highest relative switching costs, we could confirm our theoretical findings. Thus, the number of competitors is lower in markets in which the markup for the standard contract is low. Obviously in this case further market entry is not profitable. In contrast, for other customer groups we have to reject our hypothesis that lower markup prevents market entry. These results show that incumbents’ try to divide the market into different segments and engage in price discrimination. Two-part tariffs allow the incumbents to target specific groups, meaning standard contracts for lower consumption levels and competitive contract for higher consumption levels. With its standard contract pricing an incumbent can prevent market entry in low consumption segment. To increase competition also for this customer group instruments have to be implemented that reduce switching costs, especially in case of vertically integrated incumbents, and reduce information asymmetries across customers for offered alternative contracts.

Tough regulation for vertically integrated incumbents is required as our results show that distribution charges have a negative impact on competition in terms of the number of competitors. Various theoretical studies show that an integrated network provider has the incentive to raise rivals costs. Although the network access charges

are regulated there might be strategic choices among different markets, such as for household, business or industry customers, particularly in a revenue-cap regime. Therefore, chances for discrimination among different markets need to be taken into account when implementing regulation regimes. Furthermore, recent studies show that non-price discrimination (for example Höffler and Kranz, 2011) could be also an issue that does not only affect rivals' costs but also raises the switching costs for customers, e.g. by delaying the switching process.

3.8 References

- Abraham, J. M.; Gaynor, M.; Vogt, W., B., (2007), Entry and Competition in Local Hospital Markets. *The Journal of Industrial Economics*. 55 (2), 265-288.
- Bain, J.S., (1949), A Note on Pricing in Monopoly and Oligopoly. *American Economic Review* 39 (2), 448–464.
- Berry, S. T.; Waldfogel, J., (1999), Free entry and social inefficiency in radio broadcasting. *RAND Journal of Economics*. 30 (3), 397-420.
- Bresnahan, T., F; Reiss, P., C. , (1990), Entry in Monopoly Markets. *Review of Economic Studies*. 57 (4), 531-53.
- Dixit, A., (1979), A Model of Duopoly Suggesting a Theory of Entry Barriers. *Bell Journal of Economics* 10 (1), 20–32.
- Dixit, A., (1980), The Role of Investment in Entry-Deterrence. *Economic Journal* 90 (357), 95–106.
- Farrell, J., (1985), Competition with Lock-in. GTE Laboratories Working Paper.
- Farrell, J., Shapiro, C., (1988), Dynamic Competition with Switching Costs. *RAND Journal of Economics* 19 (1), 123–137.
- Ferrari, S.; Verboven, F., (2010), Empirical analysis of markets with free and restricted entry. *International Journal of Industrial Organization*. 28 (4), 403-406.
- Gaskins, D. W. Jr., (1970), Dynamic Limit Pricing: Optimal Pricing under Threat of Entry. *Journal of Economic Theory* 3, 306–322.
- Gehrig, T.; Stenbacka, R., (2004), Differentiation-Induced Switching Costs and Poaching. *Journal of Economics & Management Strategy* 13 (4), 635–55.
- Höfler, F.; Kranz, S., (2011), Imperfect legal unbundling of monopolistic bottlenecks. *Journal of Regulatory Economics*. 39 (3), pp. 273-292.
- Klemperer, P., (1987a), The Competitiveness of Markets with Switching Costs. *RAND Journal of Economics* 18 (1), 138–50.
- Klemperer, P., (1987b), Entry Deterrence in Markets with Consumer Switching Costs. *The Economic Journal* 97, 99–117.
- Klemperer, P., (1995), Competition when Consumers have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade, *Review of Economic Studies* 62, 515–539.
- Laffont, J. J., Tirole, J., (2000), *Competition in Telecommunications*. MIT Press.
- Milgrom, P. R.; Roberts, J., (1982a), Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis. *Econometrica* 50, 443–459.

Milgrom, P.R.; Roberts, J., (1982b) Predation, Reputation and Entry Deterrence. *Journal of Economic Theory* 27, 280–312.

Monitoringbericht, (2008), Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen. <http://www.bundesnetzagentur.de/media/archive/14513.pdf>

Monitoringbericht, (2010), Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen.

Rey, P., Tirole, J., (2003), A Primer on Foreclosure. *Handbook of Industrial Organization III*, North-Holland publications.

Riechmann, C., (2000), Strategic pricing of grid access under partial price-caps -- electricity distribution in England and Wales. *Energy Economics*. 22 (2), pp. 187-207.

Salies, E., Waddams Price, C., (2004), Charges, Costs and Market Power: the Deregulated UK Electricity Retail Market. Working Paper, 1–24.

Salies, E., (2008), Mergers in the GB electricity market: effects on retail charges. *Applied Economics* 40 (11), 1483–90.

Salop, S. C.; Scheffman, D. T., (1983), Raising Rivals' Costs. *American Economic Review* 73(2), 267–271.

Schmalensee, R., (1981), Output and welfare implications of monopolistic third-degree price discrimination. *American Economic Review* 71, 242–47.

Shaffer, G.; Zhang, Z. J., (2000), Pay to Switch or Pay to Stay: Preference-Based Price Discrimination in Markets with Switching Costs. *Journal of Economics & Management Strategy* 9 (3), 397–424.

Spence, M., (1977), Entry, Capacity, Investment and Oligopolistic Pricing. *Bell Journal of Economics* 8 (2), 534–544.

Stiglitz, J. E., (1979), Equilibrium in Product Markets with Imperfect Information. *American Economic Review* 69 (2), 339–345.

Tirole, J., (2003), *The Theory of Industrial Organization*. The MIT Press, Cambridge (MA).

Varian, H. R., (1980), A Model of Sales. *American Economic Review*. 70 (4), 651.

Zellner, A.; Theil, H., (1962), Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations. *Econometrica* 30 (1), 54–78.

3.9 Appendix

Data Overview and Estimation Results

In the following we separately display results for the 1500 kWh, 2800 kWh and 4000 kWh usage levels. A data overview is given in tables 9, 10 and 11.

Tables 12, 13, 14 show the coefficients and standard errors for the three measures of competition both for the unadjusted (first three columns) and the mean-adjusted (second three columns) estimations. Standard errors are displayed in brackets. The dependent variable is displayed in the first line of each equation. Below the estimation results we have displayed the root mean squared error results (RMSE) for each estimation equation as a whole

Table 9: Descriptive statistics (average one-person households)

1500 kWh	# Obs.	Mean	Std. Dev.	Min	Max
# contracts	7899	237.8	33.2	32	341
# contracts bel. standard contract	7899	88.4	31.2	5	203
# providers	7899	46.1	6.167	13	62
standard contract price	7899	385.9	18.4	291.6	459.3
low contract price	7899	357.9	21.9	290.3	417.5
lowest price	7899	286.2	11.2	220.5	351.0
price difference	7915	282.7	18.7	198.2	334.0
purchasing power/single hh	7893	41.5	44.8	0	290.0
fluctuation rate	7891	0.106	0.050	0.002	1.738
share apartment buildings	6514	0.365	0.169	0.051	0.939
distribution charge	7915	103.3	12.4	69.7	149.6
distribution area (lv)	7310	20.9	9.8	0.801	40.6
distribution area (lv)/area	6350	0.459	0.170	0.161	1.009
share cable	6225	0.693	0.102	0.300	0.975
# meter points lv	7505	0.761	0.076	0.173	0.837
hv zone Vattenfall	7833	0.208	0.406	0	1
hv zone E.On	7833	0.429	0.495	0	1
hv zone RWE	7833	0.239	0.426	0	1
hv zone EnBW	7833	0.119	0.324	0	1

Table 10: Descriptive statistics (average two-persons households)

2800 kWh	# Obs.	Mean	Std. Dev.	Min	Max
# contracts	7912	183.4	33.4	32	276
# contracts bel. standard contract	7912	92.5	29.8	5	196
# providers	7912	46.1	6.165	13	62
std. contract price	7912	644.4	28.8	542.2	807.8
low contract price	7912	605.2	30.5	525.0	696.4
lowest price	7912	524.7	7.984	393.6	574
price difference	7906	481.2	26.7	389.5	604.9
purchasing power/double hh	7907	69.4	67.3	0	581.6
fluctuation rate	7904	0.106	0.050	0.002	1.738
share apartment buildings	6505	0.365	0.169	0.051	0.939
distribution charge	7906	163.2	19.4	113.6	230.6
distribution area (lv)	7323	20.9	9.810	0.801	40.6
distribution area (lv)/area	6363	0.459	0.170	0.161	1.009
share cable	6216	0.693	0.102	0.300	0.975
# meter points lv	7518	0.761	0.076	0.173	0.837
hv zone Vattenfall	7846	0.208	0.406	0	1
hv zone E.On	7846	0.429	0.495	0	1
hv zone RWE	7846	0.240	0.427	0	1
hv zone EnBW	7846	0.119	0.324	0	1

Table 11: Descriptive statistics (average three-and-more-persons households)

4000 kWh	# Obs.	Mean	Std. Dev.	Min	Max
# contracts	7899	173.7	30.3	32	276
# contracts bel. standard contract	7899	91.3	27.0	3	189
# providers	7899	46.1	6.167	13	62
standard contract price	7899	882.9	40.7	728.5	1129.6
low contract price	7899	831.2	39.6	680.0	959.4
lowest price	7899	706.8	8.503	553.5	806.5
price difference	7893	664.3	36.4	542.6	861.2
purchasing power/family hh	7894	74.2	66.4	0	571.5
fluctuation rate	7891	0.106	0.050	0.002	1.738
share apartment buildings	6514	0.365	0.169	0.051	0.939
distribution area (lv)	7310	20.9	9.8	0.801	40.6
distribution area (lv)/area	6350	0.459	0.170	0.161	1.009
share cable	7792	70.2	38.0	2.177	140.1
# meter points lv	7505	0.761	0.076	0.173	0.837
hv zone Vattenfall	7833	0.208	0.406	0	1
hv zone E.On	7833	0.429	0.495	0	1
hv zone RWE	7833	0.239	0.426	0	1
hv zone EnBW	7833	0.119	0.324	0	1
distribution charge	7893	218.6	26.5	154.0	310.4

Table 12: Estimation results: Competition equation,

kWh	log(# contracts below standard contract)			log(# providers)			log(# contracts below standard		
	1500	2800	4000	1500	2800	4000	1500	2800	4000
log(price diff)	2.581*** (0.022)	2.400*** (0.026)	2.276*** (0.025)	0.170*** (0.013)	-0.012 (0.015)	-0.072*** (0.014)	2.409*** (0.016)	2.412*** (0.020)	2.348*** (0.019)
log(distribution charge)	0.696*** (0.034)	0.326*** (0.035)	0.490*** (0.034)	-0.186*** (0.021)	-0.297*** (0.020)	-0.315*** (0.020)	0.882*** (0.026)	0.623*** (0.026)	0.805*** (0.027)
distribution area	-0.052*** (0.013)	-0.106*** (0.013)	-0.097*** (0.013)	-0.014 (0.008)	-0.032*** (0.008)	-0.035*** (0.008)	-0.037*** (0.010)	-0.074*** (0.010)	-0.062*** (0.010)
log(purchasing power/ hh size)	-0.030*** (0.007)	-0.118*** (0.007)	-0.058*** (0.007)	-0.101*** (0.004)	-0.111*** (0.004)	-0.108*** (0.004)	0.071*** (0.005)	-0.007 (0.005)	0.051*** (0.005)
share multi-apartment houses	0.034*** (0.004)	0.013*** (0.004)	0.016*** (0.004)	0.017*** (0.002)	0.009*** (0.002)	0.005* (0.002)	0.017*** (0.003)	0.004 (0.003)	0.011*** (0.003)
fluctuation rate	-0.006 (0.005)	0.009 (0.005)	-0.005 (0.005)	-0.012*** (0.003)	-0.005 (0.003)	-0.002 (0.003)	0.006 (0.003)	0.014*** (0.004)	-0.002 (0.004)
hv zone Vattenfall	0.684*** (0.020)	0.827*** (0.021)	0.767*** (0.021)	0.482*** (0.012)	0.509*** (0.012)	0.523*** (0.012)	0.201*** (0.015)	0.317*** (0.016)	0.244*** (0.016)
hv zone E.On	0.864*** (0.020)	0.958*** (0.021)	0.970*** (0.020)	0.500*** (0.012)	0.486*** (0.012)	0.484*** (0.012)	0.363*** (0.015)	0.472*** (0.016)	0.486*** (0.016)
hv zone RWE	0.846*** (0.020)	0.952*** (0.021)	0.992*** (0.020)	0.476*** (0.012)	0.494*** (0.012)	0.501*** (0.012)	0.370*** (0.015)	0.458*** (0.016)	0.492*** (0.016)
hv zone EnBW	1.098*** (0.021)	1.201*** (0.021)	1.245*** (0.021)	0.687*** (0.013)	0.723*** (0.012)	0.740*** (0.012)	0.412*** (0.015)	0.478*** (0.016)	0.505*** (0.017)
constant	-33.7*** (0.470)	-30.6*** (0.509)	-32.7*** (0.487)	3.227*** (0.288)	6.800*** (0.294)	7.997*** (0.282)	-36.9*** (0.350)	-37.4*** (0.385)	-40.7*** (0.383)

Table 13: Estimation results: Standard contract price equation (continued)

<i>(continued)</i> kWh	log(# contracts below standard contract)			log(# providers)			log(# contracts below standard)		
	1500	2800	4000	1500	2800	4000	1500	2800	4000
log(purchasing power/ hh size)	-0.006*** (0.001)	-0.010*** (0.001)	-0.012*** (0.001)	-0.006*** (0.001)	-0.010*** (0.001)	-0.012*** (0.001)	-0.006*** (0.001)	-0.010*** (0.001)	-0.012*** (0.001)
share multi-apartment houses	-0.027*** (0.004)	-0.026*** (0.003)	-0.022*** (0.003)	-0.030*** (0.004)	-0.027*** (0.003)	-0.026*** (0.003)	-0.028*** (0.004)	-0.025*** (0.003)	-0.023*** (0.003)
fluctuation rate	0.006*** (0.001)	0.008*** (0.001)	0.009*** (0.001)	0.006*** (0.001)	0.008*** (0.001)	0.009*** (0.001)	0.006*** (0.001)	0.008*** (0.001)	0.009*** (0.001)
log(distribution area (lv))	0.015*** (0.001)	0.003** (0.001)	0.002 (0.001)	0.012*** (0.001)	0.001 (0.001)	-0.002 (0.001)	0.014*** (0.001)	0.004*** (0.001)	0.001 (0.001)
distribution area (lv)/area	-0.021*** (0.002)	-0.009*** (0.002)	-0.001 (0.002)	-0.023*** (0.002)	-0.010*** (0.002)	-0.004* (0.002)	-0.020*** (0.002)	-0.009*** (0.002)	-0.001 (0.002)
share cable	-0.050*** (0.006)	-0.067*** (0.005)	-0.087*** (0.005)	-0.040*** (0.006)	-0.066*** (0.005)	-0.079*** (0.006)	-0.057*** (0.006)	-0.069*** (0.005)	-0.091*** (0.005)
log(# meter points lv)	-0.069*** (0.005)	-0.055*** (0.005)	-0.053*** (0.005)	-0.069*** (0.005)	-0.051*** (0.005)	-0.047*** (0.005)	-0.061*** (0.005)	-0.055*** (0.005)	-0.047*** (0.005)
hv zone Vattenfall	0.025*** (0.006)	0.046*** (0.005)	0.053*** (0.005)	0.027*** (0.006)	0.047*** (0.005)	0.054*** (0.005)	0.024*** (0.006)	0.046*** (0.005)	0.052*** (0.005)
hv zone E.On	-0.023*** (0.006)	-0.013* (0.005)	-0.011* (0.005)	-0.021*** (0.006)	-0.012* (0.005)	-0.009 (0.005)	-0.024*** (0.006)	-0.013* (0.005)	-0.011* (0.005)
hv zone RWE	0.028*** (0.006)	0.032*** (0.005)	0.032*** (0.005)	0.030*** (0.006)	0.032*** (0.005)	0.033*** (0.005)	0.027*** (0.006)	0.032*** (0.005)	0.031*** (0.005)
hv zone EnBW	0.048*** (0.006)	0.058*** (0.005)	0.058*** (0.005)	0.051*** (0.006)	0.058*** (0.005)	0.061*** (0.005)	0.046*** (0.006)	0.057*** (0.005)	0.057*** (0.005)
constant	5.905*** (0.010)	6.461*** (0.009)	6.794*** (0.009)	5.904*** (0.010)	6.465*** (0.009)	6.797*** (0.009)	5.918*** (0.010)	6.461*** (0.009)	6.801*** (0.009)

Table 14: Estimation results: Distribution charge equation (continued)

<i>(continued)</i>		log(# contracts below standard contract)			log(# providers)			log(# contracts below standard		
kWh		1500	2800	4000	1500	2800	4000	1500	2800	4000
log(distribution area (lv))	area	0.021*** (0.003)	0.005* (0.002)	0.014*** (0.002)	0.004 (0.003)	-0.000 (0.002)	-0.001 (0.002)	0.020*** (0.003)	0.011*** (0.002)	0.011*** (0.002)
distribution (lv)/area	area	-0.057*** (0.005)	-0.053*** (0.004)	-0.039*** (0.004)	-0.067*** (0.005)	-0.055*** (0.004)	-0.049*** (0.004)	-0.051*** (0.005)	-0.049*** (0.004)	-0.037*** (0.004)
share multi-apartment houses		-0.036*** (0.009)	-0.056*** (0.007)	-0.050*** (0.007)	-0.050*** (0.009)	-0.060*** (0.007)	-0.064*** (0.007)	-0.034*** (0.009)	-0.051*** (0.007)	-0.051*** (0.007)
share cable		-0.419*** (0.015)	-0.372*** (0.013)	-0.397*** (0.012)	-0.399*** (0.015)	-0.371*** (0.013)	-0.363*** (0.012)	-0.461*** (0.015)	-0.386*** (0.013)	-0.415*** (0.012)
log(# meter points lv)		-0.328*** (0.014)	-0.291*** (0.012)	-0.290*** (0.011)	-0.308*** (0.014)	-0.275*** (0.012)	-0.266*** (0.011)	-0.299*** (0.014)	-0.298*** (0.012)	-0.271*** (0.011)
hv zone Vattenfall		0.032* (0.015)	0.060*** (0.013)	0.065*** (0.012)	0.037* (0.015)	0.059*** (0.013)	0.069*** (0.012)	0.025 (0.015)	0.058*** (0.013)	0.062*** (0.012)
hv zone E.On		-0.073*** (0.015)	-0.072*** (0.012)	-0.080*** (0.012)	-0.065*** (0.015)	-0.071*** (0.012)	-0.074*** (0.012)	-0.077*** (0.015)	-0.075*** (0.012)	-0.082*** (0.012)
hv zone RWE		-0.023 (0.015)	-0.010 (0.013)	-0.012 (0.012)	-0.019 (0.015)	-0.011 (0.013)	-0.008 (0.012)	-0.031* (0.015)	-0.012 (0.013)	-0.015 (0.012)
hv zone EnBW		-0.191*** (0.015)	-0.132*** (0.013)	-0.120*** (0.012)	-0.182*** (0.015)	-0.132*** (0.013)	-0.111*** (0.012)	-0.202*** (0.015)	-0.136*** (0.013)	-0.125*** (0.012)
constant		4.768*** (0.023)	5.241*** (0.020)	5.538*** (0.019)	4.797*** (0.023)	5.261*** (0.020)	5.552*** (0.019)	4.819*** (0.023)	5.237*** (0.020)	5.567*** (0.019)

Table 15: Estimation results: Summary statistics (continued)

<i>(continued)</i>	log(# contracts below standard contract)			log(# providers)			log(# contracts below standard		
kWh	1500	2800	4000	1500	2800	4000	1500	2800	4000
Observations									
competition equation	4734	4725	4714	4734	4726	4714	4734	4726	4714
price equation	4734	4725	4714	4734	4726	4714	4734	4726	4714
dc equation	4734	4725	4714	4734	4726	4714	4734	4726	4714
Parameters									
competition equation	10	10	10	10	10	10	10	10	10
price equation	11	11	11	11	11	11	11	11	11
dc equation	9	9	9	9	9	9	9	9	9
RMSE									
competition equation	0.109	0.113	0.110	0.067	0.065	0.064	0.082	0.085	0.087
price equation	0.032	0.028	0.029	0.032	0.028	0.029	0.032	0.028	0.029
dc equation	0.081	0.068	0.065	0.081	0.068	0.065	0.081	0.068	0.065
R2									
competition equation	0.914	0.893	0.895	0.737	0.748	0.759	0.925	0.904	0.900
price equation	0.494	0.572	0.581	0.495	0.572	0.582	0.493	0.572	0.581
dc equation	0.528	0.570	0.585	0.526	0.569	0.585	0.526	0.571	0.584

Note: Estimation Results using 3SLS method

*, **, *** represent significance at the 10, 5 and 1 percent significance levels, respectively.

4 MARKET ENTRY AND VERTICAL INTEGRATION IN NATURAL GAS MARKETS⁵⁶

⁵⁶ Based on joint research with Jürgen Weigand

4.1 Introduction

Natural gas in Europe and in Germany is historically one of the most strategically important markets. Since Germany's decision to phase out nuclear electricity generation, natural gas has become crucial for the security of the nations' electricity supply. Beside electricity generation, gas is used extensively for cooking and heating in German households. Despite the economic crisis in 2007/2008, price changes and other shocks in recent years households' gas demands have remained constant. Furthermore, as the wholesale gas price fell in 2009, the prices for household customers followed the wholesale price changes only moderately.

In contrast to residential electricity markets, the entry of newcomers in residential gas markets is not frequently observed. One of the reasons could be that newcomers face difficulties in purchasing gas on the wholesale market and in transporting it from one market area to another within Germany. For newcomers gas imports to Germany are de facto unrealizable due to pipeline capacity constraints at the border. These pipelines are operated by gas importing firms, which maintain contracts with foreign gas producers. About 90 percent of total consumption is imported by 5 major importing firms. Two of those namely, E.ON and RWE, are extensively forward integrated with downstream incumbents in particular downstream sub markets. Due to potential abuse of the market power at upstream and downstream markets the German Competition Authority prohibited further forward integration of natural gas importers (NGI) from 2005/2006 to 2010.⁵⁷ The Authority argued that the very few importing companies, which own and operate the natural gas pipelines, could have an incentive to foreclose the competitors or deter market entry. This action was justified by the inactive wholesale market due to illiquidity and long term contracts between the importing firms and downstream incumbents. Therefore, their potential downstream competitors were not able to buy natural gas at the wholesale market and supply the downstream customers.

We want to shed light on the effects of the vertical integration among gas importing companies with downstream incumbents on potential newcomers and their decisions to enter a particular downstream market for household customers. We employ cross sectional data for September 2009 and show the impact of integration on newcomers' variable profits of downstream newcomers. For this purpose we apply the Bresnahan and Reiss (1991) model of free market entry which can be used to uncover variable profits of the newcomers. This model is based mainly on the assumption that entry occurs as long as expected profits of potential entrants are non-negative. Thus, if all newcomers are equal (symmetry assumption), in equilibrium a firm's variable profit equals its fixed cost. This assumption allows revealing the profit and cost shifters and the magnitude of the effects arising from vertical integration.

⁵⁷ Long term contracts with a length of more than 4 years were also prohibited from 2006 until 2010.

There exist a huge number of analyses of vertical integration. The bulk of the literature focuses on the impact of integration on firm's performance, on prices, quantities and profits. In general, the effects of vertical integration on downstream outcome could be twofold. Efficiencies caused by vertical integration under particular market structure are well known in theoretical literature. For example, double marginalization or efficiency gains are arguments in favor of vertical integration. In contrast, concerns about foreclosure or exclusion of competitors are rare and brought forward only in particular industries. In general, vertical integration is classified as less harmful than horizontal integration. However, in particular markets vertical integration can cause enormous negative welfare effects. For example, Hastings and Gilbert (2005) analyzed the US gasoline market and found evidence for foreclosure caused by wholesale price setting behavior. The authors argued that vertical integration increases the incentives to raise rivals' costs in that particular market. Another example is given in Chipty (2001) for Cable TV programs. Chipty's analysis shows that vertical integrated firms tend to exclude rivals by denying access to the distribution network. However, other studies do not find any evidence that integration cause exclusion of rivals.⁵⁸

This paper is organized as follows. First, we briefly describe the German gas market and discuss the potential problems newcomers could face by entering the downstream markets. In the next section, we then discuss the free market model which has been introduced by Bresnahan and Reiss (1991) and show how it could reveal the information we need to make a statement about effects of vertical integration on newcomers' variable profits. In section 4 we describe the data employed in our empirical analyses. The data have been merged from different sources and required extensive analysis of the ownership structure. We next discuss the empirical specification and show the estimation results. And lastly, we present a conclusion based on the results.

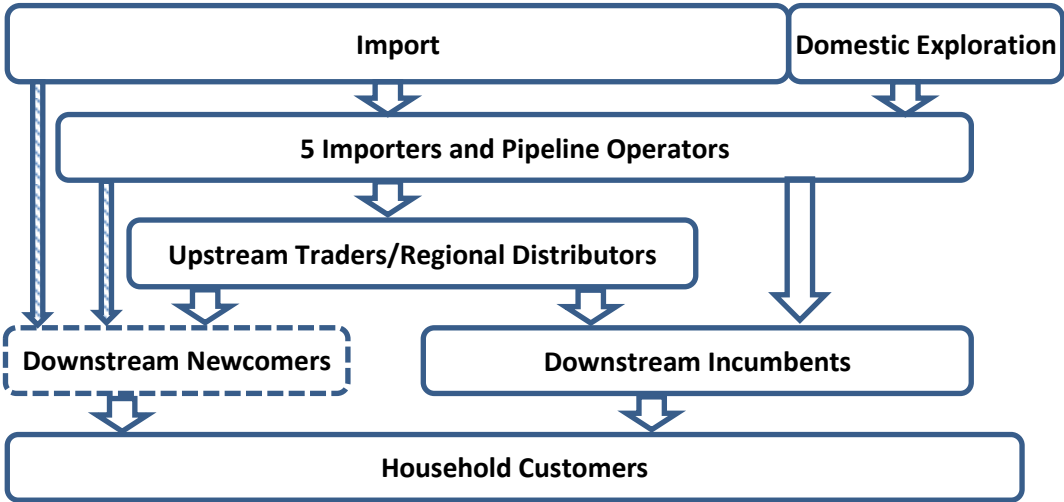
4.2 German natural gas market

The gas market in Germany consists of two main sub-markets: gas trading and gas transportation. While gas trading at the wholesale and retail level has been liberalized, the transportation, as a natural monopoly, is regulated. In contrast to the electricity market in Germany, the liberalization process of the gas market was extremely tedious due to numerous regime changes in the regulation and several processes of trial and error. The starting point for the liberalization process was the introduction of European law that forced all European countries to open their network industries for competition at the end of the nineties. As the gas market structures among the European countries differ from each other, each country had the opportunity to implement its own rules und requirements within the given European liberalization framework. This led to different market designs and regulation regimes

⁵⁸ For example Hortascu and Syverson (2007) for the cement industry, Mullin and Mullin (1997) the steel industry.

among the countries. However, some countries including Germany, engaged in a trial and error process to select the best working market mechanism. So, for example, the regulation of gas transport with “point to point” regime, which required that a firm that wants to supply a customer in area A while the gas is in B, has to negotiate and sign contracts with all pipeline and distribution system operators that lie between A and B. Since there could be numerous operators to negotiate with, this type of regulation became impracticable. As experience showed that this method of regulation did not really work, the German Regulator has implemented another regulation regime which allows the firms to ship gas with only two formal agreements. The so called “entry-exit” model requires one contract for “entry” (point where gas from outside enters the pipeline or network system) and one contract for “exit” where gas is taken out the network (for example by an end consumer). In contrast to “point to point,” the handling between entry and exit point is realized by network operators. The prices for the volume which enters and exits the system are regulated. This type of market design turned out to be more successful than the previous one and led to market entry of newcomers. However, the trial and error process caused a delay in development of competition compared with the electricity market in Germany.

Figure 12: Natural gas market structure in Germany



Natural gas demand in Germany is mainly satisfied by gas imports. About 90 percent of overall market consumption (914 TWh/a in 2009) is imported to Germany; it comes mainly from Russia, Sweden and the Netherlands. The highest share, about 35 percent, of imported gas comes from Russia. There are five firms at the wholesale level that import gas to Germany and cover almost the total consumption. Natural gas importers (NGIs) generally have long term contracts with natural gas producers. Usually, these are take-or-pay contracts which run 25 years and are mostly correlated with (or tied with a time lag of 6 months to) the oil price. Most of the contracts originated before market liberalization took place. The major gas importers also operate their own pipeline systems in Germany. Moreover, Germany acts as a transfer country for natural gas transport from Eastern Europe to France, Spain or Italy. Usually foreign firms have to buy pipeline capacities from German NGIs if they

are not operating their own. Thus, the NGIs control not only the gas imports but also the pipeline capacities in Germany (including the connection at German border.) The German Regulation Authority investigated the competition issues between pipeline operators and concluded that NGIs, in fact, do not face competition. The geographic location of pipelines is an important factor for the competition intensity between operators. As the pipelines are connected with the distribution network in regional and local markets, suppliers downstream can transport gas only through the pipelines which have a connection to a local market that they would like to supply. If the Regulation Authority ever were to state that there is competition between the pipelines, transportation costs would not be regulated. Thus, the majority of downstream network operators, which have access to only one pipeline, would suffer monopoly pricing and discrimination. At this time, the Regulation Authority has implemented the regulation of the access charge for pipelines.

In the case that a competitor would like to import gas to Germany, existing capacity constraints at the German border could put an end to that project. The capacities are booked out for a certain time period (at least two years in advance), mostly by the NGIs. Interestingly the capacity constraints arise rather from contractual situation than from physical constraints. The Regulator wants to implement an auction for the capacities in the future.

Beside capacity constraints at the border, the upstream (wholesale) market is geographically divided into several market areas. These are delineated by capacity constraints of connecting points between different pipelines (operators). If for example Eon and RWE each operate a pipeline that have a common connection point without any capacity constraints when the two pipelines delineate one market area. In contrast, capacity constraints at the connection point would divide the supplied area into two market areas, even when these are not physical but contractually caused capacity constraints. Each market area has its own virtual wholesale market. A downstream supplier usually faces these capacity constraints when delivering gas to other upstream market area that is usually operated by different pipeline operators. However, trading across markets is not only difficult due to capacity constraints but is also expensive. Since “entry-exit” rule applies also in cross market trading, a firm with gas located in market A that wants supply customer with gas in market B pays “exit” charge in A, “entry” charge in B and finally “exit” charge in B when customer consumes gas. Among others factors, this causes low liquidity in the wholesale market because upstream traders that want to sell their gas have only limited choice due to higher costs and capacity constraints. The Regulation Authority currently tries to eliminate the constraints by implementing new rules for capacity assignments since the constraints arise from long run contracts between pipeline operators and suppliers (which are mostly the same firm.) Interestingly, upstream market areas equaled the areas served by only one gas importer and pipeline operator. However, the NGIs were under the pressure to reduce the number of markets through bilateral agreements. Consequently, the number of the markets

fell from 13 in 2007 to 6 in October 2009.⁵⁹ To overcome the liquidity problem the authority aims at reducing the number of wholesale markets to only two by October 2013.⁶⁰

Wholesale trading takes place mainly over the counter. In general, the importers signed bilateral supply contracts with downstream incumbents. Until 2006 these contracts used to have a very long duration (up to 25 years). Between 2006 and 2010 the Competition Authority prohibited such long term contracts and allowed only contract terms with maximum 4 years. This action should help to develop a liquid wholesale market. As mentioned, the majority of upstream trading is based on bilateral contracts. Only a marginal part of the overall consumption (1.6 percent of all trades in 2009) is traded at the energy exchange. Although some of the regional network operators buy their balancing power at the exchange, it still is illiquid. Therefore, the resulting price at the exchange is not a reference price for other upstream deals. The virtual hubs for the wholesale trade at distinct upstream markets are also extremely illiquid.

The downstream gas market for household customers in Germany is divided into 700 sub markets. According to German Competition Authority, the markets are geographically delineated by the supplied area of a distinct distribution network operator. Thus, only one distribution network operator serves a sub-market. As in the electricity markets, this market definition is applied in cases of abuse of market power of dominant firms by the Authority. In each of these markets only one incumbent (former monopolist) is providing gas to the majority of household customers. Mostly the incumbent is vertically integrated with the distribution network operator and switching of households from incumbent to new supplier is very rare. Beginning with market liberalization until the end of 2009 only about 5 percent of the overall household consumption was supplied by other firms than the local incumbent. On average the incumbent has 90 percent of the market share for household customers. Compared with electricity markets in Germany, gas markets still lack newcomers. On average there are only five newcomers and six incumbent-entries⁶¹ in each of these markets. However, one has to distinguish between newcomer und incumbent entries, which means that incumbents enter new local markets. We discuss the difference while describing the data.

The liberalization process fell behind the development of electricity markets, although in 2008 instruments (for example “GabiGas”) were introduced to allow easy switching

⁵⁹ In general a “gas-year” in Germany begins in October and ends in September following year. Therefore, most changes in structure, prices and demand are realized or implemented in October.

⁶⁰Two markets because there are two different gas qualities with different fuel values, which are distributed in separate pipelines and cannot be easily substituted. Our cross-sectional data of September 2009 contain 13 upstream market areas.

⁶¹ These are incumbents in particular markets which enter into in a new market and compete where with the local incumbent. In some cases local incumbent and “entrant” are the same firm, so they are horizontally integrated. This allows brand and price differentiation for those customers who want to switch suppliers.

processes. This helps to avoid, for example, discrimination of competitors by vertical integrated network operators with downstream incumbent. Until 2009 the main issue for newcomers, however, remained the upstream market that lacked liquidity and available pipeline capacities. The situation has changed slightly since October 2009: the number of market areas has been reduced from 13 to 6, and the gas consumption of German manufactures decreased significantly due to the worldwide financial crisis. Since that time the prices at the wholesale market have dropped and gas importers that had long run take-or-pay contracts with foreign gas producers met problems due to gas price coupling to the (world) oil price. Interestingly, the retail prices for household customers dropped only by nine percent while the prices at the wholesale market the price decreased more than 50 percent.⁶² Regardless the crisis and price drop the household gas consumption remained constant.

While the major importing firms operate their own pipelines, two of them are extensively forward (vertical) integrated with the downstream incumbents. Eon and RWE are the biggest importers and besides the forward integration they too operate as downstream incumbents in distinct downstream markets. In our analysis we distinguish between own downstream (self-operated), direct forward integrated and indirect integrated incumbents. The latter is the case when the importer does not directly holds stakes in downstream incumbents but through other subsidiaries. Moreover, the two importers are fully integrated with distribution network operators in their markets. Thus, they control the complete vertical chain. Observing this market structure the question arise how strategic interventions of dominant upstream and downstream incumbents could affect market entry of newcomers. In particular, we want to know which rationales cause the lack of entries in downstream gas markets.

4.3 Econometric model

While the bulk of vertical integration literature focuses on firms' performance differences due to integration, we are rather interested in the effects of vertical integration on competitors. Concretely, we would like to how integration affects the performance of competitors. We presume that in particular downstream markets for household customers where the incumbent is a subsidiary of one of the major gas importers, downstream competitors face higher (upstream) costs. The rationale is the protection of the own downstream subsidiary from competition and retaining the generated profits in downstream. As household consumption is assumed to be constant⁶³, entry of newcomers leads only to business stealing effects rather than to market expansion effects.⁶⁴ Thus, the first derivative of total demand in market i D_i with respect to the number of competitors N_i is equal zero: $\frac{\partial D_i}{\partial N_i} = 0$. But the demand

⁶² Bundesnetzagentur 2010

⁶³ Bundesnetzagentur 2010

⁶⁴ See for example Ferrari & Verboven (2010) who consider the two effects caused by market entry of new press shops.

of each firm d_N is negatively affected by the number of competitors: $\frac{\partial d_N}{\partial N_i} < 0$. Given this demand situation and the entry effect, a vertically integrated incumbent loses profits at least in the downstream market. Now assume that the upstream firm is the only one at the wholesale market. The decrease in the downstream market could be compensated if the wholesale price rises high enough. But, as a monopolist the upstream will charge the monopoly price which depends on monopolist's cost and the demand. As the demand is very price inelastic and costs are constant, the increasing number of competitors would not strongly affect the monopoly wholesale price. Thus, the highest profits are generated when upstream is vertically integrated and the downstream incumbent can charge the monopoly price. This of course creates incentive for the vertical integrated gas importer to prevent market entry. There are two arguments against that: First, beside the price inelastic household demand firms supply also industry customers that show lower price elasticity and market expansion effects may appear to be due to higher downstream competition. Second, there could be other upstream firms active in the market. Nevertheless, note that usually market areas were delineated by an area supplied by single pipeline operator and gas importer. Despite the fact that the price at the gas exchange fell in 2009 the liquidity problem remained in that market areas. If a newcomer wanted to buy gas at a liquid wholesale market, the transport to the target market could be either costly because of the "entry-exit" regulation or not possible due to capacity constraints. Thus, vertical integrated firm could theoretically charge higher wholesale price and negatively affect newcomers' entry decisions. This is the question that we would like to shed light on.

To analyze vertical integration effects and market entry decision we follow the standard free entry structural model introduced by Bresnahan and Reiss (BR, 1991). The assumption of free entry is associated with the zero profit condition, that is, as long as one firm earns non-zero profits potential competitors will enter the market if their expected profits are non-negative. The entry process continues until a potential entrant's expected profits are negative and entry does not occur anymore. Due to free market entry the profits of all entrants fall to zero as the assumption in BR model is that all firms are equal and earn the same profits if they decide to enter the market. So, the zero profit condition is required to identify the variable profits or the fixed costs of the firms, respectively. The main question that we are interested in is how variable profits are affected by market and demand characteristics which influence newcomers' entry decisions into downstream market.

Assume that a firm enters a certain market i and earn the profits:

$$\pi_N = d_N v_N - F_N,$$

where d_N is N-firm's demand, v per-capita variable profit and F_N firm's fixed cost. Further decomposition of the total variable profit V_N leads to:

$$\pi_N = S k_N (P_N - C_N) - F_N.$$

As we consider entry of N newcomers the competition is about poaching customers away from former monopolist or incumbents. Thus, newcomers compete for

customers who are willing to switch their supplier. For these customers searching and switching costs are lower than the gains from switching. The demand for each newcomer can be defined as a product of total market size S and a fraction of customers k_N which are attracted by a newcomer. Due to the symmetry assumption all newcomers have the same market share k_N . The per firm demand multiplied with per-capita profit, that is equilibrium price P_N and variable cost C_N , equals the total variable profit V_N . The newcomers entered the market set the equilibrium price P_N that determines the demand for newcomers. We abstract from price discrimination that newcomers could be engaged in and as in BR (1991) assume symmetry among newcomers, so that everything, including costs and resulting profits, is the same for each newcomer.

The determinants of total variable profit are then:

$$V_N(Y_i, Z_i, N_i, P_N, X_i, W_i, Own_i) = S_i(Y_i)k_N(P_N, Z_i)[P_N(N_i, Z_i, W_i, Own_i) - C_N(W_i)]$$

where the market size S_i in market i is function of the usual market characteristics Y_i which determine the total market demand, such as total number of households, number of houses or buildings with many flats and further exogenous variables that we discuss in the data section. The fraction of customers that switch to a newcomer depends on the equilibrium price P_N and on the customers' characteristics, Z_i . For example, a customer with higher education is more likely to switch than a customer with lower education.⁶⁵ All characteristics of customers in a particular market captured in Z_i affect the fraction of switched customers. Thus, total market demand multiplied with the fraction k_N equals newcomer's demand d_N . Per-capita profit equals the equilibrium price P_N minus variable cost C_N , which is a function of market specific cost shifters W_i such as distribution charge and firm specific costs for example for the wholesale price that we are not observing. The equilibrium price is a function of the number of competing firms N_i , customer characteristics Z_i , cost shifters W_i and finally the ownership structure of local incumbent Own_i . We are especially interested in the question if vertical integration of gas importers with the downstream incumbents affects entry decisions by affecting the profits of newcomers through wholesale prices or other cost factors. We capture the degree of integration Own_i taking values $(0, 1]$ on importers' shares in downstream incumbent, thus price changes, when the downstream incumbent in market i is independent from upstream firm:

$$P_N(N_i, Z_i, W_i, Own_i) = \begin{cases} P_N(N_i, Z_i, W_i, Own_i) & \text{if } 1 \geq Own_i > 0 \\ P_N(N_i, Z_i, W_i) & \text{if } Own_i = 0 \end{cases}$$

BR (1991) assume that fixed cost, beside the variable profits, of newcomers are affected the number of entrants. We drop this assumption because we do not think that this is true in the gas market for household customers. Thus, our fixed cost

⁶⁵ A survey conducted by geo-marketing company Axciom shows which of the customer characteristics are correlated with the willingness to switch their supplier.

$F_N(W_i)$ in the profit function π_N is not affected by the number of newcomers in a certain market. Affected rather are the variable profits of newcomers due to increased competition. We assume that local cost shifters W_i , in particular the density in market area, which should be correlated with advertising costs, have an impact on the fixed cost.

As free entry lowers firms' profits in a particular market to zero, this results in equilibrium number of firms that a market "can" host:

$$\pi_N = V_N(N_i, \cdot) - F_N \geq 0 \text{ and } \pi_N = V_N(N_i + 1, \cdot) - F_N < 0,$$

which means that if an additional firm enters the market all newcomers gain negative profits due to the symmetry assumption. Therefore, in equilibrium we would observe the N_i newcomers each with $\pi_N \geq 0$. This restriction allows identifying the fixed cost and variable profit shifters as $V_N(N_i, \cdot) \geq F_N > V_N(N_i + 1, \cdot)$, e.g. firms enter as long as their fixed costs are covered by the variable profits.

4.4 Econometric specification

To estimate the effects of vertical integration we first specify the profit function of a newcomer $\pi_N = S k_N (P_N - C_N) - F_N$. Here, we follow the approach of Abraham et.al (2007) and take logarithmic specification instead of linear functions as in BR(1991). Below are the specifications for the components of the profit function:

$$S_i(Y_i) = \exp(Y_i \lambda)$$

$$k_N(P_N, Z_i) = \exp(Z_i v_z + W_i v_w + Own_i v_o - v_N)$$

$$v_N(N_i, Z_i, W_i, Own_i) = P_N - C_N = \exp(Z_i a_z + W_i a_w + Own_i a_o - \alpha_N)$$

$$F_N(W_i) = \exp(W_i \eta_w)$$

As demand data is not available we apply the reduced profit model. The vectors of the parameters $\lambda, v_z, v_w, v_o, a_z, a_w, a_o, \eta_w$ show the effects of the exogenous factors that we include in our estimation. The effects of market entry or the number of newcomers are captured in parameters v_N and α_N in the demand equation and per-capita profit equation, respectively. Note that in contrast to Abraham et al. (2007) per firm market share does not increase with the number of newcomers. Due to business stealing effects, which exceed market expansion effects, per firm share of switchers would decline with increasing number of firms. The same is true for per-capita profit that declines with the number of competitors. Thus, increasing v_N and α_N indicate a decrease in per firm profit due to market entry. Assembling all the specified profit function parts and including error terms for variable profit, and fixed cost, we construct the profit function:

$$\pi_N = \exp[Y_i\lambda + Z_i(v_z + a_z) + W_i(v_w + a_w) + Own_i(v_o + a_o) - v_N - \alpha_N + \varepsilon_v] - \exp[(W_i\eta_w + \varepsilon_F)]$$

Applying the non-zero profit condition to our profit function we obtain the compact written profit function

$$\pi_N = -\theta_N + Y_i\lambda + Z_i\beta + W_i\delta + Own_i\gamma + \varepsilon_{ij} \geq 0,$$

$$\text{with } \beta = v_z + a_z; \delta = v_w + a_w - \eta_w; \gamma = v_o + a_o; \theta_N = v_N + \alpha_N; \varepsilon_{ij} = \varepsilon_v - \varepsilon_F$$

Note that we can identify the effect of market entry on variable profits with θ_N but we cannot distinguish between v_N and α_N separately. The error term ε_{ij} , which consists of the error ε_v in variable profit function and the error ε_F in fixed cost function, captures all unobservable factors in market i and next higher market j , such cost and demand shifters that are not in our data sample. The definition of our markets follows in the next section where we also discuss the properties of the error term. The error term is assumed to be normally distributed with mean zero and standard deviation σ .

Given the free entry condition, entry does not occur if the following condition is true: $Y_i\lambda + Z_i\beta + W_i\delta + Own_i\gamma + \varepsilon_{ij} < \theta_1$. The general formulation of the free entry with N firms can be written as $\theta_N \leq Y_i\lambda + Z_i\beta + W_i\delta + Own_i\gamma + \varepsilon_{ij} < \theta_{N+1}$, where θ_N and θ_{N+1} are the threshold conditions or boundaries to observe exactly N firms.

As we assume a standard normal distribution for the error term ε_{ij} the probability that a market entry does not occur, i.e. 0 newcomers are in the market, is given by:

$$\Pr(\pi_0) = \Pr(Y_i\lambda + Z_i\beta + W_i\delta + Own_i\gamma + \varepsilon_{ij} < \theta_1) = \Phi(\theta_1 - Y_i\lambda - Z_i\beta - W_i\delta - Own_i\gamma),$$

where $\Phi(\cdot)$ is the cumulative distribution function of standard normal distribution and where the econometric model follows the standard ordered probit model. Thus the probability for N firms is then given by:

$$\Pr(\pi_N) = \Phi(\theta_{N+1} - Y_i\lambda - Z_i\beta - W_i\delta - Own_i\gamma) - \Phi(\theta_N - Y_i\lambda - Z_i\beta - W_i\delta - Own_i\gamma).$$

Finally, the probability of observing 5 or more newcomers in a market is:

$$\Pr(\pi_5) = 1 - \Phi(\theta_5 - Y_i\lambda - Z_i\beta - W_i\delta - Own_i\gamma).$$

4.5 Data description

4.5.1 Market definition

A crucial factor in this study is the definition of the market. We could, for example, use the market definition of the German Competition Authority that delineated the relevant market for household customers in cases of abuse of market power. Thus, the geographical delineation of the relevant market equals the area served by one local distribution network operator and one former downstream monopolist. According to this definition there are about 800 local markets in Germany, which we call incumbent-markets. These markets are, however, very heterogeneous with respect to the covered area. In the northern part of Germany the areas of the markets are usually larger than in south Germany. Conversely, in south Germany the population and thus the density in markets is greater. In each of the incumbent-markets only one incumbent (former monopolist) serves the majority of the customers. However, for our purpose the market definition according to the Competition Authority might not be appropriate. We observe that the newcomers, if they decide to offer gas contracts to households, do that not necessarily throughout whole incumbent-market but in a particular zip-code area within an incumbent-market. As the incumbent-market might accommodate more than one zip-code area, a cherry-picking strategy is possible. So, in some cases newcomers' offers are limited to households living in a zip-code area that is one of the few in the incumbent-market. To distinguish between the two market definitions we refer to zip-code-markets and incumbent-markets. As we consider the entry of the newcomers that do not offer gas contracts necessarily throughout the incumbent-market, and given the differences in demographic structure among the zip-code areas, we define a zip-code area as the relevant market. Note that the former monopolists' offers are available throughout an incumbent-market and not in a specific zip-code area. Furthermore the market specific costs, such as distribution charges, are the same in all zip-code markets within an incumbent-market. Table 16 reports the number of newcomers both in incumbent-markets and in zip-code-market.

Table 16: Number of newcomers

Number of entrants	in incumbent-market	in zip-code-market
1	7	20
2	105	419
3	177	1146
4	189	1591
5	106	1369
6	59	1194
7	34	1307
8	14	238
9	4	61
Sum	695	7345

Because the zip-code areas of incumbent-markets are very heterogeneous, we face some difficulties in cases where, as opposed to the case above, in one zip-code area two incumbent-markets coexist. Our data for market characteristics is at the zip-code level which means that without further information on distribution of these characteristics between the two markets making a clear cut assignment is not possible. To avoid any distortion, we decided to consider only the zip-code areas with one single incumbent. Nevertheless, in our estimation we have to take into account the fact that different zip-code-markets could be assembled to one incumbent-market.

With regard to the error term ϵ_{ij} that captures the unobservable determinants in market i and next higher market j , we define i as a zip-code market and j as an incumbent-market. In case an incumbent-market covers only one zip-code market when $i = 0$. For the reverse case, that is when the incumbent-market covers more than one zip-code area, we allow the error term to correlate between those zip-code markets i which are located within the j market. Otherwise, the assumption of independent distribution of the error term would be violated. As mentioned above, since the incumbent offers throughout the incumbent-market there could be factors which influence profits of newcomers located only in i but also ones offering throughout the incumbent-market j . Also cost shocks, for example, required payments which are set up by the local authority (for example pipeline path charges) are relevant in all zip-code areas in the incumbent-market, have to be taken into account.⁶⁶ Thus, ϵ_{ij} captures also the unobserved variables in j which affect the profits of all newcomers independent of their zip-code-market choice. There are cost shifters in W_i which are valid throughout the incumbent-market but also such that are zip-code-market specific.

⁶⁶ One example is so called „Konzessionsabgabe“ which is a permit fee set by the local authority and paid by the suppliers. Unfortunately, we do not have that specific data and capture that in the error term.

4.5.2 Entrants and newcomers

We deploy data on all available offers at zip-code level from Verivox, which is a price comparison platform for customers who want to switch their current contract or supplier. The databank includes firms that have entered a specific zip-code market by offering a gas contract to household customers. We consider the number of firms that offer contracts for households with yearly 20,000 kWh consumption.⁶⁷ It seems that a huge number of market entries occurred but we have to distinguish between different “entrant types” by analyzing their ownership structure. Without doing that we are not able to distinguish between newcomers, entry of affiliated firms and incumbent entry. For example, E.on and RWE have created discount brands (“E Wie Einfach” and “Eprimo”) and compete with other entrants in particular markets. Besides, we observe recent market entry of former local monopolists (incumbents) in many markets. Nevertheless, both the importing firms and the former local monopolists do not face the problems of the newcomers (as described above) that first have to purchase gas at the wholesale market. We are particularly interested in “real” newcomers and thus have selected firms out of the databank that do not have any ownership in relation to incumbent companies. Nevertheless, any market entry decision depends on the number of existing firms in the market regardless the ownership relations, and thus, we control for the number of entrants which either are former local monopolist or related to gas importing firms.

4.5.3 Demand and market characteristics

The market and customer characteristics we use for our estimation try to capture the demand in a particular zip-code-area. Data on characteristics are provided by Acxiom, a geomarketing firm that collects such kind of data. Firms that are interested in market entry make use of the data to screen the market for where best to enter. We selected, in particular, variables which correspondent with the total market demand, such as number of households, buildings or age of buildings. Furthermore, we use customer characteristics, which reflect the probability of switching to another supplier, as demand shifters. The entry of newcomers tends to cause business stealing rather than market expansion wherein, firms try to poach customers away from each other and from the incumbent. Thus, we have to take into account characteristics which are correlated with the probability of switching. According to results of a survey conducted by Acxiom⁶⁸ with household customers the probability is higher among customers with higher education, ages 18 to 40 and with higher monthly income. Acxiom have created an index which shows the household status in

⁶⁷ This is the typical consumption of a 4 person household or 100 m² flat.

⁶⁸ Survey among 1.5 Million household customers with 300.000 replies.

terms of education and income. The variables that we use in our estimation are described below in Table 19.

Market characteristics are mainly the distribution charges which have to be paid if a firm supplies a customer in a downstream market. For household customers these are two part tariffs with a variable charge and a fixed part independent of the consumption (the fixed charge also includes the fixed metering price). We use the total charge for 20000 kWh in our variable profit function. The distribution charges are regulated and differ among incumbent-markets. The data are provided by E'net, one of the biggest energy information providers in Germany. Their databank allows the geographical delineation of incumbent-markets and the market areas. We are able to distinguish between the (wholesale) market areas to which the incumbent-markets are connected and control for that in our estimation. Note that several incumbent-markets have access or are connected to more than one market area.

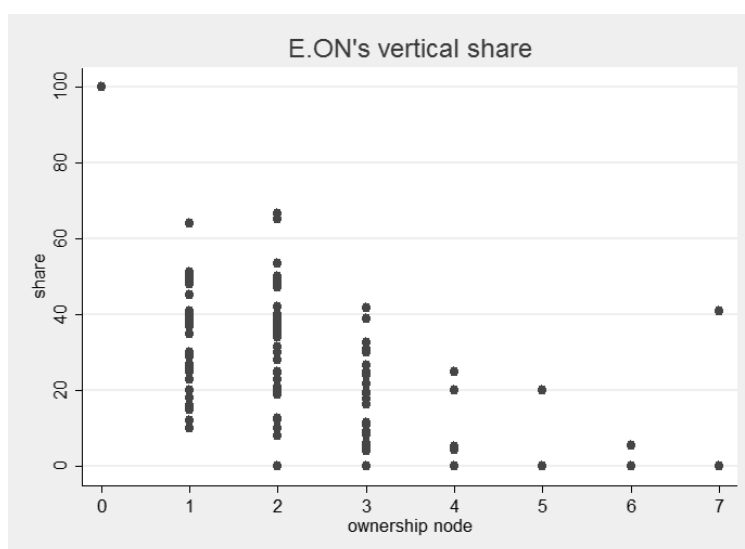
Another variable that enters into the equation affects the fixed cost of the entrants. The density of zip-code-market influences the marketing costs of entering firms. The higher the density, the more potential customers can be convinced to switch. Thus, fixed costs in dense markets might be lower compared with rural markets.

4.5.4 Ownership structure

To identify both the real newcomers and forward integrated firms we used data provided by Creditreform. The databank contains full ownership information that allows the detection of ownership links which are not directly observable at first glance. As gas importers' shares in the target downstream firm not only held directly but rather on detours, this is a crucial analysis to determine the so called ultimate firm (importer) that at the end of the chain holds the stakes. Figure 13 exemplarily shows E.ON's vertical shares in downstream incumbents. Node 0 means that E.ON itself operates as downstream incumbent in particular incumbent-markets. Node 1 shows the shares that E.ON directly holds in downstream incumbents and for example node 4 indicates E.ON's ownership link through 4 intermediary firms. As shown in this figure, E.ON accommodates at maximum 7 nodes. In all nodes greater 1 the ultimate share of an importer in a particular downstream firm have to be computed. For example, if E.ON holds 60 percent in a firm B, and B in turn has 50 percent share in downstream Incumbent A, when the E.ON's ultimate share in A is $0.6 \cdot 0.5 = 0.3$ that is 30 percent.⁶⁹

⁶⁹ There several ways to compute the ultimate share of a firm which are discussed in literature. For example the so called "weakest link" rule, which in the example above results in ultimate share of 50 percent. See, for example, Bortolotti et al. (2007)

Figure 13: E.On's vertical ownership structure



For our purposes, we distinguish between self-operated, directly linked and indirectly linked ownership relations. The latter describes the cases for nodes greater than 2. In contrast, directly linked are all the firms with nodes 1 and 2. We define the cases in the second node as directly linked because the majority of the links go through shareholding firms of the importing companies which were set up to manage the numerous stakes.⁷⁰

Another important question is the geographical location of integrated firms. Table 17 shows the correlation between the location of downstream subsidiary and the importer's covered upstream market area. About 70 percent of RWE's self-operated downstream incumbents markets are within their own (wholesale) upstream market area (RWE H-Gas Market area). Thus, the majority of downstream zip-code markets within the upstream area are controlled by RWE. In contrast, E.ON's self-operated downstream incumbents markets do not have control in their own market area. Nevertheless, the incumbents that supply about 30 percent of the zip-code markets located in E.ON's upstream market area, have direct ownership link to E.ON.

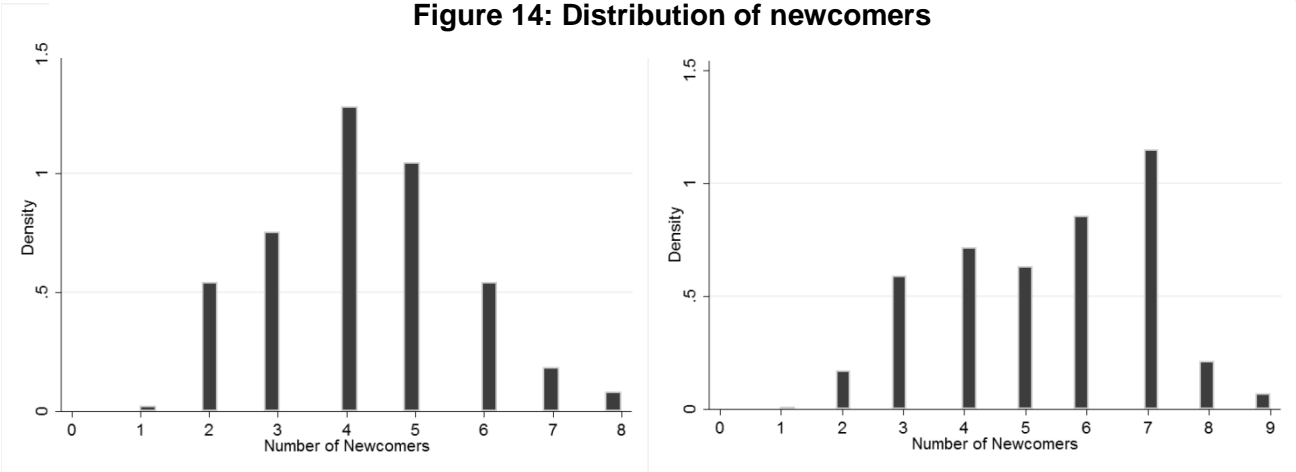
Table 17: Correlation ownership and upstream market area

			Self-operation	Direct Forward Integration	Indirect Forward Integration
RWE	H-Gas	Market Area	0.7155	0.1048	-0.0193
RWE	L-Gas	Market Area	0.2399	-0.0763	-0.0506
E.ON	H-Gas	Market Area	-0.0725	0.2857	0.0942
E.ON	L-Gas	Market Area	0.1527	-0.1617	-0.1533

⁷⁰ Recently E.ON was forced by the EU Commission to sell its holding society Thüga, which managed E'ON's more than 200 (mostly minority) stakes in downstream companies. Thüga is in our data sample.

4.5.5 Descriptive statistics

As we want to investigate how market entry of newcomers is affected by vertical integration, our first look is directed towards the distribution of the number of newcomers depending on their vertical relation with an importer. The left graph in Figure 14 shows the distribution of number of newcomers in zip-code markets where the incumbents are not integrated with gas importers. In contrast, negative skew of distribution is observed in markets with vertically linked incumbents (indirect shares are not considered). The comparison of distribution reveals that number of entrants is higher in markets with vertically linked incumbents. In our data sample with only one incumbent in a zip-code market, there are 3800 markets with dependent incumbents, whereas 1500 markets have independent incumbents.



As mentioned above, we distinguish between zip-code markets and incumbent-markets. These are not necessarily equal as Table 18 shows. In our sample 5900 zip-code markets are covered by only 510 incumbent-markets with a mean of 11 zip-code areas.

Table 18: Number of natural gas submarkets

Number of zip-code markets	5879
Number of incumbent-markets	511
Zip-code markets per Incumbent market: min	1
Average	11.5
Maximum	404

Table 19 shows the variables we have included in our estimation. The endogenous variable is the number of newcomers whose ownership is independent from gas importers and downstream incumbents. As one can see, in each of the zip-code markets there is at least one newcomer active and the maximum number of newcomers is 9. We have grouped the number of newcomers in our estimations for

markets with 5 and more newcomers. Furthermore, we have chosen variables that describe the market size, variables that affect the likelihood of customer switching (demand shifters), cost shifters and, finally, the ownership structure of the incumbent. To best describe the market size Y_i in a zip-code area we employ not only the number of households but also the type and age of buildings. As gas is usually used for heating and cooking the type and age of buildings are important determinants for the consumption in an area. Demand shifters (Z_i) are customers characteristics which correspond to customers' willingness to switch their suppliers. According to the statistics of the German Regulator and also Axiom's survey, the higher the gas consumption the greater the probability of supplier switching. Therefore, we take the share of 4-person households into account as a 4-person household has relative high consumption. Further important determinants for switching decision are also education, income and household member's age. We have two cost shifters (W_i): first, the network charge that affects the variable profits and, second, density that affects the fixed cost in zip-code area, for example, for marketing spending. Network charges are the same throughout the incumbent-market and thus are not zip-code specific. In contrast, density is measured at zip-code level. Considering the ownership structure of downstream incumbent we distinguish between self-operated and directly owned (1 or 2 nodes) downstream incumbents. We use dummy variables which indicate when the share of importers' exceeds 50 percent.⁷¹ Furthermore, we take into account the number of incumbents that entered a new market. We treat incumbents' entry decisions as exogenous.

⁷¹ We too considered the shares in our estimation but the results are the same.

Table 19: Descriptive statistics

Variable	Description	Mean	Std. Dev.	Min	Max
# of Newcomers	Number of newcomers	4.317	0.938	1	9
Market Size Y_i					
# of households (hh)	in (1000)	5.241	4.485	0.004	28.089
# of buildings age > 15	in (1000)	0.351	0.307	0.001	2.695
# of buildings age < 25	in (1000)	1.739	1.415	0.002	12.292
# individual houses	in (1000)	1.428	1.253	0.001	12.599
# of buildings > 3 Apt	in (1000)	0.417	0.461	0	3.07
Demand Shifters Z_i					
Share of hh age < 40	# hh age < 40/ # hh	0.357	0.034	0.222	0.573
Share high-status hh	# high status hh/ # hh	0.279	0.237	0	1
Share of 4-pers. hh	# 4-pers. hh/ # hh	0.122	0.033	0	0.25
Purchasing power 3-pers. hh	In Euro (Mio.)	79.905	67.104	0.05	571.536
Jobless rate	In Percent	8.850	4.972	0	32.7
Cost Shifters W_i					
Network charge (log)	Charge for 20,000 kWh (4-pers. hh)	5.453	0.222	3.599	6.420
Density	# hh/ area (in 1000)	1.117	2.492	0.003	27.404
Further Competitors					
# of Incumbent-Entrants	Incumbents that entered new markets	6.986	3.191	0	18
Self- operated Incumbents Own_i					
Eon_avacon		0.036	0.186	0	1
Eon_bayern		0.032	0.176	0	1
Eon_hanse		0.069	0.253	0	1
Eon_mitte		0.017	0.131	0	1
Eon_thüringen		0.016	0.125	0	1
Eon_westfalen		0.007	0.082	0	1
Eon_edis		0.008	0.087	0	1
RWE		0.032	0.176	0	1

		Mean	Std. Dev	Min	Max
Direct Ownership Own_i					
D. Eon > 50%	Dummy: 1 if more than 50 percent	0.083	0.275	0	1
D. RWE > 50%	Dummy	0.018	0.134	0	1
D. GDF > 50%	Dummy	0.004	0.061	0	1
Eon direct share	Direct share in downstream incumbent (%)	11.696	20.380	0	66.5
RWE direct share	in (%)	2.833	11.293	0	100
VNG direct share	in (%)	0.851	4.487	0	25
GDF direct share	in (%)	0.190	3.098	0	51

4.5.6 Endogeneity

The market characteristics which we do not observe might be correlated with the vertical ownership and with the number of entrants. In particular markets which are profitable for entry are probably also attractive for importers to integrate forward with downstream incumbent. As we consider the entry in particular zip code area newcomer's decision to enter a market will depend on characteristics at zip-code level. For example, a newcomer would enter a market if, given the demand characteristics in the zip-code market, the expected profits are positive. In contrast, gas importer might want to integrate forward if the demand characteristics for the whole incumbent-market area are promising. This depends not only on household demand but also on industry and business customers. Table 20 illustrates the number of served zip-code areas of each of Eon's downstream incumbents.

Table 20: E.on's self-operated downstream incumbents

E.ON's downstream subsidiaries (self-operated)	Number supplied markets	zip-code	Number supplied zip-code markets, with one unique incumbent
E.ON Hanse	504		406
E.ON Avacon	227		211
E.ON Bayern	203		189
E.ON Thüringen	128		94
E.ON Mitte	120		102
E.ON Edis	73		45
E.ON Westfalen Weser	42		40

Furthermore, both E.on and RWE are also the major electricity producers, maintaining about 50% percent of the production capacities in Germany. Therefore, importer's decision to integrate could also be caused by the fact that most of the downstream incumbents supply gas and electricity and serve the majority of the customers in both markets. In contrast, GDF, VNG and Wintershall are active solely in the gas market and they are hardly integrated with downstream incumbents.

4.6 Estimation results and discussion

We ran five estimations with independent equations where we vary the controls. The estimation results are shown in Table 21. The first estimation includes only the market size, demand and cost shifters without considering the ownership relations and without controlling for the market areas. In the second and third equation we take into account the number of competitors, in terms of incumbent-entrants, and the ownership relations respectively. In the fourth equation we include all controls for market areas. The references are the incumbent-markets that are not assigned to a specific market area. As mentioned above, the importers' downstream ownership is correlated with the geographical location of the market area, therefore we take out the market areas which could cause a bias in the results for markets with vertical integrated incumbents in the fifth estimation.

Considering the effects of the market size, the results show a positive but not significant effect of the number of households on market entry throughout all estimations. The age of the buildings is an important aspect for indicating the market size. In particular in zip code areas where the buildings are relatively new (< 15 years) heating with gas seems to be not very common. In areas with older buildings (> 25 years) demand is not significantly affected by the number of buildings in the last two equations although the parameter has a negative sign. Both type of buildings, individual houses and buildings with more than 3 apartments, show significant positive effects in last two equations. However, considering the effects of market size on variable profits it is shown that in almost all estimations the impact of our variables is relatively low.

Apparently, there are other factors that significantly affect the variable profits of newcomers. If we consider the demand shifters and their effects on variable profits in the first equation, we observe insignificant coefficients in our first estimation, although, almost all variables have the expected coefficient sign except the share for 4-person households. When we add the number of incumbent competitors to the first equation a surprising result shows a significant positive effect of growing competition. Thus, in markets with more incumbent-entrants we observe more newcomers. We interpret this result as lack of market information (or market knowledge) of newcomers. As the incumbents are very well informed about market and demand characteristics which reflect the potential demand, the newcomers follow the decision of incumbents by entering the same markets. This result is robust and the coefficient for the number of incumbent-entrants is significant and positive in all estimations. By

adding this variable in our second estimation the coefficients for the demand shifters change too. In particular the share of households with members younger than 40 changes the sign from positive to negative and turned out to be significant. The same is true for purchasing power although the sign of the coefficient remains the same. This indicates the multicollinearity of the number of incumbent-entrants with those two demand shifters. When including more controls in our estimations the effects become weaker. However, we keep the competition measure in our estimations since it seems the newcomers follow incumbents' decision and have a significant effect on profitability of newcomers. Note that we assume the number of incumbent-entrants to be exogenous.

The cost shifters, in particular, the network charges show another interesting though unexpected result. The coefficient for the regulated network access charge is not significant and does not have the expected negative sign. This result is opposed to findings in electricity markets as shown in Nikogosian and Veith (2011). The study shows that the number of entrants is strongly affected by the network charge. Nevertheless, the electricity markets are much more competitive compared with gas markets as the number of entrants is significantly higher in the electricity markets. Thus, in gas markets the newcomers seem not to be worried about the network access charges. We interpret this as a result of moderate competition level in gas markets. Regarding the density in a zip-code market, as fixed cost shifter, it shows the expected result with positive sign and significance in all but first estimation. The higher the density the lower the fixed costs, for example, for marketing.

To investigate the effects of vertical integration of local incumbents with gas importers we distinguish between self-operated downstream and downstream incumbents in which the importer holds shares. The Table 21 shows the results for estimation with dummy variables that take the value 1 if the importer holds more than 50 percent shares.⁷² Our third estimation includes the vertical ownership variables but do not control for the market areas. The result shows positive coefficients for almost all markets with self-operated downstream incumbents. Thus, we do not observe any negative effects of vertical integration on newcomers' profit functions in integrated markets. In markets with direct controlled downstream incumbents the effects are not significant. In the fourth estimation where we control for market areas, the results for Eon Avancon, Hanse and Thüringen show surprising changes. In contrast to previous results the coefficients turn from positive to negative and remain statistically significant. Disregarding the market areas of Eon and RWE in the last estimation due to multicollinearity issues, again change the coefficients with the exception of Eon Hanse. The results for markets with RWE's operated downstream incumbents too change strongly throughout the last three estimations. Nevertheless, the results are statistically not significant when we control for market areas.

⁷² We too estimate the equations with the shares. The results are almost the same therefore we do not include them in this paper.

Considering the market areas, the results show that the market area of EWE (regional supplier that also operates a pipeline) lacks either liquidity at a wholesale level or the resulting wholesale price is too high as market entry is rare. Furthermore, in the market area of GDF there are fewer newcomers compared with not assigned market areas. In general, it seems that market areas that supply customers with L-Gas (low quality gas) from the Netherlands or Sweden host less newcomers compared to the H-Gas areas. Currently, the European Commission works on the issues associated with different gas qualities and aims at the harmonization of the gas quality in Europe.

Considering the impact of further market entry on newcomers' profits the results show the expected effect. In all estimations further market entry reduces their profits. However, the parameters, except the 5+ category in the fourth estimation, are not significantly different from each other. That means that the profit reduction caused by the entry of up to four firms does significantly affect the profits of entered newcomers. Since competition is about poaching the customers from each other (especially from the incumbent) the competition intensity does not necessarily depend on the number of the newcomers but on the price set by firms. Thus, in case of Bertrand competition two firms are enough to reach perfect competition where the price reveals the (average) variable costs. But in that case we would observe significant results in increasing competitive effects when the second firm enters the market, which we do not. However, as there are other competitors, in terms of incumbent-entrants, in the market the effects of further newcomers seem to be negligible. Although gas itself is a homogenous product, differentiation in prices and contracts details (such as contract term) for certain customer groups (usages) is commonly used by gas suppliers. This relaxes the competition between the firms and can also lead to negligible effects on profits caused by market entry.

4.7 Conclusion

The study aims at investigating the effects of vertical integration between upstream and downstream incumbents on market entry, in particular on profits of market newcomers. To preserve downstream subsidiaries' profits, natural gas importers - upstream incumbents - have the incentive to protect their downstream markets from upcoming competition, since in markets for household customers market entry induces business stealing rather than market expansion. For importers it might be possible to hurt newcomers with limited availability of gas in the wholesale market which is caused by limited foreign purchasing sources and restrained transportation capacities at German border but also within Germany. The pipelines and border connection points are owned and operated by the (five) major importers. In particular E.on and RWE, as dominant gas importers, are extensively engaged in downstream business, holding shares in downstream incumbents or operating their own downstream subsidiaries. To analyze possible vertical integration issues empirically

we apply the framework of Bresnahan and Reiss (1991) that reveals how competition changes with market entry, employing data for about 500 sub markets for household customers. For this purpose ownership and market entry data were merged, and market and consumer characteristics were taken into account. Controlling for local market areas within Germany, each with their own wholesale market, we obtained the results showing in which sub markets entry is unlikely, for example, due to vertical integration and wholesale liquidity issues.

The results of our empirical analyses show that in a few downstream markets in which Eon has a self-operated subsidiary the number of newcomers is small compared with other markets. Nevertheless, this outcome is not robust. Furthermore, there are also other downstream markets, for example with the downstream incumbent Eon Edis that show significant positive effects. Thus, further investigations have to be conducted for those integrated markets that show significant negative effect on market entry as a clear cut result is not possible. The coefficients for direct ownership do not appear to be significant. In sum, we do not find clear evidence that market entry is restricted by vertical integration of gas importers and downstream incumbents. Moreover, we show that in high quality natural gas markets there are more market entries than in low quality gas areas. This might be due to liquidity issues specific to in these markets.

Surprisingly, the results show that market entry of newcomers and their profits are positively affected by the number of incumbent-entrants that already entered the market. In contrast, market size and demand characteristics play a minor role. We interpret our finding with information asymmetry between newcomers and incumbent-entrants, as the incumbents have much more experience and market knowledge than the newcomers. Thus, newcomers follow the decision of incumbent-entrants in entering a particular market. Furthermore, entry of further newcomers negatively affects the profits of newcomers that are already in the market but the results are not significant.

4.8 References

- Abraham, J. M.; Gaynor, M.; Vogt, W., B., (2007), Entry and Competition in Local Hospital Markets, *The Journal of Industrial Economics*. 55 (2), pp. 265-288.
- Berry, S. T., (1992), Estimation of a Model of Entry in the Airline Industry, *Econometrica*, 60 (4), pp. 889-917.
- Berry, S. T.; Waldfoegel, J., (1999), Free entry and social inefficiency in radio broadcasting., *RAND Journal of Economics*, 30 (3), pp. 397-420.
- Berry, S. T.; Levinsohn, J.; Pakes, A., (1995), Automobile Prices in Market Equilibrium, *Econometrica*, 63 (4), pp. 841-90.
- Borenstein, S., (1985), Price discrimination in free-entry markets, *RAND Journal of Economics*, 16 (3), pp. 380-397.
- Bortolotti, B.; Cambini, C.; Rondi, L.; Spiegel, Y. (2007), Capital Structure and Regulation: Does Ownership Matter?, CEPR Working Paper, 2007
- Bresnahan, T. F; Reiss, P. C., (1990), Entry in Monopoly Markets., *Review of Economic Studies*, 57 (4), pp. 531-53.
- Chipty, T., (2001), Vertical Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry, *The American Economic Review*. 91 (3), pp. 428-453.
- Ferrari, S.; Verboven, F., (2010a), Empirical analysis of markets with free and restricted entry, *International Journal of Industrial Organization*. 28 (4), pp. 403-406.
- Ferrari, S.; Verboven, F., (2010b), Vertical Control of a Distribution Network - An Empirical Analysis of Magazines, SSRN eLibrary.
- Forbes, S. J.; Lederman, M., (2010), Does vertical integration affect firm performance? Evidence from the airline industry, *RAND Journal of Economics*, 41 (4), pp. 765-790.
- Forbes, S. J.; Lederman, M., (2009), Adaptation and Vertical Integration in the Airline Industry, *American Economic Review*. 99 (5), pp. 1831-1849.
- Growitsch, C.; Wein, T., (2005), Network access charges, vertical integration, and property rights structure--experiences from the German electricity markets, *Energy Economics*. 27 (2), pp. 257-278.
- Hastings, J. S.; Gilbert, R., J., (2005), Market Power, Vertical Integration and the Wholesale Price of Gasoline, *Journal of Industrial Economics*. 53 (4), pp. 469-492.
- Lafontaine, F.; Slade, M., (2007), Vertical Integration and Firm Boundaries: The Evidence, *Journal of Economic Literature*. 45 (3), pp. 629-685.
- MacDonald, J. M., (1986), Entry and Exit on the Competitive Fringe, *Southern Economic Journal*. 52 (3), p. 640.

Mullin, J. C.; Mullin, W. P., (1997), United States Steel's Acquisition of the Great Northern Ore Properties: Vertical Foreclosure or Efficient Contractual Governance, SSRN eLibrary.

Reiss, P. C.; White, M. W., (2005), Household Electricity Demand, Revisited, Review of Economic Studies. 72 (3), pp. 853-883.

Schaumans, C.; Verboven, F., (2011), Entry and Competition in Differentiated Products Markets, SSRN eLibrary.

4.9 Appendix

Table 21: Estimation results

	(1)	(2)	(3)	(4)	(5)
Market Size Effects λ					
# of households (hh)	0.085 (0.053)	0.079 (0.052)	0.078 (0.056)	0.028 (0.055)	0.010 (0.057)
# of buildings age < 15	-0.351 (0.372)	-0.312 (0.319)	-0.537* (0.322)	-0.844*** (0.315)	-0.742** (0.323)
# of buildings age > 25	-0.463** (0.229)	-0.139 (0.204)	-0.349* (0.187)	-0.213 (0.216)	-0.165 (0.210)
# of individual houses	0.205 (0.292)	0.159 (0.262)	0.402 (0.245)	0.434* (0.241)	0.398* (0.240)
# of buildings > 3 Apt	-0.212 (0.392)	-0.017 (0.395)	0.478 (0.403)	0.662* (0.377)	0.831** (0.390)
Demand Shifters β					
Share of hh age > 40	0.145 (2.497)	-4.125* (2.382)	-5.347** (2.722)	-0.770 (2.702)	-1.285 (2.597)
Share high-status hh	0.571 (0.385)	0.403 (0.326)	0.487 (0.334)	0.296 (0.354)	0.161 (0.330)
Share of 4-pers. hh	-2.782 (2.416)	-0.635 (2.108)	-1.888 (1.986)	-1.090 (1.658)	0.086 (1.732)
Purchasing power 3-pers. hh	-0.001 (0.002)	-0.005*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)
Jobless rate	-0.005 (0.019)	0.007 (0.019)	-0.010 (0.018)	-0.023 (0.021)	-0.033 (0.022)
Cost Shifters δ					
Network charge (log)	0.263 (0.421)	0.169 (0.380)	0.092 (0.382)	0.271 (0.309)	0.303 (0.326)
Density	0.032 (0.027)	0.063** (0.030)	0.080** (0.032)	0.092*** (0.031)	0.080** (0.033)
# of Incumbent-Entrants		0.274*** (0.027)	0.289*** (0.032)	0.334*** (0.044)	0.349*** (0.043)
Ownership Effects γ					
Eon_avacon			0.485** (0.195)	-1.571*** (0.513)	-0.663 (0.455)
Eon_bayern			1.631*** (0.155)	0.717** (0.365)	0.686** (0.293)
Eon_hanse			0.500*** (0.188)	-1.221*** (0.461)	-1.094** (0.462)

<i>(continued)</i>	(1)	(2)	(3)	(4)	(5)
Eon_mitte			1.176*** (0.166)	-0.507 (0.629)	0.218 (0.448)
Eon_thüringen			0.232 (0.300)	-1.004* (0.522)	-0.356 (0.498)
Eon_westfalen			1.441*** (0.225)	0.856 (0.619)	0.789 (0.487)
Eon_edis			1.551*** (0.405)	1.500*** (0.572)	1.350** (0.540)
RWE			0.820*** (0.149)	-1.266 (1.002)	0.089 (0.721)
Direct Ownership					
D. Eon > 50%			0.312 (0.579)	-0.342 (0.459)	0.031 (0.456)
D. RWE > 50%			0.278 (0.335)	0.099 (0.521)	0.483 (0.374)
D. GDF > 50%			0.403 (0.288)	-0.242 (0.298)	0.203 (0.231)
Market Area Controls					
Bayernets				0.982*** (0.315)	1.009*** (0.305)
BEB H-Gas				1.470*** (0.337)	0.853*** (0.274)
BEB L-Gas				0.229 (0.269)	-0.041 (0.237)
E.ON H-Gas				1.143*** (0.242)	
E.ON L-Gas				0.063 (0.215)	
Erdgas Münster				-0.000 (0.361)	-0.231 (0.323)
EWE				-2.234*** (0.432)	-1.972*** (0.392)
GDF				-0.119 (0.305)	-0.722*** (0.277)
GVS-ENI				1.258*** (0.357)	0.870** (0.377)
Ontras-VNG				1.775*** (0.386)	1.421*** (0.345)
RWE H-Gas				0.126 (0.320)	

<i>(continued)</i>	(1)	(2)	(3)	(4)	(5)
RWE L-Gas				-0.423*	
				(0.220)	
Wingas				0.721***	0.870***
				(0.258)	(0.238)
Newcomers' Entry Effects θ_N					
θ_2 , Firm 2	-2.106 (2.510)	-2.239 (2.250)	-3.186 (2.219)	-0.190 (2.134)	-0.447 (2.228)
θ_3 , Firm 3	-0.718 (2.490)	-0.708 (2.227)	-1.592 (2.193)	1.750 (2.114)	1.323 (2.217)
θ_4 , Firm 4	0.095 (2.527)	0.228 (2.273)	-0.606 (2.235)	2.966 (2.113)	2.448 (2.213)
θ_{5+} , Firms 5+	0.727 (2.523)	1.038 (2.269)	0.246 (2.245)	3.996* (2.129)	3.425 (2.221)
Observations	5,879	5,879	5,879	5,879	5,879
Log likelihood	-6166	-5207	-5014	-4361	-4545

*, **, *** represent significance at the 10, 5 and 1 percent significance levels, respectively.

5 VERTICAL INTEGRATION, SEPARATION AND NON-PRICE DISCRIMINATION IN ELECTRICITY SUBMARKETS FOR RESIDENTIAL CUSTOMERS⁷³

⁷³ Based on joint research with Tobias Veith

5.1 Introduction

Vertical integration of energy network operator and supplier is a key issue in European energy markets, in particular since the European Commission (EC) has initiated a sector inquiry in 2005. The EC argues that vertical separation of electricity networks from other activities (such as production and retail) increases consumer surplus, while opponents argue that vertical integration enables cost savings due to economies of scope.⁷⁴ In a number of speeches, former European Competition Commissioner Kroes indicates the disadvantage of vertical integration in energy markets for retail customers caused by insufficient unbundling of electricity transmission/distribution and supply activities.⁷⁵

A large number of studies put forward the effects of vertical integration of an upstream monopolist offering an essential input to a competitive downstream market. Without any regulation, the upstream monopolist might favor its own downstream unit either with price-privileges or non-price-privileges. While price discrimination directly affects competitors' input costs, non-price discrimination ("sabotage") might influence quality, customer preferences, cost, and, finally, the demand. To prevent price discrimination upstream price regulation can be installed, but non-price discrimination remains an issue. In general, such non-price discrimination is legally prohibited, but can hardly be detected by the regulation authority (Economides, 1998; Beard et al., 2001).

The literature on non-price discrimination distinguishes between alternative approaches, e.g. raising rivals' costs, in case of information asymmetry, or reducing rivals' quality. Vickers (1995) analyses welfare effects of a vertically integrated upstream monopolist who provides price regulated upstream services and simultaneously acts in the retail market. Furthermore, he assumes the regulator to be imperfectly informed about upstream costs. This fact allows the monopolist to select a wholesale price from a set of prices. Vickers shows that due to information asymmetry, upstream regulation cannot completely prevent discrimination incentives. Sappington (2006) extends Vickers' setup by including economies of scope and non-price discrimination. He confirms previous findings concerning higher retail prices due to vertical integration.⁷⁶

⁷⁴ ERGEG Publications: Status Review of DSO Unbundling with Reference to GGP on Functional and Informational Unbundling for DSOs, 2009.

⁷⁵Examples are: Neelie Kroes: Improving Europe's energy markets through more competition (SPEECH/07/115), Neelie Kroes: More Competition and Greater Energy Security in the Single European Market for Electricity and Gas (SPEECH/07/212) ... "In Germany the market is dominated by vertically-integrated companies, and the retail energy prices for small users are higher than in countries where energy companies have been unbundled, such as the UK."

⁷⁶The comparison of Vicker's and Sappington's approaches shows that the outcome of a raising rivals' costs strategy does not depend on the type of downstream competition. Other studies on non-price discrimination with Cournot competition are e.g. Crew et al., 2005; Economides, 1998; and Bertrand competition: Beard et al., 2001; Sappington, 2006; Weisman, 1995.

Mandy and Sappington (2006) consider an alternative approach of non-price discrimination with an upstream provider able to influence not only competitor's costs, but also demand, by reducing the product quality. The authors show that both cost-increasing discrimination and quality-reducing discrimination are profitable under Cournot competition. However, only cost-increasing discrimination is profitable under Bertrand competition. Our theoretical model, which we use to derive our hypotheses, is related to Mandy and Sappington (2006). Similarly we analyze the effects of cost-increasing and demand-reducing non-price discrimination, and, in contrast, we consider a Hotelling game because we firmly believe the total market demand in energy markets for household customers to be price inelastic in a short run. Furthermore, we believe that the customers' choice on energy supplier depends not only on the energy price, but also on firm preference.

Aiming at preventing non-price discrimination the European Commission suggests alternative regulatory approaches to overcome the challenge of vertical integration. Legal unbundling, as an intermediate approach between ownership unbundling and vertical integration, describes a particular type of separation. Hereby, the regulation requires legal separation of grid unit from the retail/production and the operation of the network by *de jure* independent grid unit management. Cremer et al. (2006) and Bolle and Breitmoser (2006) show that the stronger unbundling is enforced by law, the more network operators try to benefit from higher distribution charges, whereas downstream competition is reduced resulting in higher retail prices. In contrast, Höffler and Kranz (2011a) compare the effects of legal unbundling, ownership unbundling and vertical integration. They find lower retail prices with legal unbundling than with ownership unbundling and vertical integration. A legally separated price-regulated network operator maximizes only its own profit by maximizing the upstream output, therefore the operator has no incentive to discriminate downstream competitors. Thus, retail prices are lower than under vertical integration. By assuming retained informal interdependence between the legally unbundled upstream and downstream units, Höffler and Kranz (2011b) show that discrimination might again occur. We extended our theoretical model by adopting several vertical regulation schemes as applied in Höffler and Kranz (2011a and b).

The literature presents a broad range of theoretical evidence of how vertical integration can affect retail prices. Nevertheless, only a very small number of articles provide empirical evidence by considering separation of the transmission networks.⁷⁷ In this study we want to take up this challenge by analyzing the impact of vertical integration of retail incumbents (downstream) - mostly former monopolistic electricity

⁷⁷Transmission networks are the highest voltage lines that are used for long distance transmission whereas distribution grid is a regional network to supply end consumers. E.g. Steiner (2001) and Hattori & Tsuitsui (2001) investigate the effects of unbundling the transmission grid. Copenhagen Economics (2005) estimated the unbundling effects on prices and productivity for 15 European countries (in 1990-2003) finding that unbundling transmission from generation leads to lower prices and higher productivities.

suppliers - and distribution system operators (DSOs) (upstream) on retail prices and distribution charges in German household electricity markets. As the vertical structure is heterogeneous across the 850 German submarkets (there exist legally unbundled, vertically integrated or fully separated firms), we are able to analyze the effects of different structures and regulation schemes on electricity prices.

The potential unbundling of distribution networks has received little attention in economic studies so far.⁷⁸ As described above, vertically integrated incumbents might have an incentive to favor their own downstream unit over competitors. Delaying supplier-switching or withholding important information (e.g. customers' energy consumption) from competitors are examples for non-price discrimination. Such a discriminatory behavior might affect the retail prices. To test our hypotheses derived from the theoretical model we employ cross-sectional data for about 600 German geographically separated markets, each served by one DSO, one downstream incumbent and a number of small energy providers. Thus, we want to know whether price differences exist in different vertical structures. Using a simultaneous equations approach, we find significantly lower prices in markets with fully separated firms compared to markets with vertically integrated or legally unbundled firms.

5.2 Market description

The electricity sector can be subdivided in five interrelated stages: Generation, wholesale, transmission, distribution and retail. In Germany, four electricity producers, EnBW, E.on, RWE and Vattenfall, hold about 85 percent of the electricity generation capacities (with different generation sources). The remaining 15 percent of production capacities are either owned by local producers or foreign companies. Usually, capacities of small producers are used to cover the peak loads. The German transmission grid is geographically divided into four regional transmission grid monopolies covering the following regions: The EnBW area is located in South-Western Germany, Vattenfall in Eastern Germany, RWE in Western Germany. The remaining territory, which stretches from Northern Germany to Bavaria, belongs to E.ON.⁷⁹

⁷⁸Nillesen and Pollitt (2008) study the effects of unbundling that was implemented in New Zealand for distribution grids.

⁷⁹E.ON – forced by European Commission - sold the transmission grid in this territory to TenneT in 2010.

In contrast to transmission, the distribution stage covers more than 850 geographically separated markets, which are, according to the German Federal Cartel Office (Bundeskartellamt), the relevant markets in case of market investigations. The markets have different distribution areas and densities, thus, they differ with electricity demand. Each of these markets has only one distribution network operator and only one retail incumbent (former monopolist).

In general, vertical integration allows for price and non-price discrimination of competitors. Therefore, in line with the 2005 Energy Act (EnWG), the Federal Network Agency (Bundesnetzagentur) started the regulation of the grid access charge, the so-called distribution charge. Until 2009, the distribution charges were cost-based regulated. Recently, a new regulation scheme, incentive regulation (revenue-cap), was implemented. Thus, if a supplier serves a customer in a particular local submarket it has to pay the local distribution charge of the customer's market. Besides distribution charge regulation, the Energy Act requires the legal unbundling of grid operators from other activities such as generation and retail, aiming to prevent non-price discrimination. *Legal unbundling* describes the functional and legal separation of the distribution network operator (DSO) from other activities in terms of management, information flows and accounting. Since 2007, grid operators with more than 100,000 customers are obliged to separate their DSO by creating a new legal entity. Operators with smaller number of customers than the required threshold are allowed to remain *vertically integrated*. In contrast, *ownership unbundling (or full separation)* requires ownership independence of producers, grid operators and retail providers. However, this stricter regulation type has not yet been implemented in EU member states. As mentioned above, Germany has a very unique market structure; about 20 percent of German distribution operators are legally unbundled including voluntary separations, whereas 75 percent are vertically integrated and 5 percent are fully separated.

In addition to network regulation, the largest electricity supplier in each retail market for household customers is obliged to offer one so-called standard (basic) contract. This contract is a "fallback" for customers who decide to switch to an alternative contract. They automatically return to the standard contract either if their new provider leaves the market, or if their contract is cancelled by the supplier and customers have not decided which supplier to switch to (§§ 36 – 38, Energiewirtschaftsgesetz (EnWG)). Moreover, this means that after the market liberalization in 1998, customers who have not yet switched their supplier or contract (about 50 percent on average in each submarket) are supplied under the conditions of the high priced standard contract. Until today, former monopolists are the providers of these standard contracts. Besides the standard contract, former monopolists offer alternative contracts to retain more price-sensitive customers. About 44 percent of customers chose an alternative incumbent contract, whereas the rest (only about 6 percent) turned to alternative suppliers. Thus, incumbents' still have high market share after the liberalization.

5.3 Unbundling experience from other countries

New Zealand is the first country that has implemented ownership separation of electricity distribution from other commercial activities. The separation, introduced in 1998 after electricity market restructuring in 1992, resulted in no significant retail price reductions. Nillesen and Pollitt (2008) analyze New Zealand's economic effects of unbundling, employing a dataset between 1995 and 2007. They show that prices for commercial customers decreased, whereas residential electricity prices increased after the unbundling intervention.⁸⁰ Furthermore, unbundling caused a strong reduction in the number of competitors as energy producers acquired retailers. In their consideration of the unbundling effect on production and distribution costs, the authors find significant operational cost reductions. However, these were not passed on to customers in terms of lower distribution charges.

Currently, the Netherlands is politically debating the ownership separation on the distribution level, which has been legally implemented since 2011. Nooij and Baarsma (2008) summarize the arguments stated in the literature that ownership separation positively affects competition. Among others, they show in a scenario analysis of the Dutch electricity sector that discriminatory activities and cross-subsidization of vertically related companies could appear. In contrast to this theory-based analysis, Mulder et al. (2005) find only a little evidence for a price effect due to vertical separation with a broad cross-country analysis of vertical integration strategies.

5.4 Theoretical model

With a simple theoretical model, we aim at illustrating the effects arising from non-price discrimination in different vertical structure settings on the downstream prices and derive hypotheses for our empirical analysis. We do not seek the non-price discrimination equilibrium in the theoretical model but rather analyze the incentives to sabotage the competitors and the impact on retail prices. We compare alternative types of non-price discrimination with alternative forms of vertical regulation.

Consider a Hotelling game with uniformly distributed potential customers and two firms located at either end of a line.⁸¹ Firms offer electricity contracts with a given amount of electricity demand per contract. It is reasonable to assume that firms

⁸⁰ For commercial customers on average from NZ\$ 18,99 to 13,72 cents, and for household customers from NZ\$ 14,40 to 18,60 cents after ownership unbundling. The average overall price remained constant (see Nillesen and Pollitt 2007, p. 30f).

⁸¹ We assume the market demand to be highly price-inelastic in the short run.

compete with differentiated contracts as, at least in Germany, the electricity price is not the only factor on which consumers decide. Consumers' preference for a particular firm (brand) is also crucial. Furthermore, we assume that the incumbent, located at 0, is vertically integrated with the distribution system operator (DSO). The DSO provides a common input, "access" to the distribution grid at a cost-based regulated per-unit price b , the distribution charge. The DSO faces constant per unit costs c_u , with $b(c_u) \geq c_u$. Each downstream firm demands one unit of network access per contract and each customer x , $x \in [0,1]$ with the reservation price v , buys one contract from the incumbent or the entrant at prices p_I or p_E , with $v \geq p_i^*$, $i = I, E$. Besides distribution charges, both firms bear constant marginal costs per contract c_i , $i = I, E$ for serving customers.

Consumers pay different "transportation costs" which depend on their firm choice. If a consumer buys from the incumbent, transportation costs are τ_I , and τ_E otherwise. In our setting, transportation costs represent the customer preferences for a particular supplier. The utility function of a customer is then defined as follows:

$$U(x) = \begin{cases} v - p_I - \tau_I x, & \text{if the customer buys from the incumbent} \\ v - p_E - \tau_E (1 - x), & \text{otherwise.} \end{cases} \quad (1)$$

Because the distribution charge is regulated, the DSO could be interested in favoring its downstream unit over its competitor by engaging in non-price discriminating activities. We distinguish between two approaches which are cost-increasing, s_c , and demand reducing, s_d , form of discrimination. Cost-increasing discrimination can appear due to delays in (important) information provision e.g. on consumers' energy consumption, whereas demand-reducing discrimination is e.g. due to delays in the contract switching process. While cost-increasing discrimination directly increases the entrant's unit costs, demand-decreasing 'investments' simultaneously increase the preference for the incumbent but decrease the preference for the entrant,

$$\frac{\partial \tau_I}{\partial s_d} < 0, \quad \frac{\partial \tau_E}{\partial s_d} > 0.$$

Discrimination induces costs $C(s_c, s_d)$ to the DSO with increasing rate,

$$C'(s_i) > 0, \quad C''(s_i) > 0, \quad \frac{\partial^2 C}{\partial s_i \partial s_j} = 0, \quad i, j = c, d, \quad i \neq j.$$

As usual in Hotelling models, the demand split is defined by the marginal consumer x_i who is indifferent between the incumbent's contract and the competitor's contract.

Thus, we get the incumbent's demand $D_I = x_i$ as:

$$D_I = x_i = \frac{p_E - p_I + \tau_E}{\tau_I + \tau_E} \quad (2)$$

and the demand for the competitor's contract as $D_E = 1 - x_i$, with $D_i'(\tau_i) \leq 0$ and $D_i'(\tau_j) \geq 0$ for $i, j = I, E$.

The entrant's profit function, the incumbent's downstream unit and the incumbent's upstream unit profit functions π_E , π_{ID} and π_{IU} are given by:

$$\pi_E = (p_E - c_E - b - s_c) D_E \quad (3)$$

$$\pi_I = \pi_{ID} + \pi_{IU} \quad \text{with} \quad (4)$$

$$\pi_{ID} = (p_I - c_I - b) D_I \quad (5)$$

$$\pi_{IU} = (b - c_u)(D_E + D_I) - C(s_c, s_d), \quad (6)$$

We assume a two stage game where, first, the vertically integrated incumbent chooses the discrimination strategy $S = S(s_c, s_d)$ and, second, downstream their prices simultaneously.

5.4.1 Vertical integration

We begin with vertical integration and the assumption that the incumbent maximizes the total profit of both units, that is $\max(\pi_{ID} + \pi_{IU})$. By backward induction, we get the best reply functions:

$$p_I^R = \frac{1}{2}(b + c_I + p_E + \tau_E) \text{ and } p_E^R = \frac{1}{2}(b + c_E + s_c + p_I + \tau_I).$$

Cost-increasing discrimination increases the entrant's price, $p_E^*(s_c) > 0$, which confirms the findings of previous studies such as Economides (1998). In contrast, demand reducing discrimination shifts the entrant's best-reply curve inwards and the incumbent's best-reply curve outwards. The results are ambiguous: First, both equilibrium prices may be higher if the (positive) effect on the competitor's transportation costs outweighs the (negative) effect on the incumbent's transportation costs. Second, demand reducing discrimination induces the competitor to respond aggressively by reducing its price, which is also shown in Mandy and Sappington (2006).

Lemma 1:

Cost-increasing discrimination raises the equilibrium downstream prices. The competitor's price rises more than the incumbent's price, $\frac{\partial p_E^*}{\partial s_c} = \frac{2}{3}$, $\frac{\partial p_I^*}{\partial s_c} = \frac{1}{3}$. Cost-increasing discrimination raises the incumbent's demand by $\frac{\partial D_I^*}{\partial s_c} = \frac{1}{3(\tau_I + \tau_E)}$ and decreases the competitor's demand by $\frac{\partial D_E^*}{\partial s_c} = -\frac{1}{3(\tau_I + \tau_E)}$.

As cost-increasing discrimination forces the competitor to choose a higher price than without discrimination, the competitor loses a fraction of the customers. As a result, these customers turn to the incumbent. That allows the incumbent to charge a higher price.

Lemma 2:

Demand-decreasing sabotage raises the incumbent's downstream price and decreases the competitor's downstream price if $\left| \frac{1}{2} \frac{\partial \tau_I}{\partial s_d} \right| < \left| \frac{\partial \tau_E}{\partial s_d} \right| < \left| 2 \frac{\partial \tau_I}{\partial s_d} \right|$.⁸²

Demand-decreasing sabotage raises the incumbent's equilibrium demand $\frac{dD_I^*}{ds_d} > 0$

and decreases the competitor's equilibrium demand $\frac{dD_E^*}{ds_d} < 0$ as long as

$$(c_I - c_E - s_c + \tau_I) \frac{\partial \tau_E}{\partial s_d} > (-c_I + c_E + s_c + \tau_E) \frac{\partial \tau_I}{\partial s_d}. \text{ This inequality holds for } c_I = c_E, \tau_I \geq s_c.$$

In contrast to cost-increasing discrimination, the effects of demand-decreasing discrimination are ambiguous and depend on additional assumptions.

We assume that the firms have the same unit costs, $c_d = c_e$, i.e. they pay the same price for electricity at the wholesale level, and the impact of demand-decreasing discrimination on the competitor's transportation costs is larger than the impact on the incumbent's transportation costs, $\left| \frac{\partial \tau_E}{\partial s_d} \right| > \left| \frac{\partial \tau_I}{\partial s_d} \right|$. With these additional assumptions, the incumbent's price increases with demand-decreasing discrimination (Lemma 2 (i)).

In the following we first discuss the exclusive effects of both discrimination types. According to Lemma 1 cost-increasing discrimination is profitable for the incumbent as this action increases both the incumbent's price and also its demand. However, taking into account the impact on the incumbent's network operator, cost-increasing discrimination decreases the competitor's quantity and raises operator's costs. As a consequence, the incumbent reaches the optimum discrimination level in the last stage with $\pi_{ID}'(s_c) + \pi_{IU}'(s_c) = 0$. If price regulation is strictly implemented, which means $b(c_u) \approx c_u$, the incumbent neglects the (negative) discrimination effect on upstream profits and, therefore, prefers cost-increasing discrimination over non-discrimination if $\pi_I(s_c^*) \geq \pi_I(0)$.

For the singular effect of demand-decreasing discrimination, i.e. $s_c = 0$, we can derive similar conditions: We know from Lemma 2 (i) that the incumbent's retail price increases and the competitor's price decreases with discrimination. Given our assumptions the incumbent engages in demand-decreasing discrimination if

⁸² If this assumption does not hold, the prices can move in the same direction, e.g. if the competitor's price is very sensitive to changes in own transportation cost compared to the effect on the incumbent's transportation cost, both prices increase. See in the appendix Lemma 2.

$\pi_I(s_d^*) \geq \pi_I(0)$ holds. The intuition is as follows: An incremental increase in the competitor's transportation cost and, simultaneously, an incremental decrease in the incumbent's transportation cost allow the incumbent to charge higher prices for its contract and, at the same time, to win more customers. The incumbent's profit rises as long as its marginal revenue exceeds the marginal costs of sabotage. In contrast, the competitor tries to keep its customers by reducing its price for the contract but does not win new customers, which, in turn, leads to lower profit.

We know from Lemma 1 that the level of cost-increasing discrimination also affects the profitability of demand-decreasing discrimination and, therefore, we have to consider the joint outcome in the next step. The previous findings, $\pi_I(s_c^*) \geq \pi_I(0)$ and $\pi_I(s_d^*) \geq \pi_I(0)$, show that non-price discrimination can be a preferable strategy for the vertically integrated incumbent. As we have seen, the total partial derivatives of an incumbent's equilibrium demand with respect to s_d and s_c are positive without additional assumptions. However, introducing demand-decreasing and cost-increasing discrimination simultaneously, total partial derivatives of the incumbent's profit with respect to s_d and s_c become mutually dependent. The mutual dependence appears when we consider the second derivatives for demand effects due to sabotage, so that, given our assumptions, these are negative $\frac{d^2 D_I^*}{ds_d s_c} = \frac{d^2 D_I^*}{ds_c s_d} < 0$. In contrast, the mutual impact of demand-decreasing and cost-increasing discrimination on the incumbent's profit is positive, because $\frac{d^2 \pi_I^*}{ds_d s_c} = \frac{d^2 \pi_I^*}{ds_c s_d} > 0$.

Employing both types of discrimination, the boundary condition $\tau_I \geq s_c$ in Lemma 2 ii is reached faster than with singular discrimination as demand-decreasing discrimination reduces τ_I and cost-increasing sabotage raises s_c . Thus, the higher the maximum level of cost-increasing discrimination, the lower the maximum level of demand-decreasing discrimination and vice versa. With the positive second derivatives and further intermediate results, we know that also $\pi_I(s_c^*, s_d^*) \geq \pi_I(0, 0)$ holds as long as $\tau_I \geq s_c$. Therefore, employing the optimum combination of both types of discrimination can result in a higher total profit than no discrimination.

Proposition 1: With $\pi_I(s_c^*) \geq \pi_I(0)$, $\pi_I(s_d^*) \geq \pi_I(0)$ and $\pi_I(s_c^*, s_d^*) \geq \pi_I(0, 0)$, non-price discrimination can be a profitable strategy for the incumbent.

The discussion in line with Proposition 1 provides theoretical evidence that incumbent's price is always lower without non-price discrimination. Therefore, given our assumptions, the upstream firm has incentives to engage in non-price

discrimination, which always results in a higher price than without any discrimination. In contrast, the competitor's price choice depends on the magnitude of demand-decreasing discrimination and customers' loyalty, i.e. the transportation costs.

5.4.2 Fully separated firms

We consider the outcome in the event of total separation as this is our reference structure for the hypotheses. Given our assumptions, the equilibrium outcome is straightforward: In case of total (full) separation the DSO has no incentives to discriminate. As each firm in our setting maximizes its own profits, the profit of the DSO is maximized without engaging in non-price discrimination, because discrimination is costly and market demand is constant, $(b - c_u)(D_E + D_I) - C(s_c, s_d) < (b - c_u)(D_E + D_I) - 0$. Therefore, downstream prices are not affected by discrimination because the DSO does not take into account the discrimination effects on downstream profits.

Hypothesis 1: *In markets with vertically integrated firms, non-price discrimination results in higher retail prices of the incumbent compared to markets with fully (ownership) separated firms.*

5.4.3 Legal unbundling

We adopt the ideas of Cremer et al. (2006) and Höffler and Kranz (2011a) and assume that the legally unbundled grid operator considers (or is forced to consider) only its grid activity and maximizes only the upstream profit,

$$\pi_{IU} = (b - c_u)(D_E + D_I) - C(s_c, s_d), \quad (7)$$

whereas the downstream incumbent maximizes total profit, upstream and downstream. With perfect legal unbundling the total profit is given by:

$$\pi_I \equiv \pi_{ID} + \pi_{IU} = (p_I - c_I - b)D_I + ((b - c_u)(D_E + D_I) - C(s_c, s_d)). \quad (8)$$

Given our assumptions, the grid operator earns the same profit independently of downstream market shares because the total market demand is constant and distribution charges are regulated. Therefore, discrimination only negatively affects the DSO's profit and – with perfect legal unbundling – the grid operator has no incentive to discriminate. This outcome is in line with the findings of Höffler and Kranz (2011a).

We check whether the partial consideration of grid profits affects the retail providers' profit maximization strategies. Deriving the incumbent's optimum retail price strategy brings us to $p_I^* = \frac{1}{3}(3b + s_c + \tau_I + 2\tau_E)$.

Proposition 2: With perfect legal unbundling, the grid operator maximizes its upstream profit with the equilibrium strategy $S^*(0,0)$. Therefore, the implementation of legal unbundling provides no incentive for non-price discrimination, in case it works perfectly.

Hypothesis 2: Perfect legal unbundling provides the same results as total separation (ownership unbundling). Therefore, incumbents' prices in markets with legal unbundling do not significantly differ from incumbents' prices in markets with total (ownership) separation.

Assuming that perfect legal unbundling eliminates the grid operator's legal relationship in the retail incumbent, the grid operator ignores the downstream effect of its strategic decisions, thus having no incentive to act in favor of its retail parent firm. However, according to the special report (Sondergutachten, 2009) of the German Monopolies Commission on issues in German energy markets, the dependence of former vertically integrated operators remains strong even with legal unbundling. In particular, it is stated that upstream management decisions seem to be influenced by requirements of the retail incumbent. This might happen when the parent company is able to create an incentive-based relation to its affiliate.⁸³ To create such a relation, the retail incumbent needs sufficient ownership shares in the grid operator to exert power (e.g. more than 50 percent).⁸⁴ In case of lower shares, conflicts of interest might appear if other owners follow different aims. Thus, we formulate Hypothesis 3:

Hypothesis 3: With imperfect legal unbundling, incentives for non-price discrimination exist which initiate higher retail prices than with total separation. The incentives increase in ownership fraction.

⁸³ See Appendix for proof and also Höffler and Kranz 2011b

⁸⁴ Of course, imperfect legal unbundling depends strongly on corporate governance. The discussed outcome is not the only equilibrium.

5.5 Data description

In the previous section we have shown that cost-increasing and demand-reducing non-price discrimination types are profitable from a theoretical point of view and, that they both increase the incumbent's electricity contract price. As sabotage is not observable (and difficult to detect by regulatory authorities), we are not able to test the theoretical model as such. However, we are able to analyze price differences for electricity contracts in markets with different vertical structures, controlling for market and customer characteristics. Thus, price differences could indicate non-price discrimination, as discussed in the theoretical model.

5.5.1 Data sources

We use data from multiple sources to cover the vertical ownership structure, retail prices, distribution charges and customer characteristics. Ownership information is provided by Creditreform, the largest German wholesale commercial credit agency. Price and contract information aggregated at the zip code level stems from the internet platform Verivox which collects information on electricity contract offers. Low-voltage grid information and grid-related information is provided by E'net, the database for network characteristics. Aggregated information about customer characteristics are taken from the Acxiom database, which provides global information for marketing services.

We employ a cross-sectional approach using Data as of August 2008 that we aggregated at the distribution grid level.⁸⁵ Quantity and price data are selected for an average household consumption level of 4000 kWh per year (3 - 4 persons).

5.5.2 Data adjustments

The most comprehensive calculations concern the calculation of ownership shares. The Creditreform database offers information about the ownership structure of each company in our sample. This information comprises both direct owners of the retail company and the grid operator, and additionally the complete link between the dependent company and the ultimate owners. Based on this information, we can calculate the individual share of an ultimate owner for each electricity company. However, what we finally need is the direct and the indirect ownership link of intermediate owners as we consider (only) the ownership structure of the retail provider and the grid owner.⁸⁶ Total ownership of a grid owner by an electricity

⁸⁵ According to the Federal Cartel Office (Bundeskartellamt), the relevant market for end consumers without real-time-metering is the low-voltage grid area of a DSO.

⁸⁶ We appreciate inexhaustible support by our colleague Thorsten Doherr.

provider and vice versa are calculated independently of the number of intermediate owners. It is important to note that we consider markets individually, i.e. we ignore cross-ownerships between alternative incumbents and alternative grid owners. However, what cannot be taken into account in this study is the aspect of common owners on a higher level.

The grid access charge consists of a fixed part, the sum of a fixed usage charge and the meter charge, and a variable part which depends on the usage level. Thus, the grid access charge for a particular usage level is the sum of these components.

Our market definition is the same as suggested by the German Regulation Authority.⁸⁷ Since incumbents' standard contract prices apply in the area where only one incumbent or DSO serves, we use that as the relevant market. Usually areas served by only one DSO are not identical with zip code areas - the level at which we have customer information. Therefore, we have first to aggregate the information at the grid area level. To do this we calculate weights using three- and four-person households for the aggregation of customer information to the grid level.

5.5.3 Data description of the key variables

The descriptive information is summarized in Table 22 in the appendix. The information used in the estimations covers about 600 geographically separated electricity (relevant) markets.

In about 6 percent of all retail electricity markets in our sample network operators and retail incumbents are fully separated (ownership unbundling). In 16 percent, companies are legally unbundled. As there are also voluntary legal separations, we take the number of meter points as a proxy for the number of connected customers, thus, as a proxy for the threshold required for legal unbundling. Therefore, we can distinguish between required legal unbundling and voluntary legal unbundling.⁸⁸ We consider the cases with partial ownership (for example with 70 percent share in DSO) as voluntarily separated, because partial ownership indicates that firms choose to hold stake in DSO without being obliged to separate their activities as they are not fully integrated. These firms might have more than 100,000 meter points (the threshold level for legal unbundling required by the German regulator). About 7 percent of the firms in our sample have more than 100,000 meter points, are legally unbundled but are fully owned by the parent company, so that they were obliged to separate the DSO (required legal unbundling). On the other hand, nearly 9 percent of the firms have voluntarily unbundled. These firms have either more or less customers

⁸⁷ Because of the particular aggregation level of consideration, we have adjusted our data set to the market level instead of zip code level.

⁸⁸ Note that voluntary 'legal unbundling' is not the same as required 'legal unbundling' because in case of voluntary separation, the firms are not obliged to separate the information flows and management.

than the threshold level. If they have more than the threshold, they are not fully owned by the incumbent. In 78 percent of markets, retail incumbents and distribution grid operators are one company, i.e. they are fully integrated and not legally separated. Thus, in these regions the standard contract provider has a strong information advantage over its competitors. It has knowledge of the quantities provided by competitors and, moreover, it knows exactly the customers served by its competitors. Note that we do not consider the ownership direction (who owns whom) because only in 3 cases out of 42, the DSO owns the retail incumbent. Therefore, we neglect the analyses of ownership direction in our estimates.

Turning to dependent variables, we find the standard contract price to be on average 44 Euros more expensive than the incumbent's lowest price offer. However, the lowest price offer of competitors which is comparable to the incumbent offers is on average more than 120 Euros cheaper than the standard contract. Taking into account pre-payment offers, the reduction is about 170 Euros for household customers. In line with the explanations in the Monitoring Report of the German Regulation Authority (Bundesnetzagentur), the distribution charge determines about 26.0 percent of the standard contract price in our sample.

5.6 Econometric model

Due to missing information about company specific incentive schemes and internal information on vertical relations between the grid owner and the retail incumbent, we are unable to fully specify the explanatory equations. However, this latent information might have an effect on both the distribution charges and retail prices as described in the theoretical model. We therefore employ a simultaneous equation model, where the distribution charge enters the standard contract price equation, the incumbent's most competitive contract price equation, and the competitors' lowest price equation. Along with the standard contract price we also consider incumbents' competitive prices to count for effects caused by price discrimination and competitors' prices (the lowest market price) to capture the cross-price effects. These are equilibrium prices. Ownership variables are used as explanatory variables for both the distribution charge equation and the price equations. We use the three stage least squares estimation method because we assume that the error terms correlate across the specified equations due to "shocks" that affect all endogenous variables.

We therefore end up with the following specification:

$$\log(\text{price}_i^{st}) = \text{ownervector}_i \beta_{\text{owners}}^{st} + \text{reg. characteristics}_i \beta_{\text{region}}^{st} + \beta_{dc}^{st} \log(dc_i) + \alpha_i^{st} + \varepsilon_i^{st}$$

$$\log(\text{price}_i^{slow}) = \text{ownervector}_i \beta_{\text{owners}}^{slow} + \text{reg. characteristics}_i \beta_{\text{region}}^{slow} + \beta_{dc}^{slow} \log(dc_i) + \alpha_i^{slow} + \varepsilon_i^{slow}$$

$$\log(\text{price}_i^{lowest}) = \text{ownervector}_i \beta_{\text{owners}}^{lowest} + \text{reg. characteristics}_i \beta_{\text{region}}^{lowest} + \beta_{dc}^{lowest} \log(dc_i) + \alpha_i^{lowest} + \varepsilon_i^{lowest}$$

$$\log(dc_i) = \text{ownervector}_i \beta_{\text{owners}}^{dc} + \text{grid characteristics}_i \beta_{\text{grid}}^{dc} + \text{reg. characteristics}_i \beta_{\text{region}}^{dc} + \alpha_i^{dc} + \varepsilon_i^{dc}$$

We include control variables for grid characteristics and regional characteristics into the distribution charge equation, and control variables to characterize relevant markets in the price equations. Grid characteristics are proxied by grid area, the size of the distribution region, supply density (population divided by grid area) and population density. As some variables for grid characteristics are correlated, we consider only the number of meter points (correlated with grid area) and supply density in our estimations. Regional characteristics include information about customers such as total population and regional purchasing power.

For reasons of comparison, we employ alternative ownership measures and different specifications of the equations. First, we estimate the model including dummy variables for markets with fully separated, fully integrated and legally unbundled incumbents. In the case of legally unbundled firms, we distinguish between required and voluntary legal unbundling (specification A). Second, we take into account the number of competitors which have entered the markets (specification B) because we assume that the number of competitors, which is a proxy for competition intensity, has an impact on market prices.⁸⁹

Furthermore, we distinguish contracts with and without prepayments, i.e. contracts which have or have not to be completely paid in advance, and estimate our model twice including contracts without prepayment and contracts with prepayment as we assume both types of contracts to address alternative customer groups. As the results with regard to our hypotheses do not differ, we only report the results for contracts without prepayment.

There might be concerns about the endogeneity of ownership structure. For example, if the error term captures an important variable that influences the price setting of

⁸⁹ As, for example, used in Bresnahan and Reiss (1991) in the entry game, where the authors consider the price effects depending on the number of competitors.

We also use the share of voluntarily legally unbundled firms to analyse whether the pricing behaviour is affected by the control of the parent company. In contrast to our conjecture (in hypothesis 3) that higher shares might have a stronger influence on prices, we find no significant results and therefore refrain from reporting the estimation results in the article.

firms and at the same time this variable was the driving force for integration or voluntary separation. However, the ownership structure, in particular the integration, of German incumbents are mostly the same as it was before market liberalization. Firms serving less than 100,000 customers were historically integrated and mostly remain integrated. For example, the number of business and industry customers in the area could influence the decision to integrate but do not necessarily affect the retail prices for household customers since these are different markets. The voluntary separation of incumbents with fewer customers than the threshold for the required separation occurred, as we presume, for reasons of taxation or simply for financial separation and regulation. Beside that some of the incumbents merge their network operators to take advantage of economies of scale. We control for that in our estimation by considering the grid characteristics.

5.7 Estimation results and discussion

The estimation results are displayed in Table 23 Table 24 in the appendix. In specification A, we examine the vertical structure ignoring the number of competitors in a market. In contrast, in specification B the number of competitors is taken into account. Full vertical integration is the reference category for the vertical structure dummy variables.

Following the theoretical model in line with *Hypothesis 1*, incumbent contract prices are expected to be lower in markets with ownership separated upstream monopolists compared with markets where the incumbents are vertically integrated. The empirical results support the expectations. Thus, Hypothesis 1 cannot be rejected. The findings suggest that in markets where the downstream incumbent and the DSO are either fully integrated or legally separated, prices for contracts offered by the incumbent are on average higher than in markets with fully separated incumbents.⁹⁰ Nevertheless, the prices for lowest-priced-contracts of competitors in markets with integrated incumbents do not differ from prices in markets with total separation. However, observing these estimation results, it could be concluded that higher incumbent prices in vertical integrated markets indicate non-price discrimination.

Hypothesis 2 - lower incumbent prices in markets with perfectly working legal unbundling - must be rejected because we find no evidence for legal unbundling to be favorable for customers' surplus in terms of retail price. The prices for the standard contract and for incumbents' low-price competitive contracts are not

⁹⁰ In specification B (estimation includes the number of competitors) the coefficient of ownership unbundling in our standard contract price equation is not significant at confidence interval of 95 %. However, the threshold of the p value to be significant at * $p < 0.1$ is just failed. Thus, we argue that the price for incumbent's standard contract is lower in markets with totally separated firms. The findings in specification A and the significance of the coefficient for ownership unbundling in the equation for incumbent's lowest price in specification B enforce our argument.

affected by any regulative unbundling options.⁹¹ One reason might be that major vertically integrated firms which were obliged to legally separate their distribution activities might lease back the network by charging sabotage-conform leasing rates (as argued in Sondergutachten, 2009 of German Monopolies Commission).⁹² The German Federal Network Agency and the Monopolies Commission also complain about the insufficient realization of operational separation of network activities. In addition, the results show that too competitors' prices are not significantly lower in markets with legally unbundled firms. Moreover, we do not observe any price difference in markets with required and voluntarily legal unbundling. In contrast, the alternative *Hypothesis 3* - in the case of imperfect legal unbundling prices do not differ from prices under vertical integration - cannot be rejected because we do not observe any difference in prices between legal unbundling and vertical integration. However, the ownership share has no impact on pricing behavior. According to the theoretical results our empirical findings indicate that legal unbundling does not work perfectly. Therefore, the European Regulators need to force further legal unbundling and, besides the charge regulation, to be aware of possible non-price discrimination effects that arise from imperfect legal unbundling. In particular, we suggest implementing rules that control and standardize the switching process. Furthermore, the Regulators must be sensitive to customers' and competitors' complaints.

Considering the *distribution charges* and the impact of vertical integration, we confirm the results reported by Kwoka (2005) and by Growitsch et al. (2009)⁹³, showing *economies of scale* in distribution network. We find that a marginal increase in the number of meter points (and total distributed electricity) marginally decreases distribution charges for household customers. The vertical structure and regulatory unbundling options, among others, are also used to examine the factors that determine the distribution charges. While we have expected a positive effect of vertical integration on distribution charges due to potential *economies of scope* (retail activity and distribution), we find no support for this argument.⁹⁴ In contrast, in markets with voluntarily legally unbundled electricity providers we find significantly higher distribution charges compared to markets with fully integrated or ownership-unbundled providers. This result provides evidence that potential economies of scope do not decrease distribution charges. The implications are: 1) vertical integration indeed does not provide economies of scope, thus, distribution charges remain unaffected regardless of the vertical structure, and 2) the regulator is not perfectly informed about actual costs. Consequently, if economies of scope in fact exist, this outcome indicates raising rivals' costs, according to Vickers (1995).

⁹¹ Although the lowest market price is significantly negative in voluntary legally unbundled markets, in specification B, the coefficient is negligibly small. Thus, we argue that the prices are de facto equal in case of vertical integration and voluntary legal unbundling.

⁹² See Monopolkommission (2009) p. 94 and also Bundesnetzagentur (2008) Monitoring 2008.

⁹³ See also Filipini (1996) and Piacenza et al. (2009).

⁹⁴ A limitation of the study is that we only consider distribution charges for household customers and disregard distribution charges for industrial customers with real-time.

“Economies of scale [scope] are frequently cited as the major reason to allow shared services and sharing of personnel. In 80% of responding countries, shared services, i.e. services performed by the integrated company for the DSO, are permitted and regulators have access to the underlying contracts. However, in about 4 out of 5 [European] Member States it has not been demonstrated that sharing services leads to lowering costs. It might be interesting for regulators to investigate this area in order to have a clear idea on the benefits of shared services.”⁹⁵.

According to responses to the European Energy Regulators [EREG (2009)] questionnaire, common shared services are IT, legal services, communication, human resources, accounting, and financial services. However, sharing services apparently does not lead to economies of scope. Observing our estimation results, we recommend quantifying potential economies of scope that arise from shared services. Similarly, EREG (2009) argues that “shared services could lead to cross-subsidization and indicates the need to further investigate this issue.”⁹⁶

In line with our previous study (Nikogosian and Veith, 2011) we find a significant impact of distribution charges on standard contract prices. The extension to the incumbent’s low-price competitive contract and competitors’ contracts shows also a significant impact of distribution charges on competitive prices. Comparing the size of distribution charges across the four high voltage zones, we find the highest distribution charges in the Vattenfall area in east Germany. The significant deviation is mainly caused by higher depreciation rates due to network investments during the 1990s.

We find no significant effect of the number of ultimate owners-measure on prices and distribution charge. Considering the outcome for variables representing the demand side in submarkets, we find that lowest-priced-contract prices are higher in regions with a higher *purchasing power*. However, the effect is negligibly small. Furthermore, there is no significant effect on the standard contract price induced by purchasing power. In markets with a higher *population* higher price for standard contract are found. Also in this case the coefficient is close to zero.

As we also consider the number of competitors in distinct markets (in specification B), the results show a significant impact of the number of competitors on market prices. Surprisingly, the effects are opposite for the incumbents and competitors. That is, the competitors’ prices for the lowest-priced-contract are negatively affected by the number of competitors, whereas the incumbents’ prices increase with the number of competitors.

⁹⁵ European Energy Regulators (EREG), 2009 p.9. In this status report of EREG, economies of scale are defined as synergies that arise from sharing services between retail activities and electricity distribution. However, we define these synergies as economies of scope, because retail and distribution are entirely different “products”.

⁹⁶ EREG, 2009 p.15

5.8 Conclusion

We consider the impact of vertical relations on retail and distribution prices in the German electricity sector. According to a recent research, price regulation of an input product in a market with upstream monopolist can only partially prevent discrimination of downstream competitors. In a theoretical model, we show that upstream monopolist with regulated distributed charges prices could use non-price discrimination to increase competitors' marginal costs or to decrease their demand and, thus, affect downstream prices. Legal unbundling is brought forward in political debates as well as in the literature as a regulatory option to prevent non-price discriminatory behavior. Such a regulation could be advantageous because it is less restrictive than ownership unbundling or total separation. However, we show that a lax implementation of legal unbundling can still provide incentives for non-price discrimination.

We test the findings of our theoretical model using firm level data for nearly 600 regional German electricity markets for household customers. We find significant differences in the retail pricing behavior of incumbents based on alternative vertical ownership structures. In markets with fully separated incumbents (equal to ownership unbundling), retail prices for incumbents' contracts are lower than in markets with fully integrated incumbents. Furthermore, we find no evidence for legal unbundling being the preferable regulatory instrument, because prices in markets with legally unbundled firms do not differ from prices in markets with vertically integrated firms. These results show that legal unbundling might not work perfectly because firms could circumvent the rules that ensure independence. To prevent non-price discrimination stricter regulation of legally unbundled incumbents can be implemented.

One shortcoming of our study is that we only focus on pricing aspects in our analysis. In particular, we do not consider any costs or investment aspects which have been brought forward in a range of theoretical articles. Nevertheless, our results provide empirical indications about the role of alternative forms of vertical unbundling regulation and their impact on downstream competition.

5.9 References

- Beard, T.R., Kaserman, D.L., Mayo, J.W., (2001), Regulation, Vertical Integration and Sabotage. *Journal of Industrial Economics* 49(3), 319-333.
- Bolle, F., Breitmoser, Y., (2006), On the Allocative Efficiency of Ownership Unbundling. Discussion paper 255, Europa-Universität Viadrina, Wirtschaftswissenschaftliche Fakultät der Europa-Universität Viadrina.
- BNetzA, (2008), Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen, 2008. Monitoringbericht 2008.
- Copenhagen Economics, (2005), Market opening in network industries: Part ii: Sectoral analysis. Copenhagen Economics for DG Internal Market.
- Cremer, H.; Crémer, J.; Donder, P., (2006), Legal vs Ownership Unbundling in Network Industries. C.E.P.R. Discussion Papers, July 2006.
- Crew, M.; Heyes, A., (2005), Introduction: Environmental Regulation. *Journal of Regulatory Economics* 28(2), 127-128.
- Davies, S.W.; Waddams Price, C., (2007), Does Ownership Unbundling Matter? Evidence from UK Energy Markets. *Intereconomics* 42(6), 297-301.
- De Nooij, M.; Baarsma, B., (2008), "An Ex Ante Welfare Analysis of the Unbundling of the Distribution and Supply Companies in the Dutch Electricity Sector. UNECOM Discussion Paper 2.
- Economides, N., (1998), The Incentive for Non-Price Discrimination by an Input Monopolist. *International Journal of Industrial Organization* 16(3), 271-284.
- ERGEG, (2009), Status Review of DSO Unbundling with Reference to Guidelines of Good Practice on Functional and Informational Unbundling for Distribution System Operators.
- Filippini, M., (1996), Economies of Scale and Utilization in the Swiss Electric Power Distribution Industry. *Applied Economics* 28(5), 543-550.
- Growitsch, C.; Jamasb, T.; Pollitt, M., (2009), Quality of Service, Efficiency, and Scale in Network Industries: An Analysis of European Electricity Distribution. *Applied Economics* 41(20), 2555-2570.
- Höffler, F.; Kranz, S., (2011a), Legal unbundling can be a golden mean between vertical integration and ownership separation. *International Journal of Industrial Organization*. In Press.
- Höffler, F.; Kranz, S., (2011b), Imperfect legal unbundling of monopolistic bottlenecks. *Journal of Regulatory Economics*. 39 (3), pp. 273-292.

- Kroes N., (2007a), Improving Europe's Energy Markets through More Competition. Industrie-Club e.V., Düsseldorf, Germany.
- Kroes N., (2007b), More Competition and Greater Energy Security in the Single European Market for Electricity and Gas. High-Level Workshop on Energy Organised By German Presidency, Berlin, Germany.
- Kwoka, J.E., (2005), Electric Power Distribution: Economies of Scale, Mergers, and Restructuring. *Applied Economics*, Taylor and Francis Journals 37(20), 2373-2386.
- Lee, S.H.; Hamilton, J.H., (1999), Using Market Structure to Regulate a Vertically Integrated Monopolist. *Journal of Regulatory Economics* 15(3), 223-248.
- Mandy, D.; Sappington, D., (2007), Incentives for Sabotage in Vertically Related Industries. *Journal of Regulatory Economics* 31(3), 235-260.
- Monopolkommission, (2009), Strom und Gas: Energiemärkte im Spannungsfeld von Politik und Wettbewerb. Sondergutachten 54, Bonn.
- Mulder, D.; Shestalova, V., (2005), Costs and Benefits of Vertical Separation of the Energy Distribution Industry: the Dutch Case. Mimeo.
- Nemoto, J.; Goto, M., (2004), Technological Externalities and Economies of Vertical Integration in the Electric Utility Industry. *International Journal of Industrial Organization* 22(5), 676-681.
- Nikogosian, V.; Veith, T., (2011), Strategic Pricing and Competition in Retail Electricity Markets. ZEW Centre for European Economic Research, Working Papers.
- Nillesen, P.; Pollitt, M., (2007), The 2001-2003 Electricity Distribution Price Control Review in the Netherlands: Regulatory Process and Consumer Welfare. *Journal of Regulatory Economics* 31(3), 261-287.
- Nillesen, P.; Pollitt, M., (2008), Ownership Unbundling in Electricity Distribution: Empirical Evidence from New Zealand. *Cambridge Working Papers in Economics* 0836.
- Piacenza, M.; Vannoni, D., (2009), Vertical And Horizontal Economies In The Electric Utility Industry: An Integrated Approach. *Annals of Public and Cooperative Economics* 80(3), 431-450.
- Pollitt, M., (2008), The Arguments for and against Ownership Unbundling of Energy Transmission Networks. *Energy Policy* 36(2), 704-713.
- Salies, E., (2008), Mergers in the GB Electricity Market: Effects on Retail Charges. *Applied Economics* 40(11), 1483-1490.
- Salop, C.S.; Scheffman, D.T., (1983), Raising Rivals' Costs. *American Economic Review*, American Economic Association 73(2), 267-271.

Sappington, E. M. D., (2006), On the Merits of Vertical Divestiture. *Review of Industrial Organization* 29(3), 171-191.

Steiner, F., (2001), Regulation, industry structure and performance in the electricity supply industry. *OECD Economic Studies* 32, 143–182.

Vickers, J., (1995), Competition and Regulation in Vertically Related Markets. *The Review of Economic Studies* 62(1), 1-17.

Weisman, D. L., (1995), Regulation and the Vertically Integrated Firm: The case of RBOC Entry into Interlata Long Distance. *Journal of Regulatory Economics* 8(3), 249-266

5.10 Appendix A

Table 22: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
lowest price without prepayment)	572	754.67	26.54	617.88	824.00
lowest incum. price	572	832.18	40.07	680.00	958.44
standard contr. price	572	876.70	42.33	734.60	999.61
Legally Unbundled Required Legal Unbundling	572	0.07	0.26	0	1
Legally Unbundled Voluntary Legal Unbundling	572	0.09	0.29	0	1
Ownership unbundled	572	0.06	0.24	0	1
number of competitors	572	43.83	6.49	12	73
distribution charge	572	228.39	30.01	149.71	314.20
population	572	92407.43	279465.50	947	3410000
purchasing power	572	104.59	81.93	0.24	490.90
population/area	572	2257.82	2202.05	2.97	33220.43
meter points	572	52215.05	164800.10	3	2322236
number of owner of retail incumbent	572	5.46	7.88	1	61
number of owner of DSO	572	5.60	7.87	1	61
hv zone EnBW	572	0.14	0.35	0	1
hv zone TenneT	572	0.41	0.49	0	1
hv zone RWE	572	0.24	0.43	0	1
hv zone Vattenfall	572	0.18	0.39	0	1

Table 23: Estimation results

A) Estimation without the number of competitors					
Prices without prepayment		(1)	(2)	(3)	(4)
		log lowest price	log lowest incum. price	log standard contr. price	log distribution charge
Legally Unbundled	Required Legal Unbundling	0.008 (0.007)	0.012 (0.009)	0.001 (0.009)	-0.029 (0.021)
	Voluntary Legal Unbundling	-0.008 (0.006)	0.005 (0.007)	0.007 (0.007)	0.031* (0.017)
Ownership unbundled		-0.002 (0.007)	-0.018** (0.008)	-0.014* (0.008)	0.002 (0.020)
Log(distribution charge)		0.357*** (0.026)	0.276*** (0.036)	0.249*** (0.036)	
Log(population)		0.000 (0.001)	-0.000 (0.002)	0.006*** (0.002)	
Log(purchasing power)		0.004** (0.002)	0.001 (0.003)	-0.004 (0.003)	
Log(# of owner of retail incumbent)			0.006*** (0.002)	0.009*** (0.002)	
Log(# of owner of DSO)					0.007** (0.003)
log (population/area)					-0.006 (0.004)
log (meter points)					-0.015*** (0.003)
hv zone EnBW					-0.006 (0.023)

<i>(continued)</i>	(1)	(2)	(3)	(4)
hv zone TenneT				0.011 (0.022)
hv zone RWE				0.031 (0.022)
hv zone Vattenfall				0.162*** (0.024)
Constant	4.668*** (0.150)	5.215*** (0.203)	5.373*** (0.203)	5.556*** (0.042)
Observations	572	572	572	572

*, **, *** represent significance at the 10, 5 and 1 percent significance levels, respectively.

Table 24: Estimation results (including the number of competitors)

B) Estimation including the number of competitors					
Prices without prepayment		(1)	(2)	(3)	(4)
		log lowest price)	log lowest incum. price)	log standard contr. price)	log distribution charge)
Legally Unbundled	Required Legal Unbundling	0.009 (0.007)	0.012 (0.009)	-0.000 (0.009)	-0.030 (0.021)
	Voluntary Legal Unbundling	-0.009* (0.006)	0.006 (0.007)	0.009 (0.007)	0.031* (0.017)
Ownership unbundled		-0.003 (0.007)	-0.017** (0.008)	-0.012 (0.008)	0.003 (0.020)
Log(# competitors)		-0.022*** (0.008)	0.019* (0.012)	0.054*** (0.012)	
Log(distribution charge)		0.358*** (0.026)	0.289*** (0.036)	0.282*** (0.036)	
Log(population)		0.001 (0.001)	-0.000 (0.002)	0.005*** (0.002)	
Log(purchasing power)		0.003* (0.002)	0.002 (0.003)	-0.001 (0.003)	
Log(# of owner of retail incumbent)			0.005*** (0.002)	0.008*** (0.002)	
Log(# of owner of DSO)					0.007** (0.003)
Log(population/area)					-0.005 (0.004)
Log(meter points)					-0.015*** (0.003)

<i>(continued)</i>	(1)	(2)	(3)	(4)
hv zone EnBW				0.005 (0.023)
hv zone TenneT				0.008 (0.022)
hv zone RWE				0.027 (0.022)
hv zone Vattenfall				0.162*** (0.024)
Constant	4.747*** (0.157)	5.071*** (0.218)	4.981*** (0.217)	5.554*** (0.042)
Observations	572	572	572	572

*, **, *** represent significance at the 10, 5 and 1 percent significance levels, respectively.

5.11 Appendix B

5.11.1 Mathematical derivations

Equilibrium Prices

Incumbent's profit in case of vertical integration is composed of downstream profit and upstream profit and is given by:

$$\pi_I = (p_I - c_I - c_u)D_I + (d - c_u)D_E - C(s_c, s_d)$$

The demand for one contract offered by incumbent is characterized by the marginal consumer who is willing to buy the contract from the incumbent:

$$D_I = \frac{p_E - p_I + \tau_E}{\tau_I + \tau_E}$$

The demand for the competitor is given by:

$$D_E = 1 + \frac{p_I - p_E - \tau_E}{\tau_I + \tau_E}$$

Given this information we can calculate the equilibrium prices:

$$p_I^* = \frac{1}{3}(3b + 2c_I + c_E + s_c + \tau_I + 2\tau_E)$$

$$p_E^* = \frac{1}{3}(3b + c_I + 2c_E + 2s_c + 2\tau_I + \tau_E)$$

and the profit function before choosing the sabotage strategy:

$$\begin{aligned} \pi_I^* = & \frac{1}{3} \left(\frac{(b - c_u)(c_I - c_E - s_c + 2\tau_I + \tau_E)}{\tau_I + \tau_E} \right. \\ & \left. + \frac{(c_E - c_I + s_c + \tau_I + 2\tau_E)(3b + c_E - c_I - 3c_u + s_c + \tau_I + 2\tau_E)}{3(\tau_I + \tau_E)} \right) - C[s_c, s_e] \end{aligned}$$

Comparative Statics

Lemma 2 is derived from the derivatives of equilibrium prices and equilibrium demand with respect to demand-decreasing sabotage in the last stage i.e. before the sabotage strategy is chosen):

$$\frac{\partial p_E^*}{\partial s_d} = \frac{1}{3} \left(2 \frac{\partial \tau_I}{\partial s_d} + \frac{\partial \tau_E}{\partial s_d} \right)$$

$$\frac{\partial p_I^*}{\partial s_d} = \frac{1}{3} \left(\frac{\partial \tau_I}{\partial s_d} + 2 \frac{\partial \tau_E}{\partial s_d} \right)$$

- a. Demand-decreasing sabotage increases incumbent's downstream price and, at the same time, decreases competitor's downstream price given that our assumptions hold and if

$$\left| \frac{1}{2} \frac{\partial \tau_I}{\partial s_d} \right| < \left| \frac{\partial \tau_E}{\partial s_d} \right| < \left| 2 \frac{\partial \tau_I}{\partial s_d} \right|.$$

- b. increases both equilibrium downstream prices given that our assumptions hold and if $\left| \frac{\partial \tau_E}{\partial s_d} \right| > \left| 2 \frac{\partial \tau_I}{\partial s_d} \right|$, i.e. competitor's price is

very sensitive to changes in own transportation cost compared to the effect on incumbent's transportation cost,

- c. vice versa, decreases both equilibrium downstream prices given that our assumptions hold and if $\left| \frac{\partial \tau_E}{\partial s_d} \right| < \left| \frac{1}{2} \frac{\partial \tau_I}{\partial s_d} \right|$,

$$\frac{dD_E^*}{ds_d} = \frac{(c_E - c_I + s_c + \tau_E) \frac{\partial \tau_I}{\partial s_d} + (c_E - c_I + s_c - \tau_I) \frac{\partial \tau_E}{\partial s_d}}{3(\tau_I + \tau_E)^2} = - \frac{dD_I^*}{ds_d}$$

- a. Demand-reducing sabotage increases incumbent's equilibrium demand $\frac{dD_I^*}{ds_d} > 0$ and decreases competitor's equilibrium demand $\frac{dD_E^*}{ds_d} < 0$ given that our assumptions hold and

$(c_I - c_E - s_c + \tau_I) \frac{\partial \tau_E}{\partial s_d} > (c_E - c_I + s_c + \tau_E) \frac{\partial \tau_I}{\partial s_d}$. This inequality is true when the companies are comparably efficient, $c_d \approx c_e$, and incumbent's transportation cost is lower than the competitor's sabotage cost, $\tau_I \geq s_c$.

5.11.2 Imperfect legal unbundling

Assuming perfect legal unbundling in our theoretical model in Section IV eliminates the grid operator's legal dependence of the retail incumbent. Consequently, the grid operator ignores the downstream effect of its strategic decisions and, thus, has no incentive to act in favor of its retail parent firm. However, according to the special report Sondergutachten 2009)) of the German Monopolies Commission on issues in German energy markets, the dependence of former vertically integrated operators remains strong even with legal unbundling. In particular, it is stated that upstream management decisions seem to be influenced by requirements of the retail incumbent.

To illustrate how such a manipulation could work, we take this imperfect legal unbundling situation into account by adjusting our model as follows:

Again, assume that the legally unbundled grid operator considers only its grid activity and maximizes the upstream profit, whereas the downstream incumbent fully or partially owns the grid operator, $\lambda \in]0,1]$, and aims at maximizing the overall profit $\pi_I \equiv \pi_{ID} + \lambda \pi_{IU}$. A fraction λ of upstream gains is transferred to the downstream incumbent.

Modeling the internal dependence, we assume that the downstream firm owning the network, but forced to legal unbundling, might lease the network to upstream subsidiary by charging a particular leasing rate r_u which is a function of the network costs. In addition, assume that this leasing rate is also affected by the sabotage strategy of the upstream, $r_u(c_u, S(s_c, s_d))$, but in contrast to regular costs that emerge from operating the network, engaging in sabotage in upstream lowers the leasing rate, $\frac{\partial r_u}{\partial s_i} < 0$ with $i = c, d$, and $r_u \in [r_u^-(c_u, \bar{S}(s_c, s_d)), \bar{r}_u(c_u, 0)]$. In contrast, the sabotage strategy of the upstream affiliate, $S(s_c(r_u), s_d(r_u))$ depends on the leasing rate r_u to be paid to parent company. This setting or the internal structure is based on principal-agent problem with the landlord incumbent) as the principal and the tenant DSO) as the agent.

In addition, assuming that the incumbent first sets the boundaries or a schedule) for the leasing rate $r_u \in [\underline{r}_u, \bar{r}_u]$ and afterwards the upstream affiliate chooses the sabotage level and the corresponding leasing rate, respectively. Given our assumptions, this setting enables the incumbent to influence decisions in upstream even though the upstream firm is legally separated. Now, we slightly change the profit functions faced by the upstream subsidiary and the downstream incumbent:

$$\begin{aligned}\pi_{IU} &\equiv (b - r_u)(D_e + D_d) - C(s_c, s_d) \\ \pi_I &\equiv \pi_{ID} + \lambda\pi_{IU} = (p_I - c_I - b)D_I + (r_u - c_u)(D_E + D_I) + \lambda((b - r_u)(D_E + D_I) - C(s_c, s_d))\end{aligned}$$

In the equilibrium the affiliate will always set the sabotage level that corresponds to the lower bound of the leasing rate because the lower the leasing rate, the higher the upstream profit, $\pi_{IU}(S^*(s_c(r_u^*), s_d(r_u^*)) = \bar{S}, r_u^* = \underline{r}_u) \geq \pi_{IU}(\tilde{S}(s_c(\tilde{r}_u), s_d(\tilde{r}_u)) \neq \bar{S}, \tilde{r}_u \neq \underline{r}_u)$. Deviation to a lower sabotage level would induce a higher leasing rate and is therefore not the optimal decision. Without engaging in sabotage the upstream firm receives 0 upstream profits, $\pi_{IU} \equiv (b - \bar{r}_u)(D_e + D_d) - 0 = 0$.

In case we have the limit $\lambda \rightarrow 1$, the incumbent's overall profit collapses to:

$\pi_{ID} + \lambda\pi_{IU} = (p_I - c_I - b)D_I + (b - c_u)(D_E + D_I) - C(s_c, s_d)$, which is exactly our initial objective profit function. Moreover, in this case r_u acts as a steering tool for upstream affiliate but has no direct impact on upstream profit in incumbent's objective function.

Proposition 3: Incentive to sabotage increases in ownership share λ of downstream incumbent on upstream affiliate. The DSO will undertake sabotage because there exist a subgame-perfect equilibrium with r_u^*, S^* ,

$$\begin{aligned}\pi_{ID}(r_u^*(c_u, S^*)) &\geq \pi_{ID}(\tilde{r}_u(c_u, \tilde{S})) \geq \pi_{ID}(\bar{r}_u(c_u, 0)) \text{ and} \\ \pi_{IU}(S^*(s_c(r_u^*), s_d(r_u^*))) &\geq \pi_{IU}(\tilde{S}(s_c(\tilde{r}_u), s_d(\tilde{r}_u))) \geq \pi_{IU}(S(s_c(\bar{r}) = 0, s_d(\bar{r}_u) = 0))\end{aligned}$$

that maximize firms' objective functions.

Proof⁹⁷: In this case, the outcome is obvious because $S^*(s_c, s_d)$ with $s_c \vee s_d \neq 0$ maximizes the incumbent's profit function as already derived in prop 1. This implies that the downstream incumbent will set the corresponding lower bound for the

⁹⁷ See also Höffler and Kranz (2011b)

leasing rate to $r_u^* = \underline{r}_u \leq \bar{r}_u$. Accordingly, the upstream firm maximizes the profit by undertaking sabotage as long as the gain from lower leasing rate corresponding to sabotage level exceeds sabotage costs so that $\pi_{IU}(S^*(s_c(r_u^*), s_d(r_u^*))) \geq \pi_{IU}(S(s_c(\bar{r}) = 0, s_d(\bar{r}_u) = 0))$ with $s_c \vee s_d \neq 0$.

Considering two different ownership shares λ_a and λ_b with $\lambda_a < \lambda_b$, in which p_I^b and r_u^b (p_I^a and r_u^a) denote downstream incumbent's optimal choice given (λ_b, λ_a) . S denotes the optimal sabotage strategy given the market share. DSO's optimal choice implies:

$$\begin{aligned} \pi_{ID}(p_I^a, r_u^a(S^a)) + \lambda_a \pi_{IU}(S^a(r_u^a)) &\geq \pi_{ID}(p_I^b, r_u^b(S^b)) + \lambda_a \pi_{IU}(S^b(r_u^b)) \\ \pi_{ID}(p_I^b, r_u^b(S^b)) + \lambda_b \pi_{IU}(S^b(r_u^b)) &\geq \pi_{ID}(p_I^a, r_u^a(S^a)) + \lambda_b \pi_{IU}(S^a(r_u^a)) \end{aligned}$$

Adding the two inequalities and dividing by $(\lambda_b - \lambda_a)$, we find that $\pi_{IU}(S^b(r_u^b)) \geq \pi_{IU}(S^a(r_u^a))$. Because upstream profit increases with lower leasing rates and higher sabotage levels, this result implies that sabotage is increasing in ownership share.

The intuition for this finding is obvious: The higher the ownership share, the higher the share of downstream firm receiving upstream profit. This profit, in turn, covers the losses that arise from lowering \underline{r}_u . In limit, $\lambda \rightarrow 1$, this leasing rate is an internal transfer to rise upstream's sabotage incentives. In contrast, lower ownership share only partially covers the losses from lower leasing rate. This outcome is in line with our assumption that the network is strictly regulated, $d \approx c_u$. Consequently, equilibrium leasing rate r_u^* might be even less than the network costs c_u .

6 SUMMARY

After the liberalization of energy markets in Germany in the 1990s, many municipalities have sold their shares in local or regional electricity providers to private owners in order to reduce budget deficits. Recently, it has been observed that several of the sold assets are repurchased. Proponents of 'public' repurchasing justify this step with a safe and cheap provision of energy for consumers. In the first study the question is whether ownership type (private vs. public) has an impact on providers' price setting. For this reason, we consider the ownership structure of electricity providers in Germany. Particularly, firm-level data of electricity incumbent providers in retail markets for household customers and of the monopolistic distribution grid operators have been employed to analyze ownership effects.

The statistics show that the majority of public and private owners try to reach full ownership of the provider and the grid operator. Considering the ownership concentration (in terms of the number of owners and their shares) across all regional German submarkets shows a lower public involvement among Eastern German utility providers and common carriers, which is to the most part due to the structural change in ownership during German Democratic Republic times.

In the empirical analysis a multivariate approach has been used to show the impact of ownership on the price setting behavior of the local incumbents. While no significant difference of the impact of public or private owners on the price setting is found, a higher ownership concentration, i.e., small number of owners with high shares in a firm, causes significantly lower prices. Following the Corporate Governance literature, owners with a high share in a company seek long-term performance goals. Owners with a low share are, on the other hand, interested in short-term profit objectives. Energy providers with a higher ownership concentration therefore choose lower prices for utility contracts in order to retain customers. In contrast, higher prices enable in a short-term higher profits for owners. Furthermore, regulated distribution charges are not affected by ownership concentration, which is mainly attributable to the target-aiming regulation.

These results contradict the standard opinion of differences in ownership types: While proponents of more public engagement in local energy supply repeatedly put forward that customers benefit from lower prices, among others, the empirical results show no significant price differences between public and private ownership. Instead, the ownership concentration can be seen as a key aspect for price setting.

Since the liberalization of the electricity market a large number of new providers has entered former monopolistic local markets for residential customers. However, only a low share of households in Germany has switched to a new supplier. Following the report of the German Regulation Authority, Bundesnetzagentur (2008), about 60 percent of households have not switched to an alternative contract or supplier, even several years after the liberalization. These households are served with incumbents'

standard (basic) contracts, the so-called “Grundversorgungsverträge”. This contract is a “fallback” for customers who decide to switch to an alternative contract. They automatically return to the standard contract either if their new provider leaves the market, or if their contract is cancelled by the supplier and customers have not decided which supplier to switch to (§§ 36 – 38, German Energy Industry Act, EnWG). Customers that have not switched their contract after the markets have been liberalized are also served under this contract. Usually, standard contracts are offered at significantly higher prices than competitive contracts due to customers’ switching costs. The question is how incumbents’ standard contract prices or the price-cost markups could be used to influence market structure, in terms of market entry.

Following the ‘Limit Pricing’ theory, a theoretical model shows that also the standard contract price level can affect the entry decision of potential competitors in retail electricity markets. In the benchmark case where market entry occurs and an incumbent then competes, it asks for higher standard contract prices and higher competitive contract prices than competitors. With a lower standard contract price, customers are less willing to switch and, additionally, it becomes more difficult for competitors to undercut the standard contract price. Under particular demand conditions depending on price elasticity this pricing strategy can prevent market entry and, thus, can be profitable for an incumbent.

To test the theoretical findings, firm-level data for German electricity markets for three different household consumption levels (one-, two- and four-person households), which differ in their relative switching costs and the likelihood of switching suppliers, have been employed. The empirical simultaneous equations approach has been applied for this analysis. The results show that the markup of a standard contract price over distribution charges has a significant positive effect mainly on the number of contracts offered in particular local sub market. In contrast, the effects on the number of providers are ambiguous. For a customer group, namely one-person households, which compared to other groups have the highest relative switching costs, we could confirm our theoretical findings. Thus, the number of competitors is significantly lower in markets in which the markup for the standard contract is low. Obviously, in this case further market entry for competitors is not profitable. In contrast, for other customer groups the hypothesis that lower markup prevents market entry can be rejected. These results show that incumbents try to divide the market into different market segments and engage in price discrimination. Two-part tariffs, as used for the standard contracts, allow the incumbents to target specific groups, meaning standard contracts for lower consumption levels and competitive contracts for higher consumption levels. Therefore, to increase competition also for the customer group with low consumption, instruments have to be implemented that reduce switching costs and reduce information asymmetries across customers for offered alternative contracts.

However, in contrast to residential electricity markets, the entry of newcomers in residential gas markets is less frequently observed. One of the key reasons can be seen in difficulties in purchasing gas on the wholesale market and in transporting it from one market area to another within Germany. For newcomers gas imports to Germany are de facto unrealizable due to pipeline capacity constraints at the border. These pipelines are operated by gas importing firms, which maintain long term contracts with foreign gas producers. About 90 percent of total consumption is imported by 5 major importing firms. Two of those, E.on and RWE, are extensively forward integrated with retail incumbents, in particular downstream sub markets. To preserve downstream subsidiaries' profits, natural gas importers - upstream incumbents - have the incentive to protect their downstream markets from upcoming competition, since in markets for household customers market entry induces business stealing rather than market expansion. For importers it might be possible to hurt newcomers by limited availability of gas in the wholesale market which is caused by limited foreign purchasing sources and restrained transportation capacities, not only at the German border but also within Germany.

To analyze possible vertical integration issues empirically, the structural market entry framework of Bresnahan and Reiss (1991), which reveals how competition and firms' performance change with market entry, has been applied by using firm-level data for about 500 natural gas sub markets for household customers (for September 2009). For this purpose ownership and market entry data were merged, and market and consumer characteristics were taken into account. Controlling for local market areas within Germany, each with their own wholesale market, allows the identification of the retail markets in which entry is unlikely, for example, due to vertical integration and wholesale liquidity issues.

The results of the empirical analyses show that in a few downstream markets in which E.on has a self-operated subsidiary the number of newcomers is small compared with other markets. In contrast, there are other downstream markets, for example with the downstream incumbent E.on Edis, in which the number of newcomers is high. In sum, the analysis does not show clear evidence that market entry is restricted by vertical integration of gas importers and downstream incumbents. Therefore, the conclusion is that the decision of the Federal Cartel Office to repeal the prohibition of further ownership integration in 2010 was appropriate.

Likewise, vertical integration of monopolistic electricity distribution network operators and electricity suppliers is a key issue in European energy markets, in particular since the European Competition Commission has initiated a sector inquiry in 2005. The European Commission argues that vertical separation of electricity networks from other activities (such as electricity generation and retail) increases consumer surplus, while opponents argue that vertical integration enables cost savings due to economies of scope. The European Competition Commission also indicates the disadvantage of vertical integration for retail customers caused by potential

discrimination of competitors. Aiming at preventing discrimination the EC suggests alternative regulatory approaches to overcome the challenge of vertical integration. 'Legal unbundling', as an intermediate approach between ownership unbundling and vertical integration, describes a particular type of separation of network and retail activities. In this case, the regulation requires legal separation of the electricity network unit from the retail/production and the operation of the network by independent management.

The introduced theoretical model shows that the integrated, monopolistic network operator might have an incentive to favor its own downstream unit over competitors. In the model demand decreasing and cost increasing non-price discrimination of competitors have been distinguished. Delaying supplier-switching or withholding important information from competitors are examples for such types of non-price discrimination. This discriminatory behavior affects the retail prices. Therefore, consumers might be worse off if the distribution network operator and the downstream retail incumbent remain vertically integrated. Further analysis of the effects that arise from introducing legal unbundling, as already implemented in several European Countries, has been conducted theoretically. In line with other studies, the theoretical results show the legal unbundling regime to be favorable if it works perfectly, i.e. can indeed prevent non-price discrimination.

To test the hypotheses derived from the theoretical model, as also in former analyses, cross-sectional firm-level data for geographically separated electricity markets for household customers in Germany (for September 2008) have been used. The extremely heterogeneous ownership structures across the large number of German electricity markets for residential customers (there exist legally unbundled, vertically integrated or fully separated firms), allow the empirical analysis of the effects of different vertical structures and regulation schemes on retail electricity prices. The estimation results provide evidence for the theoretical findings as prices are significantly higher in markets with vertically integrated firms compared to markets with fully separated firms. This finding could indicate non-price discrimination, which has negative effect on consumer surplus, in markets with vertically integrated firms. Furthermore, no evidence could be provided that the partly implemented legal unbundling eliminates the incentives for non-price discrimination because the prices do not differ from prices in markets under the vertical integration regime. Therefore, we suggest implementing stricter rules for legal unbundling to prevent potential discrimination against competitors.