Firm dynamics and competition in the electricity market

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Abstract

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This thesis consists of four independent essays that deal with the firm dynamics and competition in the electricity market. Specifically, it addresses two important facets of firm dynamics, namely, firm performance (growth and profitability) and the change in competition intensity that Swedish electricity firms face, brought by the process of deregulation in Swedish electricity market.

Essay 1 investigates whether Gibrat's law holds for individual firms. The results support the claim that Gibrat's law is more likely to be rejected ex ante when an entire firm population is considered, but more likely to be confirmed ex post after market selection has "cleaned" the original population of firms or when the analysis treats more disaggregated data.

Essay 2 examines the determinants of firm growth in the Swedish electricity sector. The results indicate that large firms do not grow faster than do other firms in the sector, and that electricity firms' internal resources are indeed the key determinants of firm growth in the Swedish electricity industry.

Essay 3 shows that although multi-plant firms are more prevalent than single-plants firms in industries characterized by scale economies and imperfect competition, multi-plant electricity firms on average have a one percentage-point lower return on total asset than their single-plant counterparts as they reach a 'steady state' firm size when an optimal size is identified. The potential reasons could be loss of control across hierarchical levels within multi-plant firms or the adaption to technological changes lag behind in comparison to single–plant firms.

Essay 4 compare competition intensity before and after the launch of Internet electricity price comparison sites (IEPCS). The heterogeneous effects on competition intensity are found, with the largest effect on competition found in parts of the market that were already characterized by high levels of competition before the launch of IEPCS.

Keywords: Firm growth, profitability, steady-state, market power, competition, Boone indicator.

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With Love,
Aili

Örebro, April 2018

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1 Introduction

Over the last 20 years, electricity markets around the world have experienced rapid restructuring. Two noticeable trends are the liberalization of electricity markets and the establishment of power exchange markets. Another trend is the integration of different geographical electricity markets. In addition to Europe, restructuring processes are ongoing in a number of places around the world, e.g., in the United States, Australia and New Zealand (Lundgren, 2011). Despite the long process of deregulation, a proper understanding of the overall health of the deregulated electricity markets and the potential underlying problems remain to be solved; this is imperative because efficient and reliable electricity markets are related to both important social functions and industrial processes.

Sweden has reformed its electricity sectors and today has access to a common electricity market consisting of two parts: (1) bilateral trade of contracts between operators; and (2) the non-mandatory power exchange at the multinational electric power exchange, Nord Pool. With these reforms in mind, it is natural to ask whether they have been successful: Specifically, has the common electricity market increased competition in the market or not? Moreover, since there was a stepwise evolution towards a largely deregulated electricity market, we should also ask how the degree of market power has evolved during this integration process.

Although there exists a fairly extensive body of literature analyzing electricity markets since the start of deregulation, most academic studies in the Swedish context are focused on price determination (e.g., Amundsen and Bergman (2006); Hellström et al. (2012) and market power assessment (e.g.,Vassilopoulos (2003); Bask et al. (2011)), whereas the public reports may reflect whether the electricity market fits the overall liberalization goals. The papers in this thesis contribute to the existing literature by addressing the questions with a direct investigation of firm dynamics in the electricity market. We consider this to be particularly relevant for understanding the electricity industrial process, considering the special firm features of the market (e.g., high entry barriers, high capital cost, and the importance of the technology component on production). In addition, this thesis may provide a different perspective on how to better implement policies or regulations in the electricity market by taking firm dynamics into account.

There are studies of firm dynamics from various perspectives in the economic literature; however, these studies mainly focus on the manufacturing sector and more recently on the service sector. This thesis consists of four essays on firm dynamics in the Swedish electricity market. All four essays are empirical studies employing econometric models to evaluate relevant topics from a micro-foundation.

Specifically, it addresses two important facets of firm dynamics, namely, firm performance (growth and profitability) and the change in competition intensity that Swedish electricity firms face, brought on by the process of deregulation in the Swedish electricity market.

The objective of this introductory chapter is to systematically organize the thesis and provide an overview of the Swedish electricity market and firms. The introduction is structured as follows: Section 1 gives a brief account of the background research in a changing Swedish electricity market. Section 2 gives a short overview of the reform of the Swedish electricity market as background information for the empirical studies. Section 3 describes the data used in the studies. Section 4 concerns the most important empirical tools used in the four essays. Section 5 gives summaries of the five papers included in this thesis. Finally, section 5 concludes the main findings of each essay and outlines the policy implications of the studies.

2 Reform in the Swedish electricity market

Before 1996, the Swedish electricity market was regulated, characterized by vertically integrated monopolies active in local markets. These local monopolies were active in all parts of the electricity market, producing electric power, selling electricity to private customers and firms, and running the distribution network. The vertical integration also meant that retailers mostly bought the electricity they sold to their customers from the vertically integrated local power generator. Prices were indirectly regulated through the state ownership of Vattenfall[1] and the requirements of its pricing formula. Vattenfall was required to apply a pricing formula that could, according to Lundgren (2013), be seen as marginal cost pricing subject to a rate of return requirement and a budget constraint. The formal objective of Vattenfall's use of this formula was to break even, and the formula also established Vattenfall as the price leader in the Swedish energy market. Moreover, prior to deregulation, the electricity market was divided into high- and low-voltage markets. The high volt-age market was a market mainly for large industries and retail distributors of elec-tricity, while the low-voltage market was mainly for households (Bergman et al., 1994). Prior to deregulation, consumers in the low-voltage market could not change suppliers even if they wanted to. As reliable access to electricity at an affordable cost is vital to welfare in today's society, providing more efficient allocation of this

[1]The national electricity market in Sweden for a long time was formerly dominated by a state-owned 'national champion', Vattenfall, with a market share of more than 50%.

essential service (electricity) and designing and implementing electricity market reform was an urgent matter in Sweden.

Following a strong push for changes in the electricity markets, in 1996, the Swedish electricity market was deregulated to create a well-functioning electricity market with competition in electric power production and retail. Distribution remained a local monopoly, but third-party access[2] was introduced. Legal unbundling between electricity production and distribution was also introduced to encourage competition. The purpose of exposing electricity production and retail to competition is to increase the choices available to consumers and to create conditions for an effective use of production resources. To spur additional competition in the electric power market, collaboration with Norway in the Nord Pool power exchange market occurred in 1996. Nord Pool provides a formal marketplace in which the price of power is determined, meaning that the participating countries' power generators had to compete with generators throughout the Nord Pool area instead of acting as monopolists in their own local markets. Finland and Denmark entered Nord Pool in 1998 and 2000, respectively; since then, Nord Pool has continued to grow and today includes collaboration with Germany, the Netherlands, Poland, and the Baltic states. The pricing principle in the Nord Pool spot market is a single-price, double-auction model in which the price is set hour by the hour based on the intersection of demand and supply bids, at the marginal cost of the marginal bid, i.e., the bid that clears the market. Assuming that no one firm can exercise market power, this pricing principle is efficient, although it allows efficient firms with a low marginal cost of production to earn profits. According to the Energy Market Inspectorate (2015), by the year 2015 Sweden was a uniform price area 86 percent of the time, and overall, price differences existed between northern and southern Sweden for just over 7 percent of the time. Price differences arise mainly during periods of transmission congestion or a loss of production.

In overall terms, one of the main aims of the deregulation and integration of the electricity market in Sweden, was to introduce competition to the market to the benefit of consumers. Traditionally organized electricity markets were believed to have incurred higher costs than were actually necessary, and those costs were able to be passed on to consumers. However, in a more competitive market, companies

[2]According to European legislation (Directive 2009/72/EC), third-party access means that independent enterprises or legal persons that operate in the electricity sector have a legal enforceable right to access and use electricity network facilities which are owned by other companies. That means that a third-party alien to the network has the right to access and use the infrastructure built by another company, whereas the owner of the network cannot prevent the third-party to access his network. Hence, third-party access is fundamental in facilitating greater competition and making energy markets work effectively.

have to seek out and respond to the needs of their customers, with no guarantee that they can recover the costs of bad decisions. The market is also open to new firms with creative ideas. Under these competitive market conditions, electricity firms are provided with incentives to improve their operating and investment efficiency, and eventually to ensure that consumers benefit from the resultant gains. Nevertheless, it is difficult to predict all of the consequences that can arise from introducing competition in a market which for a very long has been a regulated monopoly.

On the other hand, it is hard to assess how rapidly deregulation should be implemented. Excessive deregulation all at once can lead to undesired effects due to market operators lacking sufficient time to adjust to the new environment. Another observation is that after deregulation, special measures are often required to stimulate competition. Finally, the time between policy decisions regarding deregulation and their implementation in the electricity market could have been perceived by many electricity firms and customers as being insufficient for them to prepare for the new market environment.

Additionally, it should also be noted that, in order to evaluate how the adjustment to the process of deregulation and the introduction of competition has unfolded in the electricity market, we should take the characteristics of the market into account. Specifically, we should consider whether the electricity market has inherent characteristics that may make it prone to maintaining market power. There is an extensive body of literature that identifies the particular characteristics of electricity markets (e.g., Jamasb (2002); Joskow (2003); Newbery (2002) and Pollitt (2009)). Electricity markets are in general characterized by the following qualities: (1) Investments in electricity generation that are often large and can thus act as an entry barrier. (2) The electricity sector is a network industry with a strong physical dependence between the vertical segments in the market. This is transparent because the consumers and producers need to be connected to the same infrastructure – the electric grid. (3) There is at present no economically feasible way of storing electricity, thus demand and supply must equate in real time. (4) The relatively low (in absolute value) short-term price elasticity of demand. This is often mentioned as an important characteristic of the electricity market. Clearly, these characteristics affect the conclusions of the studies regarding the success or failure of the deregulation process of the Swedish electricity market.

Therefore, to draw broad conclusions from the points above, a final evaluation of the effects of the reform should not be made until after a relatively long period has elapsed. There are clear arguments for evaluating the effectiveness of the reform in the electricity market in the long run, taking firm heterogeneity into account.

3 Data

This thesis uses firm-level data on Swedish limited liability firms. All limited liability firms in Sweden are required to submit annual reports to the Swedish Patent and Registration Office (PRV). The reports are then compiled by PAR, a private consultancy firm, and used for research purposes and by decision makers in Swedish commercial life. The strengths of the dataset are its sample coverage and reliability of information. The annual report data contain comprehensive information on firms' economic performance, such as firms' revenues, profit measures, and various cost measures. To get access to the information regarding the geographical location of each electricity firm, the dataset from PAR is merged with detailed information originating from the Statistics Sweden business register, with firm characteristics appended through a unique identification code. Furthermore, firm activities are specified by the branch of industry at the 5-digit level according the European Union's NACE Classification system.

Furthermore, apart from the annual reports data provided by PAR and the information on firms from the Statistic Sweden business register; regional statistical data are also utilized. Since the firm's location is known at the municipal level for each firm and each year, the characteristics of the municipality where the firm is located at the end of each calendar year can be determined. Most of these municipal characteristics, e.g., population size, population density, educational level, are retrieved from Statistics Sweden. The data compiling processes resulted in a data set covering all Swedish electricity firms (i.e., having the NACE-2007 code of 35100 and engaging in production of electricity, transmission of electricity, distribution of electricity and trade of electricity) active at some point during the period 1997-2011, yielding a total of 18,137 firm years for 2,185 electricity firms.

4 Methodological considerations and applied measurements

The past few decades have witnessed substantial progress in empirical research into various aspects of firm dynamics. This occurred for two particular reasons. First, datasets documenting economic activities are growing much more detailed in sample size and availability. Second, the development of econometric techniques favoring empirical research have at the same time kept pace with those more informative data sets. Many complicated issues arise, including endogeneity, unobserved heterogeneity and sample selection bias. Regarding the Swedish electricity market, in addition to the special features (e.g., high entry cost; high Minimum Efficient

Scale (MES)) of the electricity market, the difficulty is also compounded by the comprehensive and somewhat skewed nature of the statistics. This can make conventional regression strategies developed to analyze the average impact on the average effect misleading, and make it difficult to conceptualize the different parts of the electricity market. Hence, the type of regression models selected should fundamentally depend on the research question and choice of measurements considering that electricity firms are heterogeneous and differ along numerous dimensions. The traditional OLS regression is the most basic model and is applied as a starting point or for the purpose of robustness checks.

In essay [1], I assess whether Gibrat's law holds in the Swedish electricity market. The law holds if the proportional change in the size of a firm is independent of its absolute size. An implication of this is that large and small firms have the same average proportionate rates of growth. According to early literature (e.g., Audretsch et al., 2004), small firms might have a higher exit rate in a capital-intense industry characterized by economies of scale and high sunk costs, implying that small surviving firms should be characterized by higher growth rates than large firms. Because electricity markets are characterized by exactly those features, it is appropriate to study whether Gibrat's law holds in this setting. Earlier studies of the growth of firms up to the early 1950's have found evidence to support the law, while more recent studies show the law has ceased to hold true and small firms are growing at a significantly faster proportional rate than large firms. There are also studies that provide the opposite evidence, which indicates that if concentration has been increasing in an industry over a long period, Gibrat's law with all its implications can hold. In the context of the Swedish electricity market, if this trend continues to hold even after a long period of deregulation, those electricity firms may eventually gain excessive market power. Following Mansfield (1962), we test if Gibrat's law holds in three groups to overcome the potential selection bias in the estimation, i.e., all firms, surviving firms, and firms exceeding MES during the study period. In addition to using traditional OLS estimation to facilitate comparison with pervious results, a random coefficient model is applied to identify whether specific electricity firms achieves a 'steady state', which indicates that the firm growth for this individual electricity firm is constant. In addition, the choice of the growth indicator is important, and both the number of employees and revenues are used to check the robustness of the results, since they are the most commonly used indicators of firm growth in the literature.

Based on the findings of the first essay, we consider that the standard OLS estimation only provides a partial picture of the relationship, as the results from essay [1] show that Gibrat's law does not hold on average for the Swedish electricity market, i.e., small electricity firms on average grow faster than do large electricity firms.

These results are generally in accordance with those of most previous studies rejecting the law at the industry level. Meanwhile, the results from the estimation of random-coefficient models at the firm level provide a different picture, as approximately 70% of Swedish electricity firms experience random fluctuations in size, indicating that their firm growth complies with Gibrat's law.

Moreover, even if standard linear regression techniques summarize the average relationship between a set of regressors and the outcome variable based on the conditional mean function, we might still be interested in describing the relationship at different points in the conditional distribution of certain indexes, such as the determination of firm growth in essay [1] and the change of competition status in different parts of the Swedish electricity market in essay [2]. Quantile regression (QR) provides just such a capability. First, QR allows us to take account of possible heterogeneity across firm growth rates that is not captured by industry-level covariates. Second, a potential shortcoming of OLS in this context is its sensitivity to deviations in the error term from the normality assumption. Previous studies of firm growth rates have demonstrated that growth rates often follow a distribution that is more fat-tailed than normal, and we expect this to be the case for our data as well. Furthermore, it is unlikely that all electricity firms will cope with changes to market conditions in the same way. A quantile regression technique is thus utilized in both essay [2] and essay [4] to go beyond the 'average effect' and examine the potential heterogeneous effects of the independent variables on the measures of firm growth and competition over the distribution of those two dependent variables.

Additionally, it has to be mentioned that one general research purpose of all the essays in this thesis is to consider the heterogeneity of firms. In other words, we consider that firms differ from each other with respect to their internal characteristics and with respect to the characteristics of the industrial and geographic environment in which firms operate. Not all these characteristics can be captured by conventional statistics or indexes employed in this thesis. The unobserved characteristics of firms might then bias the results of the empirical estimations if not controlled for with appropriate statistical techniques. Considerations concerning the unobserved heterogeneity of firms, and other methodological issues related to the estimation strategies dealt with in the individual papers are exploited in each essay. Hence, the inclusion of firm-specific indicator variables in the empirical models is adopted in essay [2], essay [3] and essay [4]. We took into consideration that previous empirical studies on firm performance commonly report that very little of the variation therein is actually explained by conventional factors such as firm size, firm age or characteristics of the region where firm is located (e.g., Geroski, 1995). The most commonly recognized reason is that there is a strong idiosyncratic component in the growth process, related to the base of resources that the firms dispose with

(Penrose, 1959). These idiosyncratic resources are, however, very difficult to measure empirically. The firm-specific indicator variables included in the empirical models of the abovementioned essays are expected to capture these effects of the idiosyncratic resources, given that the unobserved firm-specific heterogeneity is constant over time.

Essay [3] empirically examines whether firms with a multi-plant structure are more profitable than their single-plant counterparts, as predicted by classic economic theory. It adopts a factor in the empirical model which can be reinterpreted to accommodate both the firm structure and the equilibrium of growth, i.e., whether a firm owns more than one plant and reaches 'steady-state' firm size. Finding that the profit measured by return to assets is lower for multi-plant firms, reaching `steady state' suggests that it is important when delving deeper into which factors determine firm profitability, as there is an apparent trade-off between the benefits of having a hierarchical structure and the additional governance costs associated therewith.

Differences-in-Differences (DiD) estimation has become an increasingly popular way to identify the effects of policy implementation or intervention in economics, since the method can remove biases in post-intervention period comparisons between the treatment and control group (that could result from permanent differences between those groups) as well as biases from comparisons over time in the treatment group (that could be the result of trends due to other causes of the outcome). In the field of applied work, the method can be used as a test-bedding of institutional arrangements for the solution to relevant problems. In essay [4], the launch of Internet Electricity Price Comparison Sites (IEPCS) is taken as an intervention combined with the quantile treatment estimator to identify the heterogeneous connecting effects on competition that electricity firms face. A theoretically robust measure of competition, relative profit differences (RPD) is adopted as an outcome variable in order for estimation to avoid the potential theoretical inconsistency of competition measures such as PMC.

Finally, there is one important aspect of the work that should be noted. It seems that regardless of which aspect of firm dynamics is examined, only a small part of the outcome variation is explained using business statistics and utilizing statistical methods, as with those adopted in essays [1]-[4]. Moreover, the explained variation might mainly be attributed to individual firms' characteristics, such as firm age and firm size, observable in the conventional statistics, or unobserved ones, controlled for by firm specific fixed and random effects. This is particularly the case in the analysis of firm growth as in essay [2] and firm profit as in essay [3].

5 Summary of papers

Essay [1]: Does Gibrat's Law hold for Swedish energy Firms?

Gibrat's law predicts that firm growth is purely random and should be independent of firm size. We use a random effects–random coefficient model to test whether Gibrat's law holds on average in the studied sample as well as at the individual firm level in the Swedish energy market. No study has yet investigated whether Gibrat's law holds for individual firms; previous studies instead estimated whether the law holds on average in the samples studied. The present results support the claim that Gibrat's law is more likely to be rejected ex ante when an entire firm population is considered, but more likely to be confirmed ex post after market selection has "cleaned" the original population of firms or when the analysis treats more disaggregated data. From a theoretical perspective, the results are consistent with models based on passive and active learning, indicating a steady state in the firm expansion process and that Gibrat's law is violated in the short term but holds in the long term once firms have reached a steady state. These results indicate that approximately 70\% of firms in the Swedish energy sector are in a steady state, with only random fluctuations in size around the level observed over the 15 years studied.

Essay [2]: Firm growth in the Swedish energy sector: Will large firms become even more dominant?

This paper examines the determinants of firm growth in the Swedish electricity sector using a sample of 200 electricity firms active from 2000 to 2010. The article has two aims. First, we want to investigate whether there is reason to believe that the Swedish electricity market will become more concentrated in the future, dominated by just a few firms. That would be the result if, for example, large firms systematically and over time grew faster than did smaller firms in the Swedish market. Second, we want to investigate whether firm growth can mainly be explained by firm-specific variables, supporting Penrose's (1959) suggestion that internal resources are the key determinants of firm growth rates. To this end, quantile regression is used in addition to ordinary least squares regression, to provide a more complete estimation of the growth distribution of firms conditional on different attributes. The results indicate that large firms do not grow faster than do other firms in the sector and that electricity firms' internal resources are indeed the key determinants of firm growth in the Swedish electricity industry.

Essay [3]: Are multi-plant firms more or less profitable? Evidence from Swedish electricity firms.

Multi-plant firms are more prevalent than single-plant firms in industries characterized by scale economies and imperfect competition, although they require an additional management-structure tier that results in additional costs. If investors were expected to require equal returns on investments in multi-plant and single-plant firms this would imply that the additional governance costs are balanced by some benefits. Using firm-level panel data in the Swedish electricity industry, this paper shows that multi-plant firms on average have a one percentage-point lower return on total assets than their single-plant counterparts as they reach a 'steady state' firm size when an optimal size is identified. A potential reason for this could be loss of control across hierarchical levels within multi-plant firms because of their complicated management structure. An alternative potential reason could be that adaptation to technological changes lags behind in comparison to single–plant firms.

Essay [4]: Do Internet price comparison sites make markets more competitive? An analysis using the Swedish electricity market.

Internet price comparison sites may significantly reduce search costs by enabling price comparisons online, therefore intensifying competition. This paper applies a difference-in differences approach to compare competition intensity before and after the launch of Internet electricity price comparison sites (IEPCS). With firm characteristics controlled for, the difference-in-differences estimations of a theoretically robust measure of competition show that the introduction of IEPCS has had a significant effect on increasing competition, on average. Further results from quantile difference-in-differences estimations indicate heterogeneous effects, with the largest effect on competition found in parts of the market that were already characterized by high levels of competition before the launch of IEPCS.

6 General findings, implications and limitations

The rapid progress towards a deregulated and integrated electricity market in Sweden has opened up for competition. *This* requires that the research keep up with the changes. Previous research results are not necessarily true when market conditions change, and the decision makers need all the help they can get to have the

results of the process evaluated and to eventually fulfill the aim of a well-functioning electricity market.

As reported in Lundgren (2013), in 2004, the four largest electric power generators in Sweden together commanded 88% of the Swedish market, while in the Nord Pool area, the four largest electric power generators together commanded only 48% of the total market. Meanwhile, the Swedish state-owned "national champion", Vattenfall, with a market share of more than 50 percent was considerably reduced, to only 20 percent in 2007 following deregulation in 1996. Thus, the larger energy market offered improved conditions for the market to function effectively while preventing abuse of market power. However, this could change if large electricity firms systematically grow faster than smaller firms in the Swedish electricity market.

In evaluating the status of market power in the electricity market, essay [1] and essay [2] were devoted to tackling the issue in regards to firm growth. Essay [1] of this thesis studies firm growth in the Swedish electricity market by testing whether Gibrat's law holds on average as well as at the individual firm level. The main finding of this study is consistent with recent theoretical models of market selection and confirms the validity of Gibrat's law at the firm level. When selection has been completed, a 'steady-state' is reached by most firms in the Swedish electricity market. This is in line with Bergman (2005) conclusion that the benefits of increased competition in the electricity market are likely to be greater in the medium and long terms than in the short term. These gains will not be realized unless competition is maintained.

However, it is inevitable that market power arises due to the special features of the electricity market. A prominent reason is that there are increasing returns to scale in infrastructure, so large that duplication of the infrastructure is economically impossible or at least costly enough to make an infrastructural monopoly preferable[3]. Essay [2] adopts a conditional quantile regression model to take a closer and more straight-forward look at firm growth, focusing on the question of whether there is reason to believe that the Swedish energy market will become more concentrated in the future, dominated by just a few firms. We find that large firms do not grow faster than do other firms in the market.

Essay [3] examines whether Swedish electricity firms with a multi-plan structure are more profitable in relation to their position in a 'steady-state'. The main finding from this essay is that multi-plant electricity firms, after controlling for a number of

[3] Other reasons, for example, could be potential market power only for a few dominant electricity firms during peak, high demand hours and leave the profit margin only to them (Borenstein, 1999); high entry/exit barriers, etc.

covariates, on average have a 1% point lower return on total assets under 'steady state' (reaching an optimal size) than their single plant counterparts. This finding adds some interesting insight, especially when considered as a complement to the findings of the other essays. While in the other three essays we have been able to find some evidence of increasing competition in the electricity market through direct measurement of quantitative index changes in relation to competition, the finding of essay [3] shows that firm structure (i.e., single-/multi-plant firm structure) additionally seems to be associated with firm performance in the Swedish electricity market.

What we find is that although multi-plant firms are more profitable overall, they are more likely to suffer aggregately from loss of control when they have reached 'steady state' firm size, all else being equal. We suggest important factors that are linked to firm structure under the 'steady state' are responsible. That is, the lower profit for multi-plant electricity firms in 'steady-state' may be due to the aggregated loss of control due to the management structure in large-scale operations or perhaps the adaptation to the requirements of technological change lags behind in the capital-intensive electricity industry. The results are in line with a strand of literature which concludes that the presence of uncertainties regarding future returns and costs (e.g., Yang et al., 2008; Gross et al., 2010; Boomsma et al., 2012) are among the more critical factors affecting willingness to invest. This indicates that investors might be risk averse when exposed to potentially higher investment uncertainty of multi-plant electricity firms relative to single-plant electricity firms. This may explain why investors accept lower returns in multi-plant electricity firms.

From a consumer perspective, increasing competition indicates that part of the monopoly rent is transferred to the consumer end-user forcing marginal firms to become more efficient in order to survive. In other words, the most important feature of a vertically unbundled distribution network is that it should allow any retailer to sell electricity within any distribution area. Therefore, the proper functioning of the information exchange occurring between retailers and distribution companies is crucial (e.g., for supplier switching). For this purpose, the Swedish energy markets inspectorate (Ei) introduced IEPCS in 2007 to lower customers' search costs and made it fairly easy for consumers to compare electricity prices and choose between suppliers. On the other hand, many (e.g., Stigler, 1964; Tirole, 1988; Kühn and Vives, 1995, and Kühn 2001) may find that an increase in transparency on the producer side may be anti-competitive when tacit collusion is a concern. For instance, Schultz (2016) finds that in a homogeneous market an increase in transparency on both sides of the market is anti-competitive since only producers matter. This implies that if tacit collusion is a concern, then electricity market efforts to improve price transparency may not be able to achieve the desired effects on increasing

competition, as is the case when the electricity-firm-side effect dominates and it is anti-competitive. Nonetheless, individual firms may have incentive to hide the deviation by offering secret rebates and differentiate the product. Therefore, we need to assess the competitive effects of an increase in price transparency on a case-by-case basis.

To this end, essay [4] uses a theoretically robust measure of competition, RPD, and a quantile difference-in-differences estimator to capture the change of the competition intensity that each individual Swedish electricity firm faced brought on by the launch of IEPCS. The main finding from this essay is that the introduction of IEPCS seems to have increased competition the most for those Swedish electricity firms that were already facing fierce competition before the introduction of IEPCS. Hence, the results of essay [4] suggest that future reforms should target parts of the electricity market where market power is still prevalent to stimulate a more balanced result. Additionally, the results suggest that there is potential for tacit collusion in the Swedish electricity market. As electricity firms facing little competition initially being affected the least by the introduction of the IEPCS, those firms may coordinate, find a mutually acceptable price level and conduct tacit collusion in the future.

In bringing together the findings of the four essays in this thesis, we conclude that the more than ten-year-long deregulated electricity market in Sweden seems to be functioning well, meaning only that there is no sign of market power in terms of firm growth affecting the Swedish electricity market based on the findings in essay [1] and essay [2]. However, the results from essay [4] show there is a need for new investments by market actors other than the large electricity firms, such as the 'national champions'. Economic scale together with lack of profitable investment alternatives can create barriers to entry and growth. Also of interest is how institutional design could protect the consumers, e.g., the abolishment of the old Swedish standardized contracts could increase consumer protection if replaced with more market oriented pricing.

As for the future studies, a more detailed investigation at the plant level may serve as a workable alternative when further investigating the determinants of firm performance and competition intensity in the electricity market. Meanwhile, although our studies clearly indicate that firm-specific factors are important determinants of firm performance (essay [2] on firm growth and essay [3] on firm profit) in the electricity market, our results do not specify what factors in the firm cause this growth. They could be factors such as human assets, firm culture, trade agreements, entrepreneur characteristics, and business models. Many of these factors closely resemble the idiosyncratic resources that previous literature suggested primarily determine the future performance of the firm. We believe that future studies should

investigate how firm performance is affected by the firm's internal resources and that case study research presents itself as a useful complement to our study. Such studies should provide valuable additional insights into how the internal resources of electricity firms affect firm performance and competition intensity in the market.

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