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The Effect of Deregulation on Firm Leverage and Strategic Behavior: Evidence from U.S. Electricity Industry*

An-Sing CHEN – National Chung Cheng University, Taiwan (xylnxai@gmail.com) *corresponding author*

Pham Tuan ANH – National Chung Cheng University, Taiwan and Nguyen Tat Thanh University, Vietnam (ptuananh88@gmail.com) *alternate corresponding author*

Abstract

We examine the relationship between financial leverage, competition, and the strategic behavior of U.S. electricity firms under the dynamic GMM model framework. The GMM provides a framework to address the endogeneity in the leverage-competition relationship. We find that electricity deregulation induces private firms to increase financial leverage. Large and small levered firms exhibit different behaviors under the higher competitive conditions resulting from deregulation exogenous shocks. Highly levered large firms apply aggressive strategies through increasing the investment activities but slightly decreasing their retail prices, resulting in lower profit margins but drastically gaining more market share. On the other hand, small firms with higher leverage follow survival strategies to maintain their customer base at the expense of profit margins by investing more and charging higher prices after deregulation.

1. Introduction

Business competition, which was introduced by Adam Smith in 1776, is the rivalry between two or more competitors to gain some particular economic purposes. Competition is also an important and well-known factor in a variety of empirical studies in economics. Our research focuses on examining the interplay among financial leverage, the degree of competition, and strategic behavior of firms in U.S. electricity industry.

Several seminal papers have provided the theoretical framework about the main linkages between financial leverage and competition. Brander and Lewis (1986) detects that the adjustment of capital structure leads the change in returns distribution between creditors and shareholders, and thus change the output policies from shareholders. Besides, highly levered firms have incentives to take advantage of the financial structure to gain more power in the output market. Chevalier (1995) observes a positive relationship between leverage and product-market competition in the specific case of the supermarket industry. Furthermore, Chevalier and Scharfstein (1996) and Dasgupta and Titman (1998) note that highly levered firms typically charge higher prices to maintain profits in the short-run, instead of expanding market shares;

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however, this strategy is not advantageous for making profits in the long-run due to the reduction in the ability of attracting customers.

Recent empirical studies have presented a variety of viewpoints regarding capital structure decisions and market competition. Wanzenried (2003), for example, analyzes capital structure adjustment and its relation to firms' strategic position in the product market. The study finds that the economy's welfare, which is maximized at the lowest competitive level if the goods are completely substituted by others, is increased by debt issue. Moreover, it is widely accepted that the relationship between financial leverage and competition is contingent on size, growth and industry category (e.g., Grullon, Kanatas and Kumar, 2006; Guney, Li and Fairchild, 2011; Reboul and Todra-Simats, 2016). Reboul and Todra-Simats (2016) shows that the European electricity deregulation in the early 2000's has motivated firms to increase their leverage, but resulted in a decline in their competitive capabilities. The study also analyzes the differences in strategic behaviors between large and small levered firms in European electricity industry. They find that large levered firms tend to invest in increasing their output and reduce the price to expand their market shares, whereas small levered firms are more likely to increase the price to improve profit margins.

The U.S. electricity process was complicated, time-consuming and extravagant in the early 1990s (Warwick, 2002 and Jamasb, Nillesen and Pollitt, 2004). Therefore, the Federal Energy Regulatory Commission (FERC) decided to restructure and deregulate the electricity market. Warwick (2002) and Brown (2005) argue that private electricity companies serve 70-75% load of U.S. consumers, whereas public electricity firms are strictly controlled by the U.S. government for public interests. According to Hattori and Tsutsui (2004) and Al-Sunaidy and Green (2006), the U.S. electricity market deregulation happened in parallel with many other OECD countries like EU, Japan, Australia, and New Zealand, but there exists a significant difference in nature between these deregulations. In particular, U.S. authorities added more market forces to private electricity firms to expand competitive level (Warwick, 2002 and Jamasb, Nillesen and Pollitt, 2004), whereas most other OECD countries privatized state-owned electricity companies (Hattori and Tsutsui, 2004; Nakano and Managi, 2008; Fiorio and Fiorio, 2013; Hyland, 2016 and Reboul and Todra-Simats, 2016).

The deregulation of the U.S. electricity market provides a good laboratory to investigate the effects of changes in competition on firms' strategic behavior and leverage. This study contributes to existing literature in the following ways. First, given substantial differences between the U.S. and other OECD countries' deregulation environment, this is the first paper to analyze the effects of adding market forces on the competitive level of the U.S. electricity market. Our paper aims to focus on the case of U.S. private electricity firms under the deregulation exogenous shocks. We find that the profitability of these firms reduced after deregulation. The deregulation also decreased fixed assets, inventories, and cash ratios of these firms. The results differ from Reboul and Todra-Simats (2016), which finds that European electricity firms exhibit increased the profitability and accumulated assets ratios after deregulation. The different results between U.S. and European firms can be interpreted by the different natures of these deregulations. Specifically, European authorities privatize state-owned electricity firms to increase the efficiency of these firms, whereas

U.S. authorities apply more drastic measures to private companies to expand the competitive level in the electricity market.

Second, our results additionally provide insights into the different behavior of large and small levered firms after deregulation. We detect that large firms with higher debt levels increase investment activities but slightly decrease their retail prices. These aggressive strategies lead to lower profit margins but drastically gaining more market share and are consistent with the previous findings of Brander and Lewis (1986), Phillips (1995), Zingales (1998) and Reboul and Todra-Simats (2016). However, we find evidence that highly levered small firms apply survival strategies to maintain their customer base at the expense of profit margins. After deregulation, they have to invest more and charge higher prices to recover the higher operating cost from the new investment in renewable power projects.

We find similar behavior of U.S. large levered firms, but different behavior of U.S. small levered firms when compared with the corresponding firms in E.U. Reboul and Todra-Simats (2016), show small European firms with higher leverage tend to invest less and just push price up to earn higher profit margins at the expense of market shares. The differences in small levered firms' strategies between U.S. and European cases could be explained by the tougher competitive environment associated with the U.S. deregulation compared to the European one. The U.S. deregulation induces small private electricity firms to develop renewable power projects based on the Renewable Portfolio Standard (RPS) regulations and concentrate on customer services to gain more market shares. These firms can use green power or power from renewable resources as one of the key marketing strategies to access potential consumers (Warwick, 2002).

Third, companies sometimes will adjust capital structure for reasons that are not related to competitive expansion. This paper attempts to find out the appropriate instrumental variables in explaining the leverage-competition relationship. We handle the endogeneity in the leverage-competition relationship by applying the Generalized Method of Moments (GMM) model. Previous studies have employed Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) models to examine the relationship between leverage and market competition (E.g. Chevalier, 1995; Chevalier and Scharfstein, 1996; Grullon, Kanatas and Kumar, 2006 and Reboul and Todra-Simats, 2016). Hansen (1982) show that all instrumental variable models, linear or non-linear models, with cross-sectional, time series or panel data are encompassed by the GMM model. In other words, GMM is considered as the unifying econometrics model and OLS, 2SLS are only the special cases of the GMM model.

Hansen (1982), Wooldridge (2001), Jagannathan, Skoulakis, and Wang (2002) and Hansen, Hausman, and Newey (2008) argue that GMM estimator is still unbiased and efficient even under weak distributional assumptions. The weakness of the OLS model is the endogeneity problem. The OLS estimator is not consistent and could not provide a causal explanation if the zero correlation between the error term and the independent variable assumption fails. Grullon, Kanatas, and Kumar (2006) and Reboul and Todra-Simats (2016) also find that there exists the endogeneity problem for the leverage-competition relationship, so they use 2SLS model to solve this problem. The 2SLS estimates are consistent under the homoskedasticity assumption in the first-stage regression (Wooldridge, 2001 and Lin and Lee, 2010). However, when we use the Breusch-Pagan test, we find that the homoskedasticity assumption is violated in our first-stage leverage regression. Therefore, we apply the dynamic GMM model to handle the endogeneity in the leverage-competition relationship because the GMM estimates are more efficient than 2SLS estimates if errors are heteroskedasticity (Wooldridge, 2001 and Lin and Lee, 2010).

In this study, we specify leverage as the endogenous variable and use two measures of tangible assets (inventories ratio, fixed asset ratio), and cash ratio as the exogenous variables in explaining the competitive level of U.S. electricity market. Tangible assets are considered as collateral for debt financing and have a weak correlation on the competitive level (Frank and Goyal, 2009; Oztekin, 2015 and Reboul and Todra-Simats, 2016). Cash ratio is also used as an exogenous variable because the impact of cash on the competitive outcome is primarily determined by the strategic effect of debt. This impact is stronger under tighter financial constraints (Acharya, Almeida and Campello, 2007; Bates, Kahle and Stulz, 2009 and Fresard, 2010).

Though the correlations of these exogenous variables and two main competitive variables (market shares, gross profit margins) are low, our study provides some incites concerning the choice of the instrumental variables. We also use a vector of control variables, which contain assets growth, profitability, firm size, asset turnover, and Z-score. These control variables are standard determinants in explaining firms' competitive outcomes (e.g., Grullon, Kanatasand Kumar, 2006; Guney, Li and Fairchild, 2011 and Reboul and Todra-Simats, 2016).

The remainder of the paper includes six sections. Section 2 expresses the deregulation and restructuring of the U.S. electricity industry in detail. Section 3 performs descriptive statistics to compare the financial ratios of U.S. electricity firms between before and after deregulation. Section 4 describes the impact of deregulation on leverage. Section 5 examines the effect of financial leverage on two proxies of competitive level, mainly market shares and gross profit margins under the deregulation shocks. Section 6 focuses on the strategic behavior of levered firms about retail electricity prices and investment activities. Finally, section 7 draws several conclusions.

2. The Deregulation and Restructuring for U.S. Electricity Industry

According to the U.S. Department of energy document (Warwick, 2002), the U.S. electrical process was unreasonable, time-consuming and extravagant by the early 1990s. Consequently, the Federal Energy Regulatory Commission (FERC) performed policies to restructure the electricity market, with the establishment of California in 1994. The deregulation of the U.S. electricity industry happened in parallel with many other OECD countries like EU, Japan, Australia and New Zealand (Hattori and Tsutsui, 2004 and Al-Sunaidy and Green, 2006); however, the main difference is that U.S. authorities added market forces to private companies to expand competitive level (Warwick, 2002; Jamasb, Nillesen and Pollitt, 2004), whereas most OECD countries privatized state-owned electricity companies (Hattori and Tsutsui, 2004; Nakano and Managi, 2008; FiorioandFiorio, 2013; Hyland, 2016 and Reboul and Todra-Simats, 2016).

The vertically organized electrical system in the U.S. is constituted by three functions, which include generation, transmission, and distribution to retail customers.

The FERC promulgated legal documents to deregulate all services of this industry (Energy Policy Act – 1992, Order 888, 889 – 1996, Order 2000 – 1999…) (Warwick, 2002; Jamasb, Nillesen and Pollitt, 2004 and Brown, 2005). In particular, the FERC has established the mechanism of direct negotiations between consumers and wholesalers; as a result, the pricing structure in the wholesale market has been entirely decided by market participants. Moreover, the U.S. authorities require private electricity firms to develop renewable energy resources through the Renewable Portfolio Standard (RPS) regulations. With few exceptions, U.S. electricity firms have the right to sell power from renewable resources for a premium over power from conventional sources.

What's more, the transmission function is considered as a natural monopoly in most countries around the world. For instance, Higgs and Worthington (2008), Goto and Sueyoshi (2009) and Reboul and Todra-Simats (2016) argue that Australia, Japan, and EU did not introduce any deregulations to this function. However, the FERC has stipulated that all market participants, which involve electrical suppliers, demanders or traders, have rights to access the available transmission capacity (ATC) of each utility. In general, these deregulations have aimed at moving more benefit to retail customers and raising the competitive conditions among electrical companies.

3. Data and Descriptive Statistics

According to Warwick (2002) and Brown (2005), private electricity companies provide power for 70-75% load of U.S. consumers, whereas public electricity firms are still regulated by governments for public interests. Therefore, we aim to focus on the strategic behaviors of U.S. private electricity firms. We collect annual data from 65 U.S. private electricity firms that have data from 1979 to 2015. The firms of our sample are survivor firms. The primary source of the dataset is from Compustat. Variables not in Compustat such as market shares, retail prices are gathered and calculated from the Energy Information Administration (EIA).

Table 1 Variable definition

Variable	*Definition*
Panel A. Dependent variables	
MARKET_SHARES	Firm sales / Total market sales
PROFIT_MARGINS	Operating Income / Net revenue from sales
RETAIL_PRICES	Total revenue (USD) / Total sales (kwH)
INVESTMENT	Capital expenditures / Total assets.
Panel B. Independent variables	
LEVERAGE	Total liabilities / Total assets
SIZE	The natural logarithm of total assets
GROWTH	Change in log assets
PROFITABILITY	Net income/ book value of assets
ASSET_TURNOVER	Firm sales / total assets
FIXED_ASSETS	Property, plant and equipment / Total assets
CASH	Cash / Total assets
INVENTORIES	Inventories / Total assets
Z_SCORE	$1.2Z_1 + 1.4Z_2 + 3.3Z_3 + 0.6Z_4 + 1.0Z_5$, with Z_1 = working capital / total assets, Z_2 = retained earnings / total assets, Z_3 = EBIT / total assets, Z_4 = market value of equity / total liabilities, Z_5 = sales / total assets

The firms of our sample have all own generation, transmission, and distribution functions. Moreover, they operate in regional areas that are strongly affected by deregulation. The Federal Energy Regulatory Commission (FERC) spent a long time to accomplish the restructuring for the U.S. electricity industry in all aspects. In our study, we distinguish the time-periods of the deregulation based on the state level. To provide additional insights, we separate large and small firms based on about 50% largest and 50% smallest firms' average total assets, respectively (33 large and 32 small firms).

Table 2 Descriptive Statistics

Panel A: All firms						
Financial ratios	***Before deregulation***		***After deregulation***		***Comparisons***	
	Mean	***S.D.***	***Mean***	***S.D.***	***Difference***	***t-statistics***
Gross profit margins	0.33	0.08	0.28	0.09	-0.05	-14.59
Investment	0.07	0.04	0.06	0.03	-0.01	-5.10
Leverage	0.64	0.07	0.72	0.10	0.08	21.96
Fixed assets	0.81	0.10	0.67	0.15	-0.14	-29.31
Cash	0.02	0.02	0.01	0.02	-0.01	-2.18
Growth	0.06	0.10	0.05	0.14	-0.01	-1.18
Inventories	0.03	0.02	0.02	0.01	-0.01	-15.24
Profitability	0.04	0.03	0.03	0.03	-0.01	-11.67
Asset turnover	0.37	0.13	0.38	0.15	0.01	1.78
Panel B: Large firms						
Financial ratios	***Before deregulation***		***After deregulation***		***Comparisons***	
	Mean	***S.D.***	***Mean***	***S.D.***	***Difference***	***t-statistics***
Gross profit margins	0.35	0.003	0.30	0.003	-0.05	-11.57
Investment	0.07	0.001	0.06	0.001	-0.01	-5.49
Leverage	0.65	0.002	0.73	0.004	0.08	16.74
Fixed assets	0.81	0.004	0.64	0.006	-0.17	-23.85
Cash	0.01	0.001	0.01	0.001	0.003	2.80
Growth	0.06	0.004	0.06	0.007	-0.00	-0.81
Inventories	0.03	0.001	0.02	0.001	-0.01	-13.45
Profitability	0.04	0.001	0.03	0.001	-0.01	-8.28
Asset turnover	0.34	0.004	0.35	0.005	0.01	1.20
Panel C: Small firms						
Financial ratios	***Before deregulation***		***After deregulation***		***Comparisons***	
	Mean	***S.D.***	***Mean***	***S.D.***	***Difference***	***t-statistics***
Gross profit margins	0.31	0.003	0.26	0.004	-0.05	-9.62
Investment	0.07	0.001	0.06	0.001	-0.01	-2.17
Leverage	0.64	0.003	0.71	0.003	0.07	14.38
Fixed assets	0.82	0.004	0.69	0.006	-0.13	-17.89
Cash	0.02	0.001	0.01	0.001	-0.01	-4.61
Growth	0.06	0.004	0.05	0.005	-0.01	-0.90
Inventories	0.03	0.001	0.02	0.001	-0.01	-8.57
Profitability	0.04	0.001	0.03	0.001	-0.01	-8.25
Asset turnover	0.40	0.01	0.41	0.01	0.01	1.40

Notes: This table presents the descriptive statistics for the means of key financial ratios in two periods: before and after deregulation. S.D. denotes standard deviation. Difference denotes the difference in the mean values between after and before deregulation.

Table 1 describes how the dependent and independent variables that are used throughout the paper are measured. All variables are computed at the firm level.

We first analyze the influence of deregulation on U.S. electricity industry by computing the descriptive statistics of the key financial ratios. Table 2 presents the summary statistics of the variables and provides a comparison of their values before and after deregulation.

The results of Table 2 show, except for the growth and asset turnover variables, significant differences in the selected financial ratios between before and after deregulation. The differences in these financial variables provide evidence that the U.S. authorities seem to be successful in adding market forces to expand the competitive level in the electricity market. For example, the average profitability of all electricity firms reduced after deregulation, with gross profit margins decreasing from 33% to 28% and return on assets decreasing from 4% to 3%. Also, the ability of firms to accumulate assets was also significantly diminished after deregulation, with fixed assets declining from 81% to 67%, inventories declining from 3% to 2% and cash ratios declining from 2% to 1%. In line with all firms' results, these profitability and accumulated assets ratios are also considerably decreased after the deregulation in the separate cases of large and small firms.

Reboul and Todra-Simats (2016), on the other hand, find that the profitability and accumulated assets ratios of European electricity firms increased after deregulation. The different results between U.S. and European firms' financial ratios can be explained by the nature of these deregulations. Specifically, European authorities privatize state-owned electricity firms to increase the efficiency of these firms, whereas U.S. authorities apply more stringent measures to private companies to increase the competitive level in the electricity market.

Table 2 also shows that deregulation causes U.S. electricity firms to take on more debt level. Notably, large firms expanded the average leverage from 65% to 73%, and small firms increased the leverage from 64% to 71%. On the other hand, the more competitive level of the electricity market after deregulation decreased the investment ratio of these firms. The investment ratio of both large and small firms reduced from 7% to 6%. The combination of increased competition and over-leveraged policy provoke the protraction of low profitability situations, and this also leads to curtailing investment activities which are in alignment with the Modigliani and Miller (1958) theory of investment.

4. The Effect of Deregulation on Leverage

Zingales (1998), Ovtchinnikov (2010) and Reboul and Todra-Simats (2016) argue that firms tend to have a higher debt ratio in regulated industries because firms have a lower probability of financial distress under the regulated environment. Accordingly, firms should lower their financial leverage after the exogenous deregulation shock. However, the descriptive statistics of Table 2 show the opposite result. U.S. electricity firms tend to use more debts after deregulation. In this section, we explore the capital structure decisions for the particular case of the U.S. electricity industry deregulation by performing a leverage regression analysis taking into account the exogenous deregulation shock.

$$LEV_{it} = \delta_i + \delta_t + \beta_1 \, DEREGULATES_{it} + \gamma X_{it} + u_{it} \tag{1}$$

where LEV_{it} is the leverage variable of firm i at time t. DEREGULATES is the deregulation dummy variable, which equals 1 in the period after deregulation and 0 in the period before deregulation. δ_i and δ_t are in turn the firm fixed-effects and year fixed-effects. X is the list of control variables, which include size, fixed assets, cash, growth, inventories and profitability determinants (from Titman and Wessels, 1998; Frank and Goyal, 2009 and Oztekin, 2015).

We use separate samples of all firms, large firms, and small firms to run the regression (1). The coefficient of the DEREGULATES dummy variable represents the difference in leverage between after and before deregulation. Table 3 reports the leverage regression results of six different models (models 1 and 2 for all firms, models 3 and 4 for large firms, models 5 and 6 for small firms). Models 1, 3, and 5 include only the DEREGULATES dummy variable. Models 2, 4, and 6 contain the DEREGULATES and other control variables.

Table 3 The Effect of Deregulation on Leverage

Variables	*All firms*		*Large firms*		*Small firms*	
	1	2	3	4	5	6
Deregulates	0.0772*** [0.00]	0.0251*** [0.00]	0.0842*** [0.00]	0.0118** [0.02]	0.0698*** [0.00]	0.0372*** [0.00]
Size		0.0127*** [0.00]		0.0221*** [0.00]		0.0024 [0.67]
Fixed assets		-0.1765*** [0.00]		-0.2225*** [0.00]		-0.1189*** [0.00]
Cash		0.5372*** [0.00]		0.8209*** [0.00]		0.3868*** [0.00]
Growth		0.0040 [0.70]		-0.0018 [0.88]		0.0149 [0.44]
Inventories		-0.2991** [0.013]		-0.0095 [0.95]		-0.5016*** [0.00]
Profitability		-1.0767*** [0.00]		-1.1555*** [0.00]		-0.9917*** [0.00]
Constant	0.6420*** [0.00]	0.7256*** [0.00]	0.6456*** [0.00]	0.6649*** [0.00]	0.6382*** [0.00]	0.7653*** [0.00]
No. of obs.	2,405	2,340	1,221	1,188	1,184	1,152
R^2	22.49%	46.47%	25.80%	57.42%	19.21%	36.79%

Notes: this table reports the panel least squares regressions of LEVERAGE on DEREGULATES and other control variables, with the firm and year fixed-effects. We classify columns 1 and 2 for all firms, columns 3 and 4 for large firms, columns 5 and 6 for small firms. Columns 1, 3, and 5 contain only the DEREGULATES dummy variable. Columns 2, 4, and 6 contain the DEREGULATES and other control variables (size, fixed assets, cash, growth, inventories, and profitability factors). The coefficient of the DEREGULATES dummy variable indicates the difference in leverage between after and before deregulation. ***,**,* denote statistical significance at the 1%, 5% and 10% levels. p-values are shown in the square brackets.

Model 1 shows that the leverage of all electricity firms rises by 7.72% after deregulation. Once we control for the standard determinants of leverage, the leverage difference between after and before deregulation decreases sharply to +2.51% (model 2). Similarly, separate large firms and small firms also tend to increase leverage after deregulation. Moreover, the vector of control variables also shows the ability to explain the leverage difference between after and before deregulation in cases of large firms and small firms. The DEREGULATES dummy variable decreases from +8.42% to +1.18% for large firms, and decreases from +6.98% to +3.72% for small firms.

The increase in leverage after deregulation could be explained by the exogenous deregulation shock in the U.S. electricity market. The descriptive statistics of Table 2 show that the fixed assets, inventories, and the profitability ratios of electricity firms significantly reduced after deregulation because of the increase in the competitive level. Based on the regression results of Table 3, the higher leverage policies of electricity firms are originated from lower fixed assets, inventories accumulation, and lower profitability situations. Under the pecking order framework, Myers (1984) argues that firms prefer internal funds like retained earnings first, and debt is preferred to equity if firms have to access to external funds. After deregulation, U.S. electricity firms face shortages in retained earnings because of lower profits; hence, they have to access external funds through debt instruments to finance investment projects.

5. The Effect of Leverage on Competitive Level

5.1 Research Methodology

Companies normally adjust capital structure for reasons that are not related to competition. Our paper attempts to find out the appropriate instrumental variables in explaining the leverage-competition relationship.

Chevalier (1995) and Chevalier and Scharfstein (1996) employ the Ordinary Least Squares (OLS) model to examine the relationship between leverage and market competition. According to Wooldridge (2001), the key assumption for consistency of OLS estimate is the zero correlation assumption that the error term is uncorrelated with independent variables. The weakness of the OLS model is the endogeneity problem. The OLS estimator is not consistent and could not provide a causal explanation if the zero correlation assumption fails. Grullon, Kanatas, and Kumar (2006) and Reboul and Todra-Simats (2016) detect that there exists the endogeneity problem under the leverage-competition relationship, so they use 2SLS model to solve this problem. Wooldridge (2001) and Lin and Lee (2010) argue that the 2SLS estimates are consistent under the homoskedasticity assumption in the first-stage regression. However, our paper uses the Breusch-Pagan test to detect that the homoskedasticity assumption is violated in the first-stage leverage regression. Correspondingly, we apply the Generalized Method of Moments (GMM) model to handle the endogeneity in the leverage-competition relationship because the GMM estimates are more efficient than 2SLS ones if errors are heteroskedasticity (Wooldridge, 2001 and Lin and Lee, 2010).

Table 4 Correlations Between Independent Variables and Dependent Variables

Variables	*Dependent variables*			
	Market shares	*Profitmargin*	*Prices*	*Investment*
Panel A: Correlations between control variables and dependent variables				
Leverage	-0.11	-0.17	0.02	-0.26
Growth	-0.01	-0.05	-0.01	0.26
Profitability	0.12	0.24	-0.10	0.17
Size	0.67	0.12	0.06	-0.03
Panel B: Correlations between exogenous variables and dependent variables				
Inventories	-0.01	0.02	-0.23	0.21
Fixed assets	0.01	0.26	-0.29	0.40
Cash	-0.08	-0.01	0.03	-0.07

Notes: this table shows correlations between independent variables and dependent variables, which are used in GMM model. Leverage is the main independent variable. The vector of control variables are growth, profitability and size. Inventories, fixed assets and cash are considered as the exogenous variables. The market shares and gross profit margin are the two different measures of competitiveness (section 5). Prices and investment are in turn the proxies of pricing and investment strategic behaviors (section 6).

The GMM specification requires appropriate instrumental variables to handle the endogeneity problem related to the leverage-competition relationship. Two kinds of tangible assets (inventories ratio, fixed asset ratio) and cash ratio can be used as exogenous variables. Frank and Goyal (2009), Oztekin (2015) and Reboul and Todra-Simats (2016) find that tangible assets are considered as collateral for debt financing and should have a weak correlation on the competitive level. The cash ratio can also be used as the exogenous variable because the influence of cash on the competitive outcome is primarily determined by the strategic effect of debt. Also, the influence is stronger under tighter financial constraints (Acharya, Almeida and Campello, 2007; Bates, Kahle and Stulz, 2009 and Fresard, 2010). We have other reasons to consider the inventories, fixed assets and cash ratios as exogenous variables in our research. It is that the correlations of these exogenous variables and the two main competitive variables are very low. Specifically, the correlation between inventories, fixed assets, cash ratio and market shares are in turn -0.01, 0.01 and -0.08; likewise, the correlation between inventories, fixed assets, cash ratio and profit margins are 0.02, 0.26 and -0.01 respectively (see more in Table 4).

The first-stage regression of our model is:

$$LEV_{it} = \delta_i + \delta_t + \beta_1 INVENT_{it} + \beta_2 FIXED_{it} + \beta_3 CASH_{it} + \gamma X_{it} + u_{it} \quad (2)$$

where LEV_{it} is the leverage endogenous variable of firm i at time t. $INVENT_{it}$, $FIXED_{it}$, and $CASH_{it}$ are the inventories, fixed assets and cash instrumental variables respectively. X_{it} is the set of included instruments, and it is correlated with the covariates of the second-stage regression as below. δ_i ,δ_t are in turn firm fixed-effects and year fixed-effects.

Table 3 shows that the higher leverage decision is associated with higher cash and lower tangible assets (fixed assets, inventories) conditions. The results are explained by the two simple facts. First, in line with the hedging theory of Acharya, Almeida, and Campello (2007), our paper also finds a positive relationship between cash ratio and leverage. Constrained electricity firms that have higher cash ratios increase their debt capacity. Accordingly, they tend to use more debts and accumulate more cash balances into the future. Second, the electricity firms with lower tangible assets have higher investment needs before deregulation (Reboul and Todra-Simats, 2016), and they need to take on more debts once the electricity deregulation occurs. Consistent with Table 3, the first-stage regressions of Table 5, as below also provide similar results. Additionally, we use the Kleibergen-Paap F tests to show that our model has not weak instruments (see more in Table 5).

After running the first-stage regression, the fitted value of leverage variable and the vector of control variables X_{it} from the first regression are used as inputs to the dynamic GMM model in the following second-stage regression:

$$Y_{i,t+1} = \delta_i + \delta_t + \beta_1 Y_{it} + \beta_2 LEV_{it} + \beta_3 LEV_{it} * DEREGULATES_{it} + \gamma X_{it} + u_{it} \quad (3)$$

where $Y_{i,t+1}$ is a measure of competitiveness of firm i at time t+1. DEREGULATES is the deregulation dummy variable, which equals 1 in the period after deregulation and 0 in the period before deregulation. The coefficient β_2 shows the effect of leverage on competitive outcomes before deregulation. The coefficient β_3 indicates the average difference in competitive level between after and before deregulation under the impact of leverage decisions. X_{it} is the vector of control variables, which contain the firm size, assets growth, profitability, asset turnover, and Z-score. These control variables are standard determinants in explaining firms' competitive outcomes (e.g., Grullon, Kanatas and Kumar, 2006; Guney, Li and Fairchild, 2011 and Reboul and Todra-Simats, 2016).

5.2 Regression Results

To more rigorously investigate the impact of financial leverage on the competitive level in the U.S. electricity industry, we suggest the dynamic model and introduce the interaction between leverage and deregulation dummy variables in the case of all firms. For robustness, we also run regressions for large-sized and small-sized firm buckets. We employ two different measures of competitiveness. The first measurement is the market shares, calculated by sales of each firm over total sales in the U.S. electricity market. Bell, Keeney and Little (1975) and Nickell (1996) suggest that a firm that earns higher market share generates competitive advantages over competitors and induces strong barriers to entry for new firms. The second measurement is gross profit margins, computed by operating income over net revenue from sales. Shaikh (1980), Aghion, Dewatripont and Rey (1999), Nevo (2001) and Reboul and Todra-Simats (2016) argue that a high competitive level induces the likelihood of low-profit margins, whereas high-profit margins are more likely associated with a market structure in which leading firms can gain significant market shares.

Table 5 provides the GMM regression results showing the effect of leverage and control variables on market shares (Panel A) and gross profit margins (Panel B). In both panels, we classify columns 1-2 for all firms, columns 3-4 for large firms and columns 5-6 for small firms. Columns 1, 3, and 5 provide the results of the competitive level regressions using only lagged competitive outcomes, leverage, and leverage-deregulates interaction independent variables. The control variables, which include size, growth, profitability, asset turnover, and Z-score, are added more into columns 2, 4, and 6 to run the equation (3).

The coefficients of the LEVERAGE variable show the effect of leverage on the competitive outcome before deregulation. For small firms, financial leverage has a negative effect (although not significant) on both market shares and profit margins. Columns 1-2 for all firms and columns 3-4 for large firms of each panel in Table 5 also show that U.S. electricity firms with higher debt levels have significantly lower market shares and profit margin before deregulation. These results are in line with the arguments of Warwick (2002), who explains that highly levered firms could use debts to finance high risky efficient technologies projects. These unsuccessful projects have adverse (negative) effects on their profit margins and market shares in the future.

Table 5 The Effect of Leverage on Competitive Level

Panel A: Market shares

Variables	***All firms***		***Large firms***		***Small firms***	
	1	***2***	***3***	***4***	***5***	***6***
Market shares (lag)	0.9912*** [0.00]	1.0023*** [0.00]	1.0729*** [0.00]	1.1663*** [0.00]	0.8959*** [0.00]	0.8787*** [0.00]
Leverage	-0.0041*** [0.00]	- 0.0088*** [0.00]	-0.0212*** [0.00]	-0.0435*** [0.01]	-0.0003 [0.44]	-0.0010 [0.14]
Leverage * Dereg	0.0001* [0.06]	0.0002** [0.04]	0.0014*** [0.00]	0.0007 [0.17]	0.0001** [0.04]	0.0001** [0.01]
Size		-0.0001* [0.10]		0.0001 [0.63]		-0.0001* [0.08]
Growth		0.0005* [0.10]		0.0022* [0.09]		0.0003** [0.05]
Profitability		-0.0024** [0.03]		0.0052 [0.42]		-0.0003 [0.53]
Asset turnover		0.0014*** [0.00]		0.0097** [0.02]		0.0002 [0.30]
Z-score		-0.0014*** [0.00]		-0.0092*** [0.00]		-0.0002* [0.08]
No. of obs.	950	950	450	450	500	500
Kleibergen-Paap F statistic	26.50	14.55	6.58	1.82	28.08	17.43
R^2	87.10%	85.33%	75.44%	61.18%	81.69%	82.15%
First-stage regression						
Fixed assets	-0.1442*** [0.00]	-0.0627*** [0.00]	-0.0477** [0.04]	0.0074 [0.69]	-0.2570*** [0.00]	-0.1462*** [0.00]
Inventories	-0.7222*** [0.00]	-0.2616* [0.06]	-0.3714 [0.11]	0.1104 [0.53]	-1.0910*** [0.00]	-0.6546*** [0.00]
Cash	0.9720*** [0.00]	0.6816*** [0.00]	0.4659*** [0.00]	0.3196*** [0.00]	1.1952*** [0.00]	0.7374*** [0.00]

Panel B: Gross profit margins

Variables	***All firms***		***Large firms***		***Small firms***	
	1	***2***	***3***	***4***	***5***	***6***
Profit margins (lag)	0.6694*** [0.00]	0.6383*** [0.00]	0.5229*** [0.00]	0.5385*** [0.00]	0.7853*** [0.00]	0.7386*** [0.00]
Leverage	-0.0975** [0.04]	- 0.1740*** [0.00]	-0.1055** [0.05]	-0.2947*** [0.00]	-0.0516 [0.53]	-0.0770 [0.40]
Leverage * Dereg	-0.0118* [0.07]	-0.0141** [0.03]	-0.0223*** [0.00]	-0.0266*** [0.00]	-0.0080 [0.41]	-0.0075 [0.39]
Size		-0.0003 [0.92]		0.0122** [0.02]		-0.0052 [0.20]
Growth		-0.0220*** [0.01]		-0.0249** [0.03]		0.0078 [0.57]
Profitability		-0.1359** [0.02]		-0.4466*** [0.00]		0.0032 [0.96]
Asset turnover		-0.0386** [0.03]		0.0068 [0.82]		-0.0418* [0.06]
Z-score		-0.0240*** [0.00]		-0.0291*** [0.00]		-0.0170 [0.14]
No. of obs.	2,404	2,339	1,220	1,187	1,184	1,152
Kleibergen-Paap F statistic	52.54	46.48	72.72	50.18	10.76	13.81
R^2	51.91%	53.62%	39.44%	40.08%	65.22%	66.79%
First-stage regression						
Fixed assets	-0.1564*** [0.00]	-0.1211*** [0.00]	-0.2183*** [0.00]	-0.1501*** [0.00]	-0.0873*** [0.00]	-0.0805*** [0.00]
Inventories	-0.2017* [0.10]	0.0779 [0.46]	0.1358 [0.44]	0.3376** [0.02]	-0.4242** [0.02]	-0.0552 [0.71]
Cash	0.6585*** [0.00]	0.5694*** [0.00]	1.0229*** [0.00]	0.6938*** [0.00]	0.4952*** [0.00]	0.4946*** [0.00]

Notes: this table reports the dynamic GMM regression results of MARKET SHARES (Panel A) and GROSS PROFIT MARGINS (Panel B) on lagged competitive outcomes, LEVERAGE, LEVERAGE-DEREGULATES interactive terms and other control variables: columns 1 and 2 for all firms, columns 3 and 4 for large firms, columns 5 and 6 for small firms. Columns 1, 3, and 5 show the competitive level regressions with only lagged competitive outcomes, leverage, and leverage-deregulates interaction independent variables. The control variables, which include size, growth, profitability, asset turnover, and Z-score, are added more into columns 2, 4, and 6. The first-stage regressions are also shown in this table. ***,**,* denote statistical significance at the 1%, 5% and 10% levels. p-values are shown in the square brackets.

The coefficients of the interactive term between LEVERAGE and DEREGULATES indicate the effect of firms' capital structure strategies on their competitive level under the deregulation shocks. Panel A of Table 5 shows that highly levered firms have significantly higher market shares due to the deregulation shocks in both cases of large and small firms. This result could be explained by the limited liability effect of debt financing from Jensen and Meckeling (1976) and Brander and Lewis (1986). When firms use more debt level, they will have motives to follow output strategies that increase returns in good economic situations but decrease returns in bad ones. If shareholders are successful with expansible output strategies, they will earn most of the gain; otherwise, the debt-holders have to incur the losses because shareholders bear limited liabilities and only lose the maximum capital from their own initial investments.

Besides, under deregulation shocks, large electricity firms can gain the advantage of increasing market shares by using leverage more efficiently. For example, a 1% increase in leverage provides on average a 0.14% increase in market shares of large firms (columns 3 – panel A) but only a 0.01% increase in market shares of small firms (columns 5 – panel A).

Panel B of Table 5, shows significant differences in profit margins between large and small firms under the deregulation exogenous shocks. Columns 3-4 of panel B show that the leverage-deregulation interactive term exhibits a significantly negative relationship with profit margins in the case of large firms. Meanwhile, columns 5-6 of panel B show that the leverage-deregulation interactive term is not statistically significant in explaining profit margins for small firms subsample. The outcome is different from the previous empirical studies. Chevalier and Scharfstein (1996), Dasgupta and Titman (1998) and Reboul and Todra-Simats (2016) find that small firms use more debt levels to increase profit margins by charging higher prices or reducing output.

In sum, highly levered large firms increase leverage to gain more market shares but earn lower profit margins once the deregulation occurs. In alignment with Brander and Lewis (1986) and Reboul and Todra-Simats (2016), we also detect that the deregulation induced large levered firms to pursue aggressive strategies that sacrifice profit margins to raise market shares. For small firms, the impact of leverage-deregulation interaction on market shares is slightly positive, but its influence on profit margins is not significant. Apparently, after deregulation, small levered firms are forced to focus on survival strategies to maintain their customer base at the expense of profit margins. These strategies are significantly different from the small firms' strategies in European electricity deregulation. Reboul and Todra-Simats (2016) find that European small levered firms undertake leverage strategies that decrease output but earn high profit margins.

6. The Pricing and Investment Strategic Behaviors of Levered Firms

The analysis in section 5 detects that financial leverage has significantly different impacts on the behavior of large and small firms. This section aims to shed light on the market strategies that large and small firms perform to cope with the more drastic competition in the U.S. deregulated electricity market. We follow several similar previous studies such as Phillips (1995), Zingales (1998), Reboul and Todra-

Simats (2016), and apply dynamic GMM model to measure the effect of leverage on retail electricity prices and investment under the deregulation exogenous shocks. The coefficients of the LEVERAGE-DEREGULATES interactive variable show the impact of firms' capital structure strategies on their pricing policies (Table 6) and investment (Table 7) under the deregulation shocks.

To be consistent with section 5, section 6 also computes GMM model with robust standard errors. We also use the inventories ratio, fixed asset ratio and cash ratio as exogenous variables. Based on Phillips (1995), Zingales (1998), Frank and Goyal (2009), Fresard (2010), Oztekin (2015) and Reboul and Todra-Simats (2016), we also use the firm size, asset growth, profitability, asset turnover as the control variables of prices regression (Table 6), and put the firm size, profitability and asset turnover control variables into the investment regression (Table 7).

6.1 Prices

Reboul and Toldra-Simats (2016) only use the industrial prices in each E.U. market as the dependent variable. It implies that electricity prices are fixed for all electricity companies in the same country. The limitation of Reboul and Toldra-Simats (2016) is that they do not consider the electricity pricing of each E.U. firm. In our paper, we overcome this limitation by using the average retail price of each U.S. electricity firm. The average retail price represents the ability of each electricity company to negotiate with customers. In particular, electricity companies can use appropriate pricing policies for accessing their target customers. U.S. electricity firms utilize flexible pricing strategies for different utility characteristics such as residential, commercial, industrial, transportation utilities. For each firm, this variable is defined as the total revenue in USD over total sales in kWh every year. Table 6 provides the results of dynamic GMM regression retail electricity prices on the corresponding set of independent variables.

Columns 1 and 2 of Table 6 show that the highly levered firms behave strategically to adjust prices under the exogenous deregulation shocks. However, large and small levered firms have different price strategies. For large firms, the relationship between leverage-deregulation interaction and prices are negative, but not statistically significant (columns 3 and 4). It implies that the highly levered large firms tend to decrease the prices slightly under the deregulation shocks. The result is similar to those found in previous research. Brander and Lewis (1986), Phillips (1995), Zingales (1998) and Reboul and Todra-Simats (2016), also find that downward price pressures can cause firms to have lower profit margins, but can also result in increased market shares.

In contrast, the leverage-deregulation interactive term shows a significant positive relationship to retail prices in the case of small firms (columns 5 and 6 of Table 6). Small U.S. firms with more leverage tend to increase retail prices after deregulation. Reboul and Todra-Simats (2016) show that European highly levered small firms tend to charge higher prices after deregulation to increase their profit margins. For the U.S., firms also tend to push the price up after deregulation but are not able to improve their profit margins because of higher operating costs from new investments in energy efficiency projects (Warwick, 2002 and Woo et al., 2006).

Table 6 The Effect of Leverage on Prices

Variables	All firms		Large firms		Small firms	
	1	2	3	4	5	6
Prices (lag)	0.9447*** [0.00]	0.9147*** [0.00]	0.9966*** [0.00]	0.9898*** [0.00]	0.9394*** [0.00]	0.9039*** [0.00]
Leverage	-0.0022 [0.85]	0.0020 [0.87]	0.0811** [0.04]	0.0803** [0.03]	-0.0173 [0.17]	-0.0203 [0.14]
Leverage * Dereg	0.0039*** [0.00]	0.0024** [0.03]	-0.0028 [0.41]	-0.0023 [0.36]	0.0044*** [0.00]	0.0030* [0.07]
Size		0.0032*** [0.00]		0.0003 [0.86]		0.0039** [0.03]
Growth		0.0034 [0.33]		-0.0016 [0.78]		0.0026 [0.63]
Profitability		-0.0079 [0.62]		0.0377 [0.25]		-0.0273 [0.17]
Asset turnover		-0.0010 [0.74]		-0.0021 [0.70]		-0.0040 [0.35]
No. of obs.	950	950	450	450	500	500
Kleibergen-Paap F statistic	23.02	24.89	6.61	7.62	29.87	30.91
R^2	87.38%	87.62%	85.27%	85.44%	86.57%	87.01%
First-stage regression						
Fixed assets	-0.1459*** [0.00]	-0.1318*** [0.00]	-0.0322 [0.19]	-0.0441** [0.05]	-0.2592*** [0.00]	-0.2294*** [0.00]
Inventories	-0.6302*** [0.00]	-0.6867*** [0.00]	-0.1005 [0.66]	-0.1911 [0.36]	-1.1951*** [0.00]	-1.1355*** [0.00]
Cash	0.9985*** [0.00]	0.9626*** [0.00]	0.5835*** [0.00]	0.6305*** [0.00]	1.1831*** [0.00]	1.0757*** [0.00]

Notes: This table reports the dynamic GMM regression results of PRICES on lagged PRICES, LEVERAGE, LEVERAGE-DEREGULATES interactive terms, and other control variables; columns 1 and 2 for all firms, columns 3 and 4 for large firms, columns 5 and 6 for small firms. Columns 1, 3, and 5 provide the results for the price regressions with only lagged prices, leverage, and leverage-deregulates interaction independent variables. The control variables, which include size, growth, profitability, asset turnover, are added more into columns 2, 4, and 6. The first-stage regressions are also shown in this table. ***,**,* denote statistical significance at the 1%, 5% and 10% levels. p-values are shown in the square brackets.

6.2 Investment

Following Warwick, 2002; Brown, 2005 and Reboul and Todra-Simats, 2016, the primary characteristic of electricity firms is that they have to invest in long-term assets such as power plants, transmission and distribution systems, machineries, equipments and other infrastructures. This subsection focuses on the different investment behavior of large and small firms. Based on Titman and Wessels (1998) and Reboul and Todra-Simats (2016), we measure the investment dependent variable by the ratio of capital expenditures and total assets. Table 7 reports the dynamic GMM regressions of investments on the set of independent variables.

According to Table 7, both large and small levered firms show similar investment strategies. Before deregulation, financial leverage is not significantly related to investment (columns 1-6 of Table 7), which is in line with the less-competitive situation in the U.S. electricity market before deregulation. The U.S. electricity firms did not have enough motivation to issue more debts for investment activities before deregulation. However, under the deregulation pressure, the positive coefficients of leverage-deregulates interactive terms suggest that both highly levered large and small firms tend to invest more to increase market shares (Table 5).

The reason why both large and small levered firms invest more after deregulation can be explained by the nature of U.S. deregulation (Warwick, 2002). First, U.S. authorities require private electricity firms to invest more in new renewable energy or energy efficiency plants through the Renewable Portfolio Standard (RPS) regulations. With few exceptions, U.S. electricity firms have the right to sell power from renewable resources for a premium over power from conventional sources. Second, the deregulation induces private electricity firms to concentrate on customer services for gaining more market shares. These firms use green power or power from a renewable resource as one of the key marketing strategies to access potential consumers.

Table 7 The Effect of Leverage on Investment

Variables	***All firms***		***Large firms***		***Small firms***	
	1	***2***	***3***	***4***	***5***	***6***
Investment (lag)	0.6884*** [0.00]	0.6857*** [0.00]	0.7939*** [0.00]	0.7818*** [0.00]	0.6201*** [0.00]	0.6304*** [0.00]
Leverage	-0.0383 [0.14]	-0.0395 [0.20]	-0.0163 [0.42]	-0.0296 [0.24]	-0.0561 [0.40]	-0.0342 [0.63]
Leverage * Dereg	0.0129*** [0.00]	0.0147*** [0.00]	0.0110*** [0.00]	0.0151*** [0.00]	0.0152** [0.05]	0.0135* [0.07]
Size		-0.0019 [0.14]		-0.0030** [0.03]		-0.0009 [0.70]
Profitability		-0.0037 [0.92]		-0.0370 [0.33]		0.0174 [0.81]
Asset turnover		0.0133*** [0.00]		-0.0006 [0.92]		0.0197*** [0.00]
No. of obs.	2,404	2404	1,220	1,220	1,184	1,184
Kleibergen-Paap F statistic	32.98	30.52	54.32	57.86	6.35	7.75
R^2	49.26%	49.63%	62.02%	61.90%	41.26%	42.23%
First-stage regression						
Fixed assets	-0.1252*** [0.00]	-0.0989*** [0.00]	-0.1817*** [0.00]	-0.1551*** [0.00]	-0.0609*** [0.00]	-0.0422** [0.04]
Inventories	-0.0366 [0.77]	-0.0983 [0.39]	0.2793* [0.10]	0.2024 [0.19]	-0.2568 [0.15]	-0.3492** [0.03]
Cash	0.6363*** [0.00]	0.5577*** [0.00]	1.0525*** [0.00]	0.8184*** [0.00]	0.4309*** [0.00]	0.4201*** [0.00]

Notes: This table reports the dynamic GMM regression results of INVESTMENT on lagged INVESTMENT, LEVERAGE, LEVERAGE-DEREGULATES interactive terms, and other control variables; columns 1 and 2 for all firms, columns 3 and 4 for large firms, columns 5 and 6 for small firms. Columns 1, 3, and 5 provide the results of the investment regressions with only lagged investment, leverage, and leverage-deregulates interaction independent variables. The control variables, which include size, growth, profitability, asset turnover, are added more into columns 2, 4, and 6. The first-stage regressions are also shown in this table. ***,**,* denote statistical significance at the 1%, 5% and 10% levels. p-values are shown in the square brackets.

6.3 Summary of Large and Small Levered Firms' Strategic Behaviors

Based on the regression results from Tables 5, 6, and 7, we can provide a comprehensive understanding of the significant differences in strategic behaviors between large levered and small levered firms. Notably, in line with previous findings of Brander and Lewis (1986), and Reboul and Todra-Simats (2016), we also find that large firms with higher leverage tend to apply the more aggressive strategy after deregulation. They invest more to increase their output and set slightly lower prices.

These strategic behaviors lead to lower profit margins but will expand market shares drastically.

In contrast, the highly levered small firms follow survival strategies to keep their customer base at the expense of profit margins. They have to invest more and charge higher prices to recover the higher operating cost from the new investment in energy efficiency projects. The more demanding competitive environment of the U.S. deregulation compared to that of the European deregulation could explain the differences in the small levered firms' strategies between U.S. and European cases. Reboul and Todra-Simats (2016) find that European highly levered small firms invest less and push the price up to earn higher profit margins at the expense of market shares.

7. Conclusions

This study examines the effect of financial leverage on the competitive level and analyzes the strategic behavior of firms under the higher competitive conditions resulting from the U.S. electricity deregulation in the 1990s. The paper provides several pieces of evidence about the success in adding market forces to expand competitive level in the U.S. electricity market. After deregulation, we find evidence of a significant decrease in the profitability and the assets accumulation ability of U.S. electricity firms. Moreover, our paper applies the dynamic GMM model to handle the endogeneity in the leverage-competition relationship. The GMM model has the advantage over other econometric methodology in that it can directly model the endogeneity in the leverage-competition relationship.

Our study also analyzes the strategic behavior of levered firms when the U.S. electricity market deregulation occurs. After deregulation, the highly levered large firms apply aggressive strategies to expand market shares at the lower magnitude of profit margins. They invest more to increase their output and set slightly lower prices. Meanwhile, the small firms with higher leverage follow survival strategies to keep their existing customer base at the expense of profit margins, given the deregulation pressures. Moreover, they have to invest more and charge higher prices to recover the higher operating cost from new investments in renewable energy projects.

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