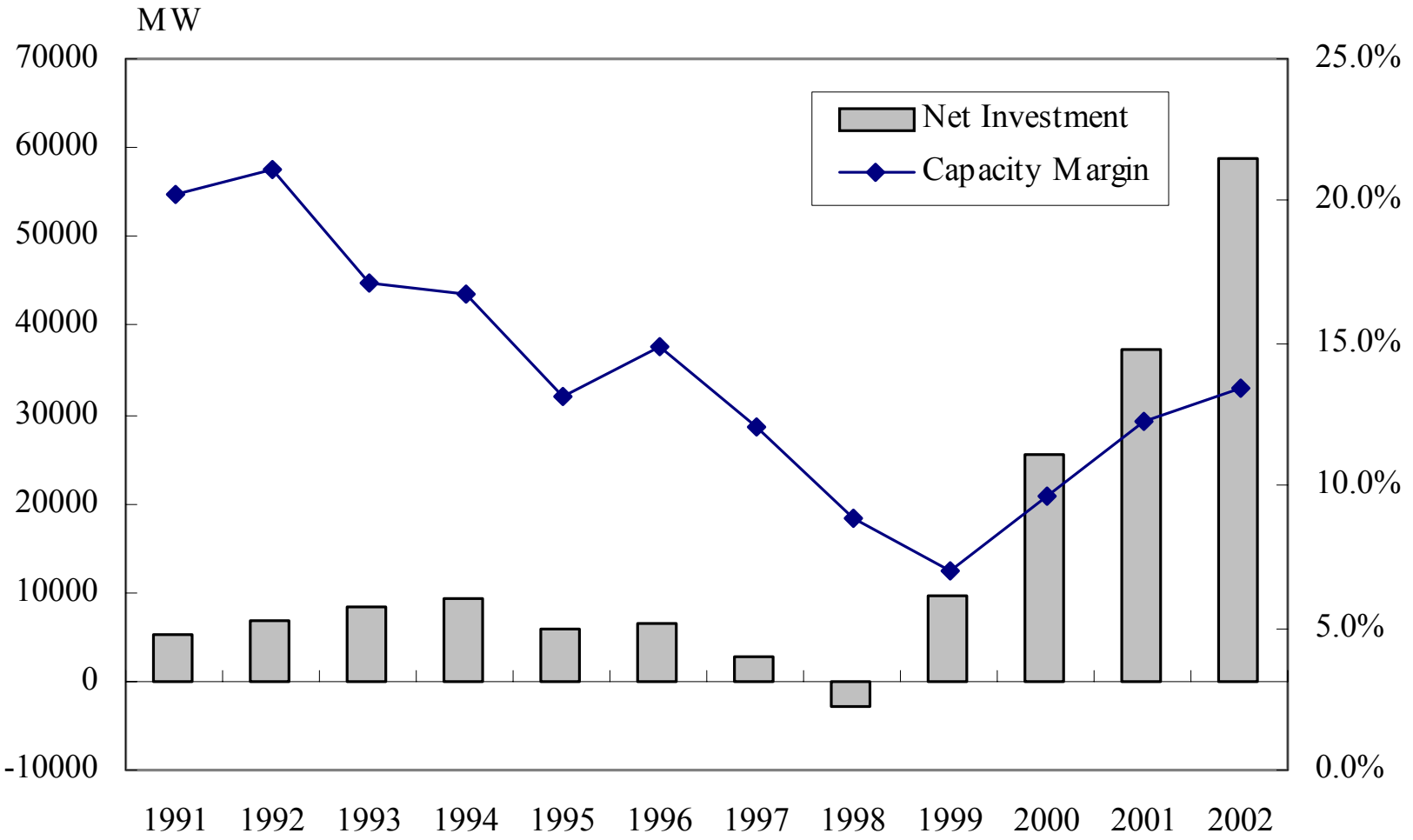
Electric Restructuring and Capacity Investment in Power Generation in the U.S.: A Panel Data Analysis of Generating Capacity

Toru Hattori
Central Research Institute of Electric Power Industry
Tokyo, Japan

Introduction

- Growing concern about capacity investment in restructured electricity industries across the world
- In recent years, the generating capacity in the U.S. has increased rapidly, reverting to the declining trend in the capacity margin
- However, the relationship between the industry restructuring that began in the 1990s and the recent trend in capacity addition is unclear

Net Capacity Investment



Source: EIA and EEI

U.S. Electric Restructuring

- Creation of a competitive wholesale market
  - Open access policy at the federal level initiated by FERC
  - ISOs and centralized spot markets created in some regions
- Allowing retail access to introduce retail competition
- Transfer of ownership of generation assets from regulated utilities to unregulated generators

Implications for Capacity Investment

- Creation of a competitive wholesale market
  - The increased transparency of system operation and the opportunity to trade in the market would encourage capacity investment
  - The opportunity to trade may discourage the investment incentive (make it relatively simple to defer investment)
  - The overall impact of facilitating wholesale competition is ambiguous

Implications for Capacity Investment

- Allowing retail access
  - Retail access creates business opportunities for competitive suppliers and may encourage new investment
  - Risks associated with its implementation may discourage investment
  - Again, the overall impact is ambiguous

Implications for Capacity Investment

- Transfer of ownership of generating assets
  - Unregulated nonutility generators would be more sensitive to profit opportunities as well as risks
  - Regulated utilities tend to overinvest as was suggested by Averch and Johnson (1962), suggesting unregulated generators would invest less
  - Regulatory risks have made the regulated utilities reluctant to invest, suggesting unregulated generators would invest more

Empirical Model

- We use state-level panel data for the period 1990-2002 to examine the impact of the electric restructuring on the generating capacity investment
- We formulate the following regression equation:

$$y_{it} = X'_{it}\beta + Z'_{it}\gamma + \mu_i + \nu_{it}$$

y: Net capacity investment

X: A set of exogenous variables that are not directly related to the restructuring

Z: A set of restructuring indicators

μ: Unobservable time-invariant state-specific effect

The subscript *i* indicates the state and *t* indicates the time period (year)

Empirical Model

- For dependent variable, we use the annual rate of change in the total generating capacity (*DELTACAP*) measured in terms of summer capability (MW)
- Denoting the total capacity in state *i* for the year *t* as $CAPACITY_{it}$, *DELTACAP* is defined as follows

$$DELTACAP_{it} = \frac{\left(CAPACITY_{it} - CAPACITY_{i,t-1}\right)}{CAPACITY_{i,t-1}}$$

Empirical Model

- Independent variables (all lagged one year) that are not directly related to the restructuring (but would affect the investment incentive)
  - The existing capacity (*CAPACITY*)
  - The level of demand (*DEMAND*)
  - The share of nuclear capacity (*PCTNUC*)
  - The share of sale of the industrial customers (*PCTIND*)
  - The ratio of the electricity generated within each state to the electricity sold (*PCTGEN*)
  - The attitude toward environmental concern measured by the score of the National Environmental Scorecard (*ENVSCORE*)

Empirical Model

- Four independent variables to capture the effect of the restructuring
  - A dummy variable for the years after 1996 to capture the effect of the passage of FERC Order 888 (*OPENACC*)
  - A dummy variable for the establishment of the ISOs and centralized wholesale market (*ISOMKT*, *ISOOPR*, or *ISOREG*)
  - A dummy variable for the decision to allow retail access (*LEGACC*, *FSTACC*, or *FULACC*)
  - The share of unregulated nonutility generators in the total capacity (*PCTNUG*)

Estimation

- In our base case estimation, we assume that the restructuring variables are exogenous and independent of each other
  - Potential endogeneity biases are examined by employing two-step estimation, etc.
- We employ simple linear specification for the model described above
  - We also consider a specification that includes multiplicative interaction terms among the restructuring variables
- We estimate the model by OLS, Fixed Effect, and Random Effect models

Empirical Results (Base case)

Variable	Estimate	Variable	Estimate
CAPACITY	-0.2720 *	*OPENACC*	-0.0202 *
	(-2.534)		(-3.31)
DEMAND	0.2505 *	*ISOMKT*	-0.0428 *
	(5.678)		(-2.724)
PCTNUC	-0.3223 ##	*FULACC*	0.0435 #
	(-1.616)		(1.622)
PCTIND	-0.2510 *	*PCTNUG*	0.0971 *
	(-3.41)		(2.495)

Note) Adjusted R-squared is 0.23. t-ratio in parentheses is based on the Newey-West Corrected standard errors.

* indicates statistically significant at the 5% level of significance based on Newey-West standard errors

and ## indicate statistically significant at the 5% and 10% level of significance, respectively, based on the assumption of equal variance within the same state

Empirical Results

- The coefficient of the existing capacity (*CAPACITY*) was significantly negative and that of the total demand (*DEMAND*) was statistically positive, as expected
- The share of nuclear power (*PCTNUC*) was negative as expected
- The share of large industrial demand (*PCTIND*) was negative
  - The ratio of the electricity generated to the electricity sold (*PCTGEN*) and the attitude toward environmental concern (*ENVSCORE*) were not statistically significant in the fixed effect model

Empirical Results

- The dummy variable *OPENACC* was statistically significantly negative, suggesting that FERC order 888 discourage new investment (decreased 2 percentage points)
- The dummy variable *ISOMKT* or *ISOOPR* was statistically significantly negative, suggesting that the operation of ISO discourage new investment (decreased 4 percentage points)
  - The dummy variable ISOREG was not statistically significant, implying that the operation of ISO is critical to discourage new investment

Empirical Results

- The dummy variable *FULACC* was statistically significantly positive, suggesting that allowing retail access encourage new investment
  - But it may not be significant at 5% level of significance
  - The dummy variables *FSTACC* and *LEGACC* were not statistically significant, implying that the impact of allowing retail access can only be observed after the full liberalization
  - The results of the two-step estimation suggest that an increase in the probability of implementing full retail access leads to an increase in investment

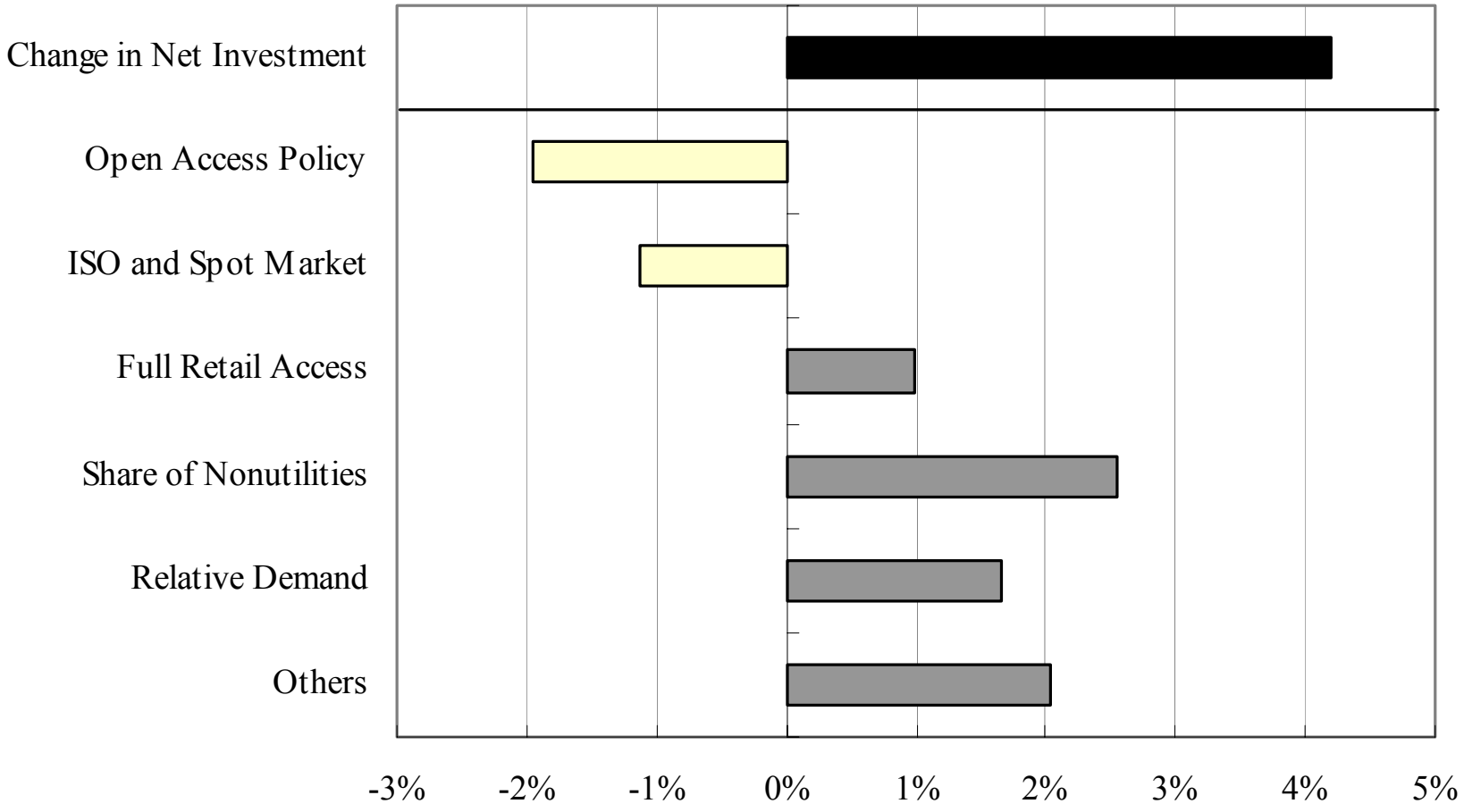
Alternative Specifications

Variable	Estimated Impact on Investment	P-value
(a) Impact of ISO		
ISOMKT (ISOs and spot market in operation)	-4.28%	0.6%
ISOOPR (ISOs in operation)	-3.49%	1.3%
ISOREG (ISOs registered)	-0.84%	37.2%
(b) Impact of Retail Access (treated as exogenous)		
FULACC (Full retail access)	4.35%	10.5%
FSTACC (Full or partial retail access)	0.92%	69.7%
LEGACC (Legislation passed)	0.72%	38.9%
(c) Impact of Retail Access (coefficient of inverse-Mill's ratio)		
FULACC (Full retail access)	2.50%	4.90%
FSTACC (Full or partial retail access)	0.92%	49.50%
LEGACC (Legislation passed)	0.67%	20.60%

Empirical Results

- The capacity share of unregulated nonutility generators PCTNUG was statistically significantly positive, indicating a 10% increase in the capacity share of the nonutility generators increases investment by 1 percentage point
  - This suggests that in the U.S., the unregulated generators are more aggressive investors as compared with the regulated utilities
  - It may also suggest that the incumbent utilities have been relatively cautious with regard to capacity investment under regulation due to the regulatory uncertainty triggered by investment cost disallowance during the 1980s

Contribution of Each Factors



Concluding Remarks

- The impact of electric restructuring on the capacity investment depends on the combination of different aspects of restructuring
  - The federal-level open access policy as well as the establishment of ISOs and spot markets did not necessarily encourage new investment
  - Allowing retail access might have led to an increase in investment, but only after the full liberalization
  - The total capacity investment increased with the nonutility generator capacity
- The U.S. restructuring, has not contributed significantly to the recent growth in investment