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Excess Capacity and Effectiveness of Policy Interventions: Evidence from the cement industry*

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Abstract

Excess production capacity has been a major concern in many countries, in particular, when an industry faces declining demand. Strategic interaction among firms might delay efficient scrappages of production capacity, and policy interventions that eliminate such strategic incentives may improve efficiency. This paper empirically studies the effectiveness of policy interventions in such environment, using plant-level data on the Japanese cement industry. Our estimation results show that a capacity coordination policy that forces firms to reduce their excessive production capacity simultaneously can effectively reduce excess capacity without distorting firms' scrappage decisions or increasing the market power of the firms.

Keywords: Excess capacity, Capacity coordination, Cement, Industrial policy
JEL classification: D24, L13, L52, L61.

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1 Introduction

Excess production capacity has been a major concern in many countries, in particular, when an industry faces declining demand, e.g., the US steel industry in the 1970s, the shipbuilding industry in China and Korea, and the hard disk drive industry in Asia in the 2010s. The excess capacity literature dates back to at least Bain (1962), who defines excess capacity as a "persistent tendency toward redundant capacity at times of maximum or peak demand." Excess production capacity is one source of social inefficiencies; it might cause capital misallocation or limit land use. Policymakers have been particularly concerned about this excess capacity issue, which has been a major topic in several high-level OECD meetings since the 1970s and, more recently, in an OECD policy roundtable in 2011 that discussed this problem of excess capacity in the context of competition law and policy. Although policymakers have extensively discussed the best way to solve the issue of excess capacity, economists have yet to provide a rigorous empirical economic analysis.

As shown theoretically by Ghemawat and Nalebuff (1990), the problem with excess capacity may be resolved through natural selection; excess capacity may put downward pressure on profits, resulting in divestment of unused production capacity and exit of firms from the market. However, it is also well known that, in oligopolistic markets, firms' strategic interaction may delay the process. Firms may keep their excess capacity if they can discourage other firms' production or if they are in a situation of "war of attrition" (Smith, 1974). If such strategic considerations delay the process of capacity adjustment, public policies that eliminate strategic incentives may help restore efficiency.

This paper studies a series of unique policy interventions introduced by the Japanese government to solve the excess capacity problem in the cement industry in the 1980s and 1990s. Although the Japanese cement industry experienced strong growth in demand after the World War II, the industry faced declining demand in the 1970s, triggered by two oil crises. The oligopolistic firms in the industry did not divest their production capacity and the Ministry of Industry and International Trade (hereinafter MITI) initiated a series of policies called "capacity coordination" that forced the cement firms to divest their production capacity *simultaneously*, based on the allotment authorized by MITI. The first capacity coordination policy, implemented between January 1985 and March 1986, targeted a reduction of 30 million tons out of the 129 million tons of existing capacity. Out of the 30 million tons, 25 million tons was nonoperating capacity and five million tons was operating capacity. The second capacity coordination policy, implemented between December 1988 and March 1991, targeted a further reduction of 10.7 million tons of the existing 98 million tons, all of which was operating capacity.

In our empirical analysis, we first show qualitatively that, even with declining demand, the cement firms did not engage in divestment, which leads to the question of why these firms retained their excess capacity. Our empirical analysis shows that their behavior was driven by strategic interaction rather than their production needs. Here, strategic interaction does not mean the firms retained their excess capacity to discourage other firms' production, but instead that the firms played an attrition game, expecting other firms to divest.

This paper then proceeds to evaluate the capacity coordination policy; in particular, whether this policy intervention: (1) distorted the scrappage decisions of the firms, and (2) increased their prices and/or markups. As for the first point, our estimation results show that the firms were likely to divest inefficient plants before policy introduction and their scrappage decision rules were unchanged during the policy implementation period. This result enables us to conclude that capacity coordination could effectively reduce excess capacity without distorting firms' scrappage decisions. As for the second point, we first obtain the plant-level marginal costs based on the first-order conditions for the firms and, using regression analysis, find that both capacity coordination policies did not increase markups charged by the cement firms.

These results might be counterintuitive, as capacity coordination policies are typically viewed as an anticompetitive policy intervention. In particular, after the second policy intervention when the cement firms divested *operating* plants, we naturally expect that the firms would have enhanced their market power. However, this was not the case and further investigation finds that the cement firms concentrated their production within the remaining plants and the utilization rates for those plants increased to almost 100%. In other words, although the second capacity coordination policy forced the firms to shut down some operating plants, they could meet demand with their remaining capacity. Thus, in some sense, these divested plants were excess capacity. Of course, our estimation results for the first capacity coordination policy suggest that, if a capacity coordination policy eliminates just excessive capacity, then the policy would not lower consumer welfare. Therefore, if allotments and total reduction capacity are well crafted, capacity coordination policy potentially accelerates the divestment process without distorting firms' scrappage decisions or lowering consumer welfare.

This paper contributes to the literature on (1) declining industries, and (2) capacity coordination. Even though the study of declining industries is becoming increasingly important, there is only a handful of theoretical and empirical studies in this area. Ghemawat and Nalebuff (1985, 1990), Fudenberg and Tirole (1986), and Whinston (1988) consider an oligopolistic market and examine the firms' decisions to divest and/or exit when the industry faces declining demand. On the empirical side, Lieberman (1990), Deily (1991), and Nishiwaki and Kwon (2013) study firms' exit or plants' closure behavior relating to the firms' observable characteristics and unobserved productivity. More recently, Nishiwaki (2016) and Takahashi (2015), using a structural approach, study firms' exit and divestment decisions, respectively, in declining industries. Nishiwaki (2016) examines the effect of mergers on divestment behavior in the Japanese cement industry and finds that strategic interaction, through business stealing in particular, distorts incentives for divestment. Takahashi (2015) estimates an exit game played by US movie theaters, which builds upon a theoretical framework developed by Fudenberg and Tirole (1986), and finds that strategic interaction among the theaters delay the exit date substantially. Both results suggest that policy intervention may help restore efficiency by eliminating strategic interaction among firms.

Excess capacity in declining industries creates social inefficiency, and one of the policy instruments discussed among policymakers that can address this is capacity coordination. Kamita (2010) investigates a recent case from the US airline industry: the Aloha–Hawaiian immunity agreement. In response to declining demand after September 11, 2001, the US Department of Transportation (DOT) allowed Aloha Airlines and Hawaiian Airlines to coordinate capacity for a limited period of time.[1] She finds that the two firms maintained high prices not only during the immunity period, but also during the subsequent 2.5 years, until a new competitor entered the market. Although empirical analysis on capacity coordination is scarce, Hampton and Sherstyuk (2012) conducts an experimental study. They show that capacity coordination by an enforceable institution, e.g., the government initiative in our context or agreements with enforceable punishment in the Aloha–Hawaiian case, accelerates the capital adjustment process. While their main focus is the effects of capacity coordination on the prices and speed of the capital adjustment process, we also examine their implications for effectiveness and efficiency of the capacity coordination policy.

This paper is organized as follows. Section 2 describes the industry and provides the historical background of the Japanese cement industry, as well as the data used in our empirical analysis. Our empirical models and estimation results are presented in Section 3. Given our findings, we discuss the policy implications and caveats in Section 4. Section 5 concludes.

[1]See Blair, Mak and Bonham (2007) for more detailed information.

2 Industry and Historical Background

2.1 Cement

Cement is one of the most important ingredients for construction works, as concrete or mortar are made from cement. To produce cement, crushed limestone, cray and other minerals are mixed and put into a kiln to be heated. This process yields clinker, which is an intermediate cement product. The final procedure of mixing grinded clinker with gypsum produces cement. The simplicity of this process and homogeneity of the product allow us to analyze and evaluate the capacity coordination policy precisely. In our analysis, we mainly use clinker as our measure of output, because some plants specialize in the production of cement from clinker and do not own any kilns.

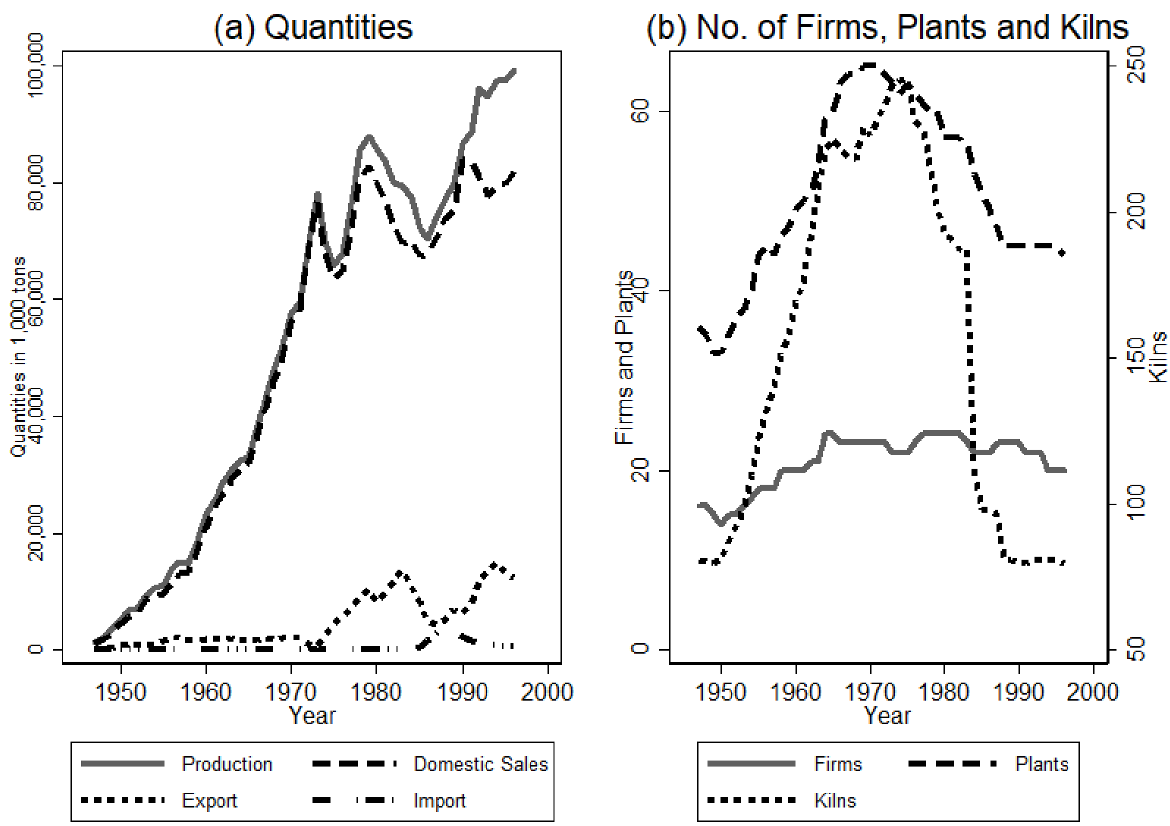
2.2 The Japanese Cement Industry

2.2.1 Historical Background and Excess Capacity

The cement industry in Japan, which dates back to the late 19th century, grew rapidly with the recovery and high growth of the Japanese economy from the late 1940s to the early 1970s. In the period of economic recovery between 1946 and 1954, there was an urgent need to reconstruct the infrastructure and buildings damaged during World War II. In addition, in the so-called high growth period between 1955 and 1973, further investment in infrastructure, such as roads, sea ports, and dams were necessary. These construction investments generated vast demand for cement.

Panel (a) of Figure 1 illustrates the demand and supply of cement in Japan. As shown in the figure, domestic sales of cement, denoted by the dashed line, increased sharply until 1973, when the first oil crisis occurred, and demand was met by domestic production, denoted by the solid line. Indeed, the average annual growth rates of domestic sales and production from 1947 to 1973 were 15.8% and 16.0%, respectively. This production increase was due to new entries of firms as well as expansion of existing firms. As summarized in Panel (b) of Figure 1, new entries took place mainly from the late 1950s to the early 1960s. In this period, strong growth in the cement market induced new entries from related industries, such as coal, chemicals, iron, and steel (Wada, 1995). The number of cement firms in the industry increased from 17 in 1954 to 24 in 1964. Furthermore, the number of cement plants and kilns increased in tandem with the new entries, and it continued to increase in the late 1960s, when the new entries of firms ceased. The production capacity of the cement industry

Figure 1: Industry Evolution over Time

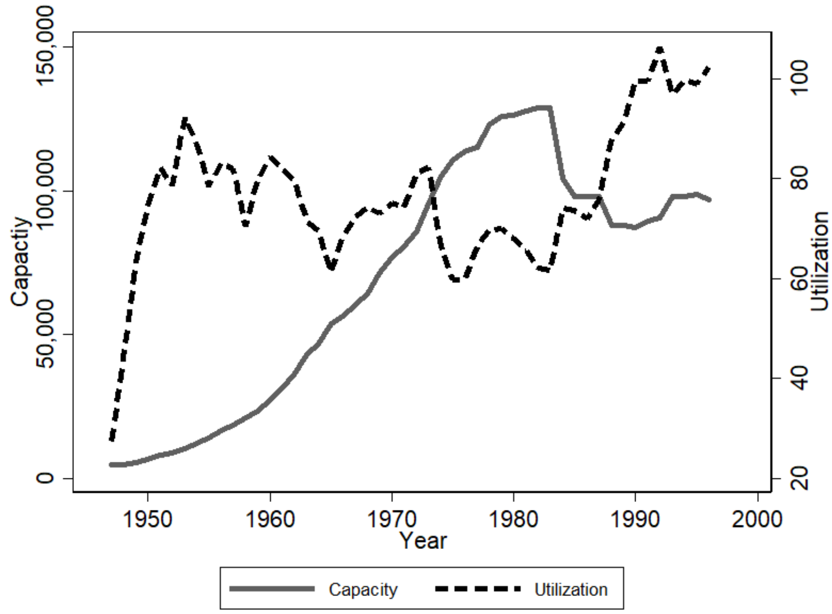


Source: Japan Cement Association (1998), p.117.

increased even more rapidly in the 1950s and 1960s, as denoted by the solid line in Figure 2.

The first oil crisis in 1973 was a turning point of the postwar Japanese economy. In 1974, the growth rate of real GDP became negative for the first time in the postwar period, and put an end to the high growth of previous decades. In the 1950s and 1960s, the Japanese economy continued to grow at around 10% per year, but after the first oil crisis the growth rate fell to 4–5%. This slowdown in economic growth caused a decline in construction investment. Moreover, the increase in the cumulative government deficit and the effort toward fiscal reconstruction reduced public construction investment. The substantial decline in construction investment after the first oil crisis caused a decline in domestic demand for cement, as shown in panel (a) of Figure 1. In addition, the second oil crisis occurred in 1979. After the oil crises, excess capacity emerged in the cement industry. While demand for cement declined, production capacity was maintained or increased slightly until 1985. In the high growth period, the utilization rate of the equipment (production/capacity) was

Figure 2: Capacity and Utilization Rate



Source: Japan Cement Association (1998), p.118-119.

around 70–80%, although it fell below 70% during recessions. After the first oil crisis, the utilization rate was consistently below 70% and sometimes fell below 60%, as in Figure 2.

2.2.2 Policy Interventions

The change in the economic environment after the two oil crises had a serious impact on the cement industry. To maintain profitability under a sharp increase in the oil price, the cement firms organized three series of "recession cartels" to reduce production. These cartels were approved by the Japan Fair Trade Commission under the Antitrust Law. The terms of the cartels were (1) November 11, 1975 to January 31, 1976, (2) June 24, 1977 to December 31, 1977, and (3) August 3, 1983 to December 31, 1983 (Japan Cement Association, ed, 1998: pp.49–50). Although these recession cartels raised the cement price temporarily, they did not promote divestment of capacity, which led to further policy intervention by MITI.

In 1984, the cement industry was subject to the Temporary Law for Structural Improvement of the Special Industries (Tokutei Sangyō Kōzō Kaizen Rinji Sochi Hō) with 25 other industries, including electric furnace steelmaking, aluminum refining, and synthetic fiber (Editorial Committee of the History of Trade and Industrial Policy and Okazaki, eds, 2012: pp.52–3).[2] This law aimed to reduce excess capacity in industries whose utilization rates of

[2]Prior to this law, a similar law called "the Temporary Law for Stabilization of the Special Recession

equipment remained low for a certain period of time, and MITI arranged capacity coordination in each designated industry by organizing cartels ("instructed cartels"). In August 1983, the cement industry applied to MITI for a capacity coordination plan, which was approved in April 1984, and the "Basic Plan for Structural Improvement of the Cement Industry" was announced by MITI in August 1984 (Japan Cement Association, ed, 1998: p.51). To implement this capacity reduction plan, MITI instructed the cement firms to organize a cartel on January 31, 1985 (Cement Press ed. 1985, p.18).

The plan consisted of two main components: (a) capacity coordination, and (b) organization of firms into five groups to promote cooperation within the groups. Regarding capacity coordination, the plan prescribed that 30 million tons of the 129 million tons of existing capacity for cement clinker be scrapped. Of this 30 million tons, 25 million tons was nonoperating equipment and five million tons was operating equipment (Cement Press ed. 1985, pp.16–7). Moreover, the allotment of capacity reduction to each firm was decided through negotiation with the firms and MITI by January 1985. The allotment is shown in Table 1 and indicates there was heterogeneity in divestment rates. The firms were required to dispose of their excess capacity according to the allotment by the end of March 1985 except for six operating kilns, and these six operating kilns were to be disposed of by the end of March 1986. To alleviate unequal allotment across the firms, monetary side-payments were introduced.[3] To smooth the implementation of capacity coordination, 23 cement firms were organized into five groups, each of which established a new company for cooperative businesses within the group, such as consignment production, joint sales, and arrangement of transportation (Japan Cement Association, ed, 1998: p.51).[4]

By the end of March 1986, the divestment plan associated with the Temporary Law for Structural Improvement of the Special Industries was completed. However, at that time, the cement industry faced a new challenge, namely, a sharp appreciation of the yen after the Plaza Agreement in September 1985. Because of the increase in imports and decline in exports, excess capacity remained despite completion of the divestment plan. In the meantime, because the Temporary Law for Structural Improvement of the Special Industries was due to expire in June 1988, MITI prepared a new law for capacity reduction, the Law for Facilitating Transformation of Industrial Structure (Sangyō Kōzō Tenkan Enkatsuka Rinji

Industries" (Tokutei Fukyo Sangyō Antei Rinji Sochi Hō) was legislated in May 1978. Although the cement industry was not subject to this earlier law, many other industries that were subject to the Temporary Law for Structural Improvement of the Special Industries were also subject to the earlier law.

[3] See Appendix A.

[4] This grouping remained after the removal of the Temporary Law for Structural Improvement of the Special Industries (Japan Cement Association, ed, 1998: p.53).

Table 1: Allotment of Capacity Reduction

		1st Policy Intervention			2nd Policy Intervention		
		Existing	Reduction		Existing	Reduction	
Group	Firm	capacity	Amount	%	Capacity	Amount	%
1	Onoda Cement	15,378	5,605	36.4	9,840	746	7.6
	Mikawa Onoda Cement	-	-	-	360	0	0.0
	Hitachi Cement	1,543	230	14.9	872	0	0.0
	Mitsui Kozan	3,827	1,618	42.3	2,209	0	0.0
	Shin-Nittetsu Kagaku	1,172	378	32.3	794	0	0.0
	Toyo Soda Kogyo	4,134	906	21.9	3,228	0	0.0
2	Nihon Cement	17,967	4,936	27.5	13,031	1,555	11.9
	Myojo Cement	3,150	699	22.2	2,451	0	0.0
	Daiichi Cement	1,449	357	24.6	1,092	0	0.0
	Osaka Cement	7,965	1,205	15.1	6,760	1,469	21.7
3	Mitsubishi Kogyo Cement	14,120	926	6.6	12,799	2,198	17.2
	Tokuyama Soda	6,886	1,780	25.8	5,106	0	0.0
	Tohoku Kaihatsu		0	0	2,314	0	0.0
4	Sumitomo Cement	12,558	1,833	14.6	10,112	1,677	16.6
	Hachinohe Cement	1,310	0	0	1,310	0	0.0
	Aso Cement	1,672	356	21.3	1,316	0	0.0
	Karita Cement	2,318	661	28.5	1,657	659	39.8
	Nittetsu Cement	1,789	282	15.8	1,507	0	0.0
	Denki Kagaku Kogyo	3,517	881	25	2,636	0	0.0
5	Ube Kosan	10,887	363	3.3	10,524	2,411	22.9
	Chichibu Cement	10,797	5,020	46.5	5,777	0	0.0
	Tsuruga Cement	1,893	248	13.1	1,645	0	0.0
	Ryukyu Cement	690	150	21.7	540	0	0.0
	Total	125,615	29,027	23.1	97,880	10,705	10.9

Source: Cement Press (1989), p.47.
Note: The values in the third, fourth, sixth and seventh columns are measured in thousands of tons.

Sochi Hō) in April 1987. Cement kilns were subject to this law, along with 22 other kinds of equipment, and a capacity coordination policy similar to that under the Temporary Law for Structural Improvement of the Special Industries was implemented (Editorial Committee of the History of Trade and Industrial Policy and Okazaki, eds, 2012: pp.62-7). In December 1988, a divestment plan to scrap 10.7 million tons of the existing 98 million tons of capacity was authorized by MITI, and this plan was completed by March 1991. At that time, however, because of an increase in demand under the "Heisei bubble" boom, cement firms experienced capacity shortages. Consequently, they applied to MITI to cancel their obligations under the law, which was approved in May 1991 (Japan Cement Association, ed, 1998: pp.52-3).

2.3 Data Sources and Descriptive Statistics

We manually collect the data from various issues of *Cement Yearbook (Cement Nenkan)*, published by the Cement Press Co. Ltd. (Cement Shinbunsha), which is also used by Nishi-

Table 2: Summary Statistics

	Num. of Obs.	Mean	Std. Dev.	Min	Max
Panel (a): Firm-Level Statistics					
# of Firms		–	–	20	24
# of Plants within a Firm		2.50	1	1	11
Panel (b): Plant-Level Statistics					
In 1970 (beginning year)					
Monthly Capacity	54	128,815	80,133	25,000	350,000
Production (clinker)	54	1,031,160	616,927	48,000	2,684,197
Utilization	54	69.1%	20.7	9.3%	115.3%
# of Workers	54	318.8	175.6	114	1205
In 1995 (last year)					
Monthly Capacity	40	202,656	123,469	55,167	588,417
Production (clinker)	40	2,227,377	1,528,054	616,784	7,405,758
Utilization	40	88.9%	10.8	54.4%	104.9%
# of Workers	40	145.2	67.0	51	399

waki and Kwon (2013) and Nishiwaki (2016). This yearbook provides plant-level information on monthly production capacity, production output (both clinkers and cement), number of workers, number of kilns, size of individual kilns, kiln ownership, and the geographical location of the plants. In terms of geographical location, we divide the territory of Japan into eight areas, as in Nishiwaki (2016). We obtain the price of gypsum from the Corporate Goods Price Index, published by the Bank of Japan. We use the price as an instrument when estimating the demand function in our empirical analysis.

Summary statistics of our data, from 1970 to 1995, are given in Table 2. Panel (a) presents two firm-level statistics: the number of firms and the number of plants within a firm. The number of firms varies across the years in the sample, ranging from 20 to 24, because of some entries and exits, as shown in Figure 1. The number of plants within a firm varies substantially, ranging from 1 to 11, which indicates there is heterogeneity in firm size. Panel (b) of Table 2 presents plant-level statistics for 1970 and 1995, the start and end years of our sample. It is clear that the number of plants decreased from 54 to 40 during this period. Both monthly capacity and annual production increased but the growth rate of production was higher than that of monthly capacity, which resulted in a higher utilization rate in 1995. Note that the average utilization rate in 1970 was about 70%, which is lower than our expectation, as in 1970 the Japanese economy was still experiencing high growth and it was prior to the first oil crisis. We can also see a dramatic decrease in the number of workers: in 1970, the average number of workers was about 382, but in 1995 this had fallen to 145. This change indicates that there was substantial technological advancement in the form of automation and, as consequently, labor productivity increased sharply.

3 Empirical Analysis

Given our motivation stated in the previous section, this section attempts to evaluate the policy introduced by the Japanese government. Before assessing the policy, however, we first investigate why the firms have an incentive to keep their excess production capacity in Subsection 3.1. Then, given our findings, we proceed to policy evaluation. In particular, Subsection 3.2 examines whether or not the firms' divestment decisions were distorted by the policy, whereas Subsection 3.3 examines whether the policy affected the market power of the cement firms.

3.1 Why did not the Firms Divest?

As shown in the previous section, the firms did not divest their production capacity even though demand for cement was much lower than the industry's total capacity. A natural question then arises: "Why did the firms not divest their production facility?" In answering this question, we first investigate the firms' behavior theoretically to determine the possible impacts of holding (excess) capacity. Consider a dynamic oligopoly model, similar to Nishiwaki (2016), with both static and dynamic decisions. Static decisions include choices regarding quantity, whereas dynamic decisions include investment/divestment and entry/exit. This framework enables us to determine whether excess capacity could potentially affect other firms through three distinct channels. Excess capacity may affect (1) quantity produced by rival firms, (2) investment or divestment of rival firms, and (3) entry or exit of rival firms. The last channel is addressed in two different bodies of literature: strategic entry deterrence as in Wenders (1971) and Spence (1977), and exit games as in Fudenberg and Tirole (1986), Smith (1974), Ghemawat and Nalebuff (1985), and Takahashi (2015). In our case, however, there were few entries or exits observed in the data, which does not allow us to study such effects quantitatively. Therefore, in the following analysis, we focus on the first and second channels which are closely related to each other.

The first channel examines the effect of investment, a dynamic decision, on the quantity produced, a static decision. Naturally, firms cannot produce more than their capacity and thus, quantity is affected by capacity choices as in Kreps and Scheinkman (1983). Moreover, if production cost depends on production capacity (e.g., economies of scale), firms may invest more to reduce their own production costs, which results in a change in production quantities of their rivals. Even capacity has no direct impact on production costs; however, unused capacity may still affect other firms' production quantities in a repeated game. As pointed out by Devidson and Deneckere (1990), by holding excess capacity, it is easier to sustain collusion because excess capacity makes the punishment harsher. The second channel has been studied mainly in growing industries since the seminal work of Spence (1979), who unravel the preemptive role of investment. The literature has extended to declining industries, both theoretically and empirically, as demonstrated by Ghemawat and Nalebuff (1990) and Nishiwaki (2016). Motivated by these theoretical explanations of why firms have an incentive to keep their production capacity, we empirically examine whether having (excess) capacity affects the production and investment of other firms.

Impact of Excess Capacity on Quantity Produced We start by empirically investigating the first channel, i.e., whether having (excess) capacity affects production. To do so, consider the following static maximization problem of firm j:

$$\max_{q_j} P(q_j, q_{-j})q_j - c_j(q_j) \ \text{ s.t. } q_j \leq K_j,$$

where q_j and q_{-j} are the output of firm j and all other firms, respectively, $c_j(\cdot)$ is a cost function for firm j, and K_j is the maximum capacity that firm j can produce. When solving for an equilibrium, the equilibrium quantity for firm j is expressed as:

$$q_j^* = Q_j^*(K_j, K_{-j}),$$

which means that the equilibrium quantity is a function of capacities.[5] Therefore, we first estimate this relationship using the following specification:

$$\text{[Specification 1]} \qquad q_{j,t} = \alpha_0 + \alpha_1 K_{j,t} + \alpha_2 \sum_{i \neq j} K_{i,t} + \varepsilon_{j,t}.$$

Here the parameter of interest is α_2, which quantifies the impact of rivals' capacity on the quantity produced. Although Specification 1 is derived from a theoretical model and α_2 reveals whether or not having capacity itself affects the production of other firms, we still cannot determine whether having *excess* capacity affects production. To see the impact of excess capacity on quantity produced, therefore, we further control for the total quantity produced by other firms in Specification 2:

$$\text{[Specification 2]} \qquad q_{j,t} = \alpha_0 + \alpha_1 K_{j,t} + \alpha_2 \sum_{i \neq j} K_{i,t} + \alpha_3 \sum_{i \neq j} q_{i,t} + \varepsilon_{j,t}.$$

[5]Note that cost differences across the firms are already captured by the differences in function $Q_j^*(\cdot)$.

Intuitively, by adding the production quantity of the other firms, the coefficient on rivals' capacity now captures the effect of excess capacity on own production. Furthermore, there is one additional reason for controlling for the production quantity of the other firms. Production technology in the cement industry might exhibit economies of scale, which implies that a larger capacity may enable firms to produce cement at lower marginal cost. Suppose a rival firm has a large production capacity. This cost advantage induces more output from this rival firm and, in response to such a cost advantage, firm j must produce a smaller amount because of strategic interaction. This effect arises from economies of scale, and Specification 1 cannot capture this effect separately from the other strategic effects of capacity. Thus, we must control for production quantity of the other firms. If this is the only strategic role of capacity, we would expect that α_2 is zero. However, if capacity has some other strategic roles, such as a threat of future punishment as found by Devidson and Deneckere (1990), we would expect α_2 to be negative.

Unfortunately, from an econometrics point of view, this relationship cannot be estimated straightforwardly, as there is an endogeneity concern between $q_{j,t}$ and $\sum_{i \neq j} q_{i,t}$ because of simultaneity, and a possible nonlinearity concern with $\sum_{i \neq j} q_{i,t}$. Thus, we use an instrumental variable approach and flexibly control for $\sum_{i \neq j} q_{i,t}$. The instruments exploited here are similar to that of Berry, Levinsohn and Pakes (1995), i.e., other firms' quantity produced in another area and other firms' number of kilns in another area. Usage of this set of instruments assumes that a firm having a cost advantage in one region must have the same cost advantage in other regions. Hopefully, these instruments solve the endogeneity problem, but to further ease concerns about endogeneity, we control for fixed effects for year, area, and firm.

Impact of Excess Capacity on Investment Next, we empirically investigate the second channel: whether the (excess) capacity of other firms affects investment. According to the aforementioned literature, investment itself may have some strategic roles, i.e., investing in capacity may deter investment by other firms. In our context, firms may delay divestment because they expect divestment by other firms. Demonstrating such an effect, however, is difficult because we cannot directly observe firms' expectations. Rather, we employ the following regression model to test our hypothesis:

$$\text{[Specification 3]} \qquad i_{j,t} = \alpha_0 + \alpha_1 \sum_{i \neq j} i_{i,t-1} + \varepsilon_{j,t}, \qquad \text{where } i_{j,t} = K_{i,t} - K_{i,t-1}.$$

Table 3: Impact of Excess Capacity on Production

	Specification 1		Specification 2			Specification 3	
	(i) OLS	(ii) OLS	(iii) IV	(iv) IV	(v) IV	(vi) OLS	(vii) OLS
Dependent Variable	$q_{j,t}$	$q_{j,t}$	$q_{j,t}$	$q_{j,t}$	$q_{j,t}$	$i_{j,t}$	$i_{j,t}$
Own Firm Capacity	.950***	.948***	.955***	.955***	.961***		
$\log(K_j)$	(.030)	(.031)	(.062)	(.036)	(.074)		
Other Firm Capacity	-.493***	-.502***	-.312	-.299	-.270		
$(\log(\sum_{l \neq i} K_l))$	(.099)	(.104)	(.235)	(.246)	(.397)		
Other Firm Quantity			-.257	-.510	-14.99		
$\log(\sum_{l \neq i} q_l)$			(.233)	(1.814)	(152.0)		
Other Firm Quantity^2				.008	-.934		
$(\log(\sum_{l \neq i} q_l))^2$				(.056)	(9.720)		
Other Firm Quantity^3					-.020		
$(\log(\sum_{l \neq i} q_l))^3$					(.207)		
Investment of Others						-.120**	-.101*
$\sum_{i \neq j} \log(i_{i,t-1})$						(.055)	(.054)
Own Investment							-.142***
$\log(i_{j,t-1})$							(.041)
Other Controls		√	√	√	√	√	√
Fixed Effects							
Year	√	√	√	√	√	√	√
Area	√	√	√	√	√	√	√
Firm	√	√	√	√	√	√	√
No. of Observations	461	461	419	419	419	388	388
Adjusted R^2	.919	.919	.921	.920	.919	.083	.112

Note: Significance levels are denoted by < 0.10 (*), < 0.05 (**), and < 0.01 (***). The numbers in parentheses show the standard errors. In Specification 2, instrumental variables are used to cope with endogeneity for $\sum_{i \neq j} q_{i,t}$ arising from simultaneity.

If our hypothesis is true, no divestment by other firms in the previous periods leads to divestment in the current period. Or, equivalently, by observing divestment of other firms, firms may decide to keep their production capacity. Therefore, we expect α_1 to be negative.

Results Table 3 summarizes the results for all specifications. The first two columns, labeled (i) OLS and (ii) OLS, present the results for Specification 1. Although both (i) and (ii) include year, area, and firm fixed effects, (ii) additionally includes regional-level GDP, and plaster and oil prices to control for demand and supply conditions. The third to fifth columns, labeled (iii) IV, (iv) IV, and (v) IV, present the results for Specification 2. As explained above, these three models under Specification 2 use an IV approach to cope with endogeneity arising from simultaneity of $q_{j,t}$ and $q_{-j,t}$. The differences among (iii), (iv), and (v) are the number of higher order terms that are included: (iii) includes up to a second order term of other firms' quantities, but (iv) and (v) include up to third and fourth order terms, respectively. Moreover, these three models include, again, regional-level GDP, and plaster and oil prices to control for demand and supply conditions.

In both specifications, we are ultimately interested in the coefficient on other firms' capacity. When not controlling for other firms' production as in Specification 1, other firms' capacity has negative impacts on own production quantity. Regardless of the inclusion of some additional controls, this finding is robust. However, after controlling for the quantity produced by other firms as in Specification 2, other firms' capacity no longer has any impact. The absence of any effect of other firms' capacity suggests that it plays a strategic role *via* other firms' production behavior. When a firm competes against rival firms that have large capacity, then naturally these rival firms produce more, which results in less production by this firm. However, we do not observe other strategic aspects of excess capacity, such as the channel pointed out by Devidson and Deneckere (1990).

The last two columns of Table 3 show the results for Specification 3. We run two regressions, including and excluding own investment as a right-hand-side variable. Model (vi) does not include own investment, whereas Model (vii) does. Moreover, both models (vi) and (vii) include regional-level GDP, and plaster and oil prices, to control for demand and supply conditions. In Specification 3, our interest is in the coefficients on other firms' investment, which are negative and statistically significant for both models. This result suggests firms do take into account other firms' investment (divestment) behavior in the previous year, when making investment (divestment) decisions this year. In particular, the results mean that the firms divest their capacity less when they observe divestment of other firms. These outcomes are consistent with the hypothesis that firms delay divesting, and wait for other firms to divest.

Returning to our original question of "why did the firms not divest their production facility?" our short answer is because of strategic interaction. Here strategic interaction does not mean that *excess* capacity discourages other firms' production. Instead, the cement firms may have played an attrition game by not divesting their production facility, while expecting other firms to divest. The government may have noticed this strategic incentive and thus initiated the capacity coordination policy—reducing the firms' capacity simultaneously—which eliminates such strategic incentives.

3.2 Which plants were divested?

Turning to the policy assessment, we first address the question of which plants were divested during the policy implementation. Given the allotment and relatively short timeframe, the firms might have shut down the plants that were relatively efficient. This question motivates us to examine the following relationship between the investment (divestment) decision and the productivity of the plants:

$$\begin{aligned}\Delta\text{Capacity}_{i,t} &= \beta_0 + \beta_1\text{Productivity}_{i,t-1} + \beta_2\text{Productivity}_{i,t-1}\cdot\mathbf{1}_{\{t=1985,1986\}} \\ &\quad +\beta_3\text{Productivity}_{i,t-1}\cdot\mathbf{1}_{\{t=1988,1989,1990\}} + \text{Controls}_{i,t} + \epsilon_{i,t},\end{aligned}$$

where $\Delta\text{Capacity}_{i,t} = \text{Capacity}_{i,t} - \text{Capacity}_{i,t-1}$. The left-hand-side variable is positive (negative) if the firm invests (divests). The right-hand-side variables reflect the productivity of plant i, and interact with the two indicator variables during policy implementations. Naturally, we expect that β_1 is positive, as we believe that the firms invest in plants that are efficient plants and divest otherwise. If the estimates of β_2 are different from zero, then it means that the divestment decision during policy implementation is different from the base years. In particular, if β_2 is statistically significantly positive, it implies that the firms divested inefficient plants more than they did in the base years. Conversely, if β_2 is statistically significantly negative, it implies that the firms divested inefficient plants less than they did in the base years. The same inference holds for β_3.

In terms of the measure of productivity of the plants, we use three productivity measures. The first one is labor productivity, which is conveniently available in the dataset. The second measure is the utilization rate of plants, which is a proxy of productivity like investment.[6] The third measure is total factor productivity, which is widely used in the industrial organization literature. Assuming Cobb–Douglas production functions, our measure can be recovered as unobserved productivity, ω_{it}, in the following model:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \epsilon_{it},$$

where (i) y_{it}, k_{it}, and l_{it} are logarithms of output, capital input, and labor input for plant i at period t; and (ii) ϵ_{it} is an idiosyncratic error term. We estimate this model using an approach developed by Olley and Pakes (1996) that relies on dynamic investment in an entry/exit model of firms.

[6] For example, Gavazza (2011) also uses the utilization rate as a productivity measure.

Table 4: Divestment Decisions with Three Productivity Measures

Productivity Measure	(i) Labor Productivity	(ii) Utilization Rate	(iii) TFP from OP (1996)	(iv) Labor Productivity	(v) Utilization Rate	(vi) TFP from OP (1996)
Productivity Baseline	.030***	.002***	.113***	.021***	.002***	.111***
	(.009)	(.000)	(.014)	(.007)	(.000)	(.013)
Productivity × 1985/1986	-.027	-.001	-.031	-.026	-.001	-.023
	(.027)	(.001)	(.049)	(.027)	(.001)	(.048)
Productivity × 1988/1990	-.012	-.001	-.030	-.015	-.001	-.026
	(.026)	(.001)	(.078)	(.026)	(.001)	(.076)
Local Price	.301**	.186	.255*	0.285**	0.161	0.219
	(.145)	(.152)	(.141)	(.145)	(.151)	(.140)
Fixed Effects						
Year	√	√	√	√	√	√
Firm	√	√	√			
Area	√	√	√	√	√	√
N	908	972	908	908	972	908
Adj$-R^2$	.230	.244	.276	.230	.244	.284

Note: Significance levels are denoted by < 0.10 (*), < 0.05 (**), and < 0.01 (***). The numbers in parentheses show the standard errors.

The estimation results are presented in Table 4, whereas the production function results are summarized in Table B1 in Appendix B. Table 4 includes the results for six specifications: the first and fourth columns use labor productivity as the productivity measure, the second and fifth columns use utilization rate as the productivity measure, and the third and sixth columns use TFP, recovered using the method of Olley and Pakes (1996), as the productivity measure. For all specifications, we add local prices to control for market demand conditions. The first, second, and third columns include fixed effects of year, firm, and area, whereas the fourth to six columns include only year and area fixed effects.

Regardless of the productivity measures, the estimates of baseline productivity, β_1, are always positive and statistically significant at any level, which implies that the firms invest in more productive plants and divest unproductive plants. This result is consistent with our expectation. However, the coefficients for productivity interacted with the 1985/1986 or 1988/1990 dummies, β_2 and β_3 respectively, and are statistically insignificant for all specifications, which indicates that the firms did not change their investment/divestment decisions during policy implementations. These results are very robust and we can conclude that this policy did not distort the firms' scrappage decision rule.

These results naturally raise an additional question: were those divested plants also inefficient from a social point of view? The results described above imply that inefficient plants within a firm were divested; but not necessarily that inefficient plants from a social point of view were divested. Therefore, to answer this additional question, we drop firm fixed effects from the regression and the results are presented in the fourth to sixth columns in Table 4. As is clear from the results, the previous results still hold, not only qualitatively but also quantitatively, which means that the divested plants were not only individually inefficient but also socially inefficient. How is this possible? We believe that it is because the plan proposed by MITI was very well crafted. A simple production process, one of the characteristics of this industry, enabled the regulator to easily measure unobserved productivity of the plants and the side-payment scheme helped the firms to agree on the allotment. We discuss this issue further in Section 4.

3.3 Impact on Prices and Markups

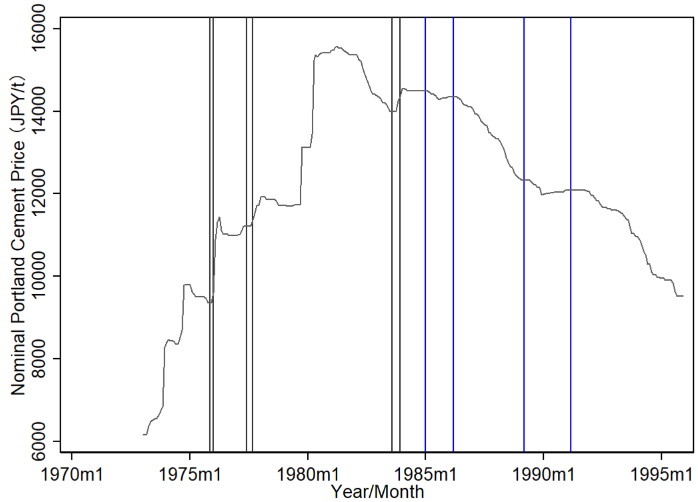
In the previous section, we showed that firms' scrappage decisions were not distorted by the policy. The next question is whether the policy had any impact on prices and markups that could affect consumer welfare. In other words, we are interested in examining whether the policy distorted the functioning of the market. Figure 3 shows changes in the nominal national average price of Portland cement in Japan. This figure shows that, although there were significant price increases during the three recession cartel periods in the 1970s and the early 1980s, there were no significant price changes during the capacity coordination policy implementations. However, existing literature, e.g., Kamita (2010) and Hampton and Sherstyuk (2012), points out that capacity coordination policies have procollusive effects. To examine whether this policy facilitated collusion, we focus on not only the prices but also the markups charged by the firms, because prices are also driven by other factors, whereas markups are a more accurate measure of market power.

To estimate the markup, which is unobservable, we use a two-step method commonly used in the literature, including by Röller and Steen (2006) who study the Norwegian cement industry. In the first step, we specify and estimate the following demand function:

$$\log(Q_{mt}) = \alpha \log(P_{mt}) + X_{mt} + \varepsilon_{mt},$$

where Q_{mt} and P_{mt} are the total quantity produced and the price in region m in a given year t, X_{mt} are region- and year-specific demand shifters, and ε_{mt} is the regression error term. Notice that the unit of observation here is a combination of year and region. The use of this

Figure 3: Transition of the Nominal Portland Cement Price in Japan



Note: The first three sets of black vertical lines represent the recession cartel formation periods, whereas the last two sets of blue vertical lines represent the periods when the capacity coordination policy was introduced.

log–log specification for cement demand can be also found in Ryan (2012). To address the simultaneity bias, we take an instrumental variable approach and the instrument used here is the price of gypsum, which is an intermediate input explained in Section 2.

The second step relies on microeconomic theory. Assuming that the firms compete in quantity, we can use the first order conditions with respect to the quantity, which gives us the following equation:

$$\frac{\partial \pi_{fmt}}{\partial q_{fmt}} = P_{mt} + \frac{\partial P_{mt}}{\partial Q_{mt}} q_{fmt} - \frac{\partial c(q_{fmt})}{\partial q_{fmt}} = 0,$$

where π_{fmt} and q_{fmt} are the profit and production of firm f operating in region m at time t, respectively, and $c(\cdot)$ is a cost function. On the right-hand-side of the equation, the sum of the first two terms represents the marginal revenue, whereas the last term is the marginal cost, which we want to recover. In the data, we directly observe P_{mt} and Q_{mt}. Moreover, as the estimates of α are elasticities of demand, we can rewrite $\frac{\partial P_{mt}}{\partial Q_{mt}}$ using α, P_{mt}, and Q_{mt}:

$$\frac{\partial P_{mt}}{\partial Q_{mt}} \bigg/ \frac{P_{mt}}{Q_{mt}} = \alpha, \tag{1}$$

which means that, knowing α, P_{mt}, and Q_{mt}, we can obtain the marginal cost. Once we have the marginal costs, we can easily calculate the markups as a function of α, q_{fmt}, and Q_{mt}:

$$\frac{P_{mt} - mc}{P_{mt}} = \alpha \frac{q_{fmt}}{Q_{mt}}.$$

Table 5 shows the estimation results for the demand function. Ideally, we want to include the year fixed effects. Unfortunately, there is no variation in gypsum prices across regions, i.e., we only observe a national level gypsum price in a given year. Thus, instead of including the year fixed effects, we control for the year effects using a flexible function of year. The table contains the results for four different demand specifications. The first column, labeled (i) OLS, shows the regression results without using any instruments, whereas the rest of the specifications use an instrument, but the flexibility of year is slightly different in each case. As expected, the estimated price coefficient using OLS is higher than those of other specifications, indicating that Model (i) suffers from upward bias. Although models (ii) to (iv) provide similar qualitative results, the magnitude of the price coefficient in Model (ii) is slightly different from those of models (iii) and (iv). We believe this discrepancy reflects the shape of price. As in Figure 3, the trend in price movement is inverse-U shaped, but not exactly symmetric. Thus, to mimic this pattern, we should include at least the third order term of the year effects.

Table 5: Demand Function Estimation

	Model (i) OLS	Model (ii) IV	Model (iii) IV	Model (iv) IV
$\log(P_{mt})$	-0.07	-5.99*	-.83*	-1.11*
	(.16)	(3.35)	(.47)	(.58)
Controls				
Year	√	√	√	√
Year^2	√	√	√	√
Year^3	√		√	√
Year^4	√			√
GDP	√	√	√	√
Area Fixed Effects	√	√	√	√
Instrument Used				
Gypsum Price		√	√	√
N	184	176	176	176
Adj or Centered R^2	0.96	.63	.96	.95

Note: Significance levels are denoted by < 0.10 (*), < 0.05 (**), and < 0.01 (***). The numbers in parentheses show the standard errors.

Using the estimated demand elasticity coefficients and equation (1), we recover the markups for the firms, which are given in Panel (a) of Table 6. The three specifications correspond to the three different elasticities estimated by models (ii), (iii), and (iv) in Table 5. Again, although models (ii), (iii), and (iv) provide similar qualitative results, the magnitude in Model (ii) is quite different from those in models (iii) and (iv): Model (ii) gives us a 4% markup on average, whereas models (iii) and (vi) give us a 25% markup. Inclusion of the higher order terms of year effects does not change our quantitative results from those in models (iii) and (vi). Given that cement is a typical process industry with high fixed costs, we believe that relatively large markups in models (iii) and (vi) seem more realistic than the estimates in Model (ii).

Next, to investigate whether the policy increased markups for the firms, we regress the markups on the indicator variables for 1985/1986 and 1988/1990:

$$\text{Markup}_{jmt} = \gamma_0 + \gamma_1 \mathbf{1}_{\{t=1985,1986\}} + \gamma_2 \mathbf{1}_{\{t=1988,1989,1990\}} + F_m + F_f + \varepsilon_{mt}.$$

If the markups increased during policy implementations, the estimated coefficients for these indicator variables, namely γ_1 and γ_2, will be positive. The estimation results are summarized in panel (b) of Table 6. Again, we use three different demand specifications to check the robustness of our results, corresponding to models (ii), (iii), and (vi) in Table 5. The first, third, and fifth columns in panel (b) of Table 6 present the results, assuming that each individual firm maximizes its own profit; whereas the results in the second, fourth, and sixth columns assume that each group of firms maximizes its joint profit. As explained in Section 2, when MITI initiated this capacity coordination policy, the firms were categorized into five groups and the firms in a group could cooperate to some extent. Thus, to capture such effects and to check robustness, we also estimate the model assuming that each group maximizes its joint profit.

Regardless of the specifications, the coefficients for the indicator variables of 1985/1986 and 1988/1990 are not statistically significant, implying that the policy had no effect on markups. How is this possible? The reason the coefficient for the 1985/1986 dummy is insignificant is because most of the scrapped capacity during the first capacity coordination policy was nonoperating capacity. Thus, even though the firms shut down these plants, the market power of the firms was unaffected. However, it is unclear why the 1988/1990 dummy has no impact on markups. The second capacity coordination policy in fact forced the firms to shut down some *operating* plants, and thus, demand would most likely have exceeded supply (production capacity), which must have given firms market power.

Table 6: Markup Charged by the Firms

Panel (a): Summary Statistics for Recovered Markups			
	Model (ii)	Model (iii)	Model (vi)
	IV + 2nd	IV + 3rd	IV + 4th
Average Markup	4.2%	30.2%	22.6%
Median Markup	3.1%	22.6%	16.9%

Panel (b): Markup Regression Results						
	Model (ii)		Model (iii)		Model (vi)	
	Ind. Firm	Group	Ind. Firm	Group	Ind. Firm	Group
1985/1986 Dummy	.000	.000	.001	.001	.001	.001
	(.003)	(.002)	(.020)	(.016)	(.015)	(.012)
1988/1990 Dummy	.000	-.000	.003	-.002	.002	-.002
	(.003)	(.002)	(.021)	(.017)	(.015)	(.013)
Year up to 4th	√	√	√	√	√	√
Firm Fixed Effects	√	√	√	√	√	√
Area Fixed Effects	√	√	√	√	√	√
Num. of Obs.	829	829	829	829	829	829
Adj R^2	.643	.828	.643	.828	.643	.828

Panel (c): (Log) Marginal Cost Regression			
	Model (ii)	Model (iii)	Model (vi)
log(Capacity)	.0127	.0148	.0193
	(.0096)	(.0254)	(.0161)
log(Clinker)	-.0116	-.1355***	-.0893***
	(..0114)	(.0302)	(.0192)
Productivity	√	√	√
Plant Fixed Effects	√	√	√
Year Fixed Effects	√	√	√
Num. of Obs.	972	696	972
Adj R	.9374	.9547	.9510

Note: Panel (a) shows the average and median markups for three different specifications, corresponding to models (ii), (iii) and (iv) in Table 5. In Panel (b), we run the following regression:

$$\text{Markup}_{mt} = \gamma_0 + \gamma_1 \mathbf{1}_{\{t=1985,1986\}} + \gamma_2 \mathbf{1}_{\{t=1988,1989,1990\}} + \text{Controls} + \varepsilon_{mt}.$$

As indicated in the table, we include the firm and area fixed effects as control variables. In panel (c), we run the following regression:

$$\log(\text{MC}_{jmt}) = \delta_0 + \delta_1 \log(\text{Clinker}) + \delta_2 \log(\text{Capacity}) + \text{Controls} + \varepsilon_{mt}.$$

To investigate why the firms did not experience an increase in market power during the second policy intervention, we hypothesize that demand did not exceed supply (production capacity), as plant utilization rates were relatively low prior to the second policy intervention and the firms could concentrate production to the remaining efficient plants. Motivated by this hypothesis, we regress utilization rates on the indicator variables for 1985/1986 and 1988/1990, and the results are presented in Table 7. We control for year effects through polynomial approximation in models (i) and (iii), and through year fixed effects in models (ii) and (vi). The estimation results are consistent with our expectations and support our hypothesis. Regardless of the specifications, positive and statistically significant coefficients on the 1988/1990 dummy variable indicate that the firms increased utilization rates of their remaining plants to meet demand during the second policy intervention. Our hypothesis is also supported by figures 1 and 2, as we can clearly see that the firms met demand exactly by fully utilizing their remaining production facilities.

To further examine our hypothesis, panel (c) of Table 6 quantitatively shows how capacity reduction affected the costs of production. We regress the estimated marginal cost on capacity, production quantity, productivity measures, and other controls.[7] Our focus is on the coefficient of capacity. As for productivity, we use either labor productivity or TFP. We report the estimates when we use labor productivity as the productivity measure. The results are qualitatively similar to the case with TFP.[8] The coefficient on capacity is positive but not statistically significant, which means that capacity has no effect on production cost. Therefore, reducing unused capacity would not change production cost, which results in no change in the market price and quantity. This result is also consistent with Specification 2 in Table 3, where we see *excess* capacity of the other firms has no direct effect on own production.

Based on our analysis, we conclude that the policy interventions did not have any significant impact on the markups charged by the firms. In other words, the policy successfully accelerated the capital adjustment process without lowering consumer welfare. As a corollary, if the government reduced production capacity a little bit more, then there would be excess demand which would possibly increase the market power of the firms. Therefore, the amount of capacity reduction was key to the success of the policy, and we discuss this issue further in Section 4.

[7] We recover marginal costs via $mc_{imt} = P_{mt} + \frac{1}{\alpha}\frac{Q_{mt}}{P_{mt}q_{fmt}}$, as for the estimation of markups.

[8] We control for the production quantity as in Specification 2 in Table 3 to see the effect of *excess* capacity on production costs. The coefficient on production quantity is negative and statistically significant; however, it is difficult to give a reasonable interpretation of this result. This may be because the production technology exhibits economies of scale. At the same time, even though we control for plant fixed effects and productivity measures, this may be because of endogeneity: the firms may increase production at those plants with lower marginal cost.

Table 7: Plant-Level Utilization Rate and Policy Interventions

	(i) Utilization	(ii) Utilization	(iii) Utilization	(vi) Utilization
1985/1986 Dummy	1.974	-3.979	1.574	-4.841*
	(2.173)	(2.911)	(1.835)	(2.885)
1988/1990 Dummy	5.798***	14.666***	5.613***	13.881***
	(2.405)	(2.925)	(2.011)	(2.896)
Year up to 4th	√		√	
Year Fixed Effects		√		√
Area Fixed Effects	√	√	√	√
Firm Fixed Effects	√	√	√	√
Plant Fixed Effects			√	√
Num. of Obs.	1,206	1,206	1,206	1,206
Adj R^2	.280	.329	.498	.598

Note: Significance levels are denoted by < 0.10 (*), < 0.05 (**), and < 0.01 (***). The numbers in parentheses show the standard errors.

4 Policy Implications and Caveats

Our empirical analysis shows that this series of policy interventions accelerated capital adjustment successfully without distorting the firms' divestment decisions or increasing their market power. In principle, the policy helped the firms to reduce unused production capacity and thus should not have any influence on their market power. Although this policy seems to be anticompetitive, our estimation results do not support this view. Do these results support the application of this policy to other industries? This section provides some discussion on the possibility of generalization and caveats regarding the capacity coordination policy.

Estimation of excess capacity and its allotment One of the key factors that led to the success of this policy was the well-crafted divestment allotment. For effective policy implementation, regulators need estimates of the productivity of firms' facilities. As often pointed out in the literature on regulation, however, productivity is typically private information and such asymmetric information between regulators and private companies results in inefficiency. In our context, asymmetric information is not a serious problem because the technology of cement production can be evaluated relatively straightforwardly. In particular, during the period of our analysis, technological advancement was modest and the regulator was able to catch up with firms in terms of understanding and evaluating existing technology. Furthermore, detailed micro data on production was available to obtain precise estimates of productivity. These factors enabled the regulator to assess the facilities accurately.

Moreover, even without perfect information on the productivity of each plant, regulators can induce private firms to design a mechanism that would efficiently allot divestment. Indeed, under the policy private firms in the Japanese cement industry developed such a mechanism with side-payments through negotiations.

Determining how much capacity should be scrapped in the industry as a whole is another challenge. This issue raises again an informational problem: the government may not be able to predict future demand accurately, whereas firms in the industry have better information about demand and supply. If regulators can predict future demand with high accuracy, they can correctly measure excess capacity. In practice, however, this may not be realistic. In fact, right after the policy intervention, the Japanese economy faced a boom called the "Heisei bubble" between December 1986 and February 1991, and cement demand recovered during this period, as shown in panel (a) of Figure 1. Even though net exports were consistently positive, the cement industry needed to decrease exports and increase imports during this period to meet domestic demand. Although this might be an irregular event in declining industries, it is important that policymakers keep such possibilities in mind when developing policy.

Dynamic consequences As pointed out by Kamita (2010), capacity coordination is essentially an anticompetitive policy and may induce collusion over time. In this regard, we do not find evidence of such anticompetitive behavior in the Japanese cement industry after policy implementation, whereas the Aloha–Hawaii case promoted cooperation for several years until new entrants joined the market. It is, therefore, important to monitor the industry even after policy implementation. Another dynamic consequence that our analysis cannot capture is whether this policy prolonged the life of inefficient firms. Thanks to this policy intervention, some inefficient firms did survive in the low demand periods. Without this policy intervention, some inefficient firms would have been forced to exit the market. Unfortunately, our analysis is silent on this issue. To predict such a dynamic consequence, we need to build a structural dynamic model as is done by Nishiwaki (2016).

5 Conclusion

Excess production capacity has been a major concern in many countries, particularly when an industry faces declining demand. Strategic interaction among firms may delay efficient scrappages of production capacity and policy interventions that eliminate such strategic incentives may improve efficiency. Using plant-level data on the Japanese cement industry, this paper empirically studies the effectiveness of a capacity coordination policy which forces the firms to simultaneously reduce their production capacity.

Our estimation results show that a capacity coordination policy can effectively reduce excess capacity without distorting firms' scrappage decisions or increasing their market power. Although this series of policy intervention seem to be successful, some caveats apply in relation to capacity coordination policy in other industries/countries: (i) estimation of excess capacity and its allotment, and (ii) dynamic effects and consequences of the policy intervention. Thus, policymakers with an interest in introducing capacity coordination policy must keep these caveats in mind.

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Appendix A: Side-Payment Scheme for Divestment Allotment

On February 1, 1985, 22 cement firms concluded an agreement to divest cement kilns. This agreement included such items as quantity of divestment for each firm, a reporting and auditing scheme, penalty charges for deficiency of divestment, side-payment to adjust for divestment costs, and so on. The agreement had two supplementary agreements, i.e., an agreement on auditing and an agreement on side-payment. The latter supplementary agreement prescribed a side-payment scheme as follows:

1. **Subsidies**: Each firm receives the following amount of subsidies from the special account of the Japan Cement Association based on the quantity of capacity reduction:

   - Nonoperating kilns:
     Hourly production capacity of divested kilns (in tons) × 7200 (annual operating hours) × 50 JPY
   - Operating kilns:
     Hourly production capacity of divested kilns (in tons) × 7200 (annual operating hours) × 100 JPY

2. **Contribution**: Each firm contributes a portion of the total subsidies according to the following "adjustment coefficient" for each firm:

$$\begin{aligned}&\text{Adjustment Coefficient}_i\\&\quad= [(\text{Average of clinker production shares from FY 1981 to 1984})\\&\quad\;+ (\text{The share of expected remaining production capacity after the}\\&\qquad\text{capacity reduction in FY 1985})] \times \frac{1}{2},\end{aligned}$$

   where FY denotes fiscal year.

Appendix B: Production Function Estimation

Table B1: Production Function Estimation

	FE	OP
Capital	.856***	.941***
	(.025)	(.112)
Labor	.286***	.160***
	(.036)	(.056)
Firm Fixed Effects	√	
Controlling for Year	√	√
Num. of Observations	1,130	1,124

Note: Significance levels are denoted by < 0.10 (*), < 0.05 (**), and < 0.01 (***). The numbers in parentheses show the standard errors.