Does Competition Spur Productivity? Evidence From Post WWII U.S. Cement Manufacturing∗

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1. Introduction

During the 1960s and 1970s, the U.S. cement industry turned in a poor productivity performance. Whether measured by energy productivity, labor productivity, or TFP, the industry experienced little or no growth in productivity. This was not true of cement industries in other countries, many of which had very strong productivity growth. By 1980, U.S. cement productivity was substantially below that in many countries.

Then, in the 1980s, the industry engineered a productivity turnaround. Whether measured by energy productivity, labor productivity, or TFP, the industry experienced strong productivity growth. This growth was widespread, occurring in plants throughout the country. In this paper, we explore the reasons behind this strong productivity performance in the 1980s.

There are clearly a number of suspects or candidates for the productivity growth. The industry experienced some unprecedented changes during the 1980s. First, there was a very large increase in foreign ownership in the industry. As a share of capacity, foreign ownership increased from about 23% in 1980 to 64% in 1990. Perhaps foreign owners, for example, brought new technology, thereby increasing productivity.

Second, the level of imports increased significantly. Whereas imports were a very small share of domestic production for decades before 1980, during the 1980s they reached 25-30% of production. Moreover, while imports before 1980 were primarily from Canada, and sent over the Great Lakes, they were now coming from countries all over world: Japan, Spain, Greece, Australia and Mexico, to name a few of the countries. Perhaps “competitive pressure” from imports, for example, led to increased “effort” at plants (which would be measured as increased productivity).

Third, there had been a strong national union in this industry for over two decades prior to 1980. It had succeeded in pushing wages to high levels and also in taking control of plants through restrictive work rules. These high wages, and restrictive work rules, were in place throughout the country. This union collapsed in May, 1984. Plants then either became non-union, or were
represented by weak unions with little workplace control. Perhaps these changes in work rules, which occurred throughout the country, increased productivity.

These events, increased FDI, large increases in imports, and the collapse of the union, were all interrelated. And we’ll discuss in detail how they related to each other. But the conclusion we reach is that the 1980s productivity growth was driven in large part by the collapse of the union, and the change in work rules. That the productivity growth was driven by work rule changes does not mean that FDI and imports did not play a role in the 1980s productivity growth. But we’ll argue that the role they played was “working through” the collapse of the union, and the change in work rules.

Looking over the entire post WWII period, our conclusion is that as the national union began to gain strength in the late 1950s, and succeeded in imposing restrictive work rules in the 1960s, the industry’s productivity suffered. Two decades of poor productivity growth led to opportunities for other cement producers (whether domestic or foreign) to enter the industry and for foreign producers to export cement produced abroad to the United States. This entry of new producers and exporting of cement to the United States ultimately led to the collapse of the union, a change of work rules throughout the industry, and a resurgence of productivity growth.

What evidence do we have? We have two types of evidence to support this conclusion. First, we present “direct” evidence that FDI and imports did not play a large role in the 1980s growth (other than through their impact on the union collapse). This, then, leaves the union as “residual.” This is evidence by exclusion. Second, there is some “direct” evidence that changes in work rules were the main source of productivity gain.

Let’s talk about the first type of evidence, by exclusion. We will explore plant-level regressions, and ask how changes in plant productivity were related to changes in the three suspects or forces listed above. Consider the main period of productivity gain, which was between 1982-87. First, we know whether a plant changed ownership in the period. Second, we have proxies for the
extent of competitive pressure a plant faced from imports. While cement is shipped long distances over water, it is typically not shipped very far over land, 300 miles or less. So, plants that were close to ports faced a greater increase in competitive pressure than those far from ports. As for changes in work rules, nearly all plants changed them between 1982 and 1987. There are only a handful of plants that did not change work rules so, at this point, we cannot use variation across plants on this dimension.

We find that changes in plant productivity are not correlated with changes in plant ownership. So, there is no evidence that, for example, transfer of technology played a big role in productivity growth (or any other factor that would have directly influenced the plant that changed ownership). But the history of the industry, which we discuss below, tells us that foreign owners questioned the “status quo” in bargaining with the union, and played a role in the ultimate collapse of the union.

We find that changes in plant productivity are also not strongly correlated with how close a plant was to a port. So, there is no evidence, for example, that increased effort at plants facing direct competitive pressure played a big role in productivity gains (or any other factor that would have directly influenced the plant). But, again, the history of the industry tells us that imports did play a role in the collapse of the union. Imports weakened the union in many ways, not least through the loss in union membership as union jobs were lost, meaning union revenue was reduced.

In this sense, then, we have direct evidence that FDI and imports did not play a big role (other than through their impact on the union collapse). By exclusion, it provides some evidence that the changes in work rules were a big part of the 1980s productivity gains.

Let’s turn to the second type of evidence, direct evidence on work rule changes. As we suggested above, there was not much variation in the 1980s in the extent to which plants changed their work rules. First, there were only a handful of cement plants that were non-union in 1980 (and, by definition, did not change work rules). So, we cannot use these plants as a “control” group (for plants that did not change their work rules). Second, among the unionized plants, nearly all
of them changed their work rules to the same extent. Hence, at this point, we are not able to use cross sectional variation across plants in work rule changes (though below we'll briefly describe some exercises we may be able to do in the future).

But we have a few other types of evidence to provide. First, as we describe the work rules established in the industry in the 1960s, it will be clear that they led to overstaffing, as maybe is not surprising. But it will be clear that they also led to idle machinery. And that they also led to wasted energy. We think there is little doubt that the rules reduced productivity.

Second, the same union had organized Canadian cement plants, though the contracts never were as restrictive. So, we should see that 1980s growth in U.S. productivity would outpace that in Canada, as we show below. Third, one rule, introduced in 1965, greatly extended job protection. We argue that there is evidence that this did change the path of employment in the industry.

2. The Productivity Performance of the U.S. Cement Industry

Cement is a building material that is the key ingredient in making concrete. It is manufactured throughout the United States from materials, like limestone, which are heated in kilns to make clinker (pellets). The clinker is later ground, with gypsum, to make cement.

In this section, we’ll show that U.S. cement productivity performed poorly in the 1960s and 1970s. We’ll show that various measures of U.S. cement productivity (TFP, energy, and labor) showed little or no growth (and even declines) during this period.

This poor productivity performance in cement was not a world-wide phenomenon. In comparing cement productivity across countries, we’ll have measures of both energy productivity and labor productivity. Though it would be nice to also have measures of TFP across countries, these two productivity measures (energy and labor) are those that we have most confidence in. Moreover, these measures are in units that we can readily compare across countries, like tons of cement per unit of energy (measured the same across countries) and tons of cement per hour (or employee).
Before presenting these energy and labor productivity measures, Figure 1 shows U.S. cement industry TFP over time. It was stagnant or falling over the 1960s and 1970s and increasing from the mid-1980s on. Clearly, on this measure, U.S. productivity looks poor in the 1960s and 1970s.

A. U.S. and Foreign Productivity Compared: Energy

Measures of U.S. energy productivity are available from the NBER and from the Portland Cement Association (PCA). Both measures show little growth in energy productivity in the 1960s and 1970s. In Figure 2, we plot energy productivity from the NBER. The series is fairly volatile, though its clear that there was not much growth in the 1960s and 1970s.

How did U.S. energy productivity compare to foreign countries? It is well known that U.S. energy prices are “low,” so one expects energy to be substituted for other inputs in the U.S. relative to other countries. This would lead to low U.S. energy productivity relative to other countries. But, of course, there is the opposite effect that the U.S. is a productivity leader.

U.S. cement energy productivity was in fact much lower than that in many countries in the 1960s, and it fell further behind during the 1970s. In Figure 3, we plot U.S. energy productivity relative to energy productivity in some other developed countries (from Fog and Nadkarni (1983), p. 16). In 1960, U.S. energy productivity lagged behind each of these countries. U.S. energy productivity was 80 percent of Japan’s in 1969, falling to about 55 percent by 1978.

There are two main types of kilns used in the cement industry, “wet” kilns and “dry” kilns. This distinction refers to the extent of the dryness of the materials that enter the kiln. Wet kilns are the older, typically more energy intensive, technology. One reason that the United States was a productivity laggard in energy is because it was slow to adopt the dry kiln technology. In this regard, its interesting to compare U.S. energy productivity with that of other countries that had a

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1The TFP series in Figure 1 is from the NBER Manufacturing data base, as described in Bartlesman and Gray (1996). TFP bounces around a lot, but a conservative statement is that productivity declined about 10 percent in the first period (from roughly .95 to roughly .85), and then grew about 35 percent in the latter period (from roughly .85 to roughly 1.15).
similar share of capacity in wet kiln technology. In the United States, in 1978, 53 percent of clinker capacity was in wet kilns. In fact, there were not many countries in the world that had such a large share of capacity in wet technology. Among the developed countries, the UK was an outlier with the United States in using a large share of wet kiln technology. The UK had a wet kiln share of 69 percent (in 1974), yet it was still more energy productive than the United States (see Figure 3).

Even among developing countries, the dry technology was used more heavily than in the United States. In Fog and Nadkarni (1983), the average share of wet kiln capacity is 29 percent across the developing world. In their Table “Annex 3.1” they report cement energy productivity for 25 developing countries. Only three have a smaller productivity than the United States. In Table 1, we give some of these countries, presenting those with a high wet kiln share of capacity, and a few others. As can be seen, U.S. energy productivity lagged that in countries that had similar wet kiln shares, like Malaysia and Nigeria. U.S. productivity was higher than that in Colombia and Pakistan.

B. U.S. and Foreign Productivity Compared: Labor

Given that wages in the U.S. cement industry were being driven up to very high levels in the 1960s and 1970s (see below), one expects plants to substitute away from labor, and that there would be strong labor productivity growth. Measures of U.S. labor productivity are available from the NBER and from the PCA. Figure 4 plots U.S. labor productivity from both sources over 1947-1996. Labor productivity growth was strong in the United States until the middle 1960s, and then there was little growth until the 1980s.\(^2\)

While U.S. energy productivity lagged that in most countries, we might expect that its labor productivity was higher (given high U.S. wages). While U.S. labor productivity was among the highest in the world in, say, 1960, its poor productivity performance from the mid 1960s onward

\(^2\)Below we show that a work rule protecting jobs was introduced in 1965.
meant that many countries also overtook the United States in labor productivity as well.

In Figure 5, we plot the labor productivity of the U.S. cement industry relative to the Japanese cement industry over 1970-1990.\textsuperscript{3} The Japanese data only starts in 1970, and is only available every five years. By 1970, U.S. labor productivity was only about 60 percent of Japanese labor productivity, and it falls further during the 1970s to about 25 percent by 1980.\textsuperscript{4}

We have data on labor productivity for a large number of foreign cement industries from Cembureau (various years) for the period 1959-75. Over this period, many countries caught, and then passed, U.S. productivity levels.

In Figure 6, we plot U.S. labor productivity relative to the labor productivity of a number of countries. The data are available only every few years, and then only for the period 1959 through 1975. By 1975, U.S. labor productivity had fallen behind that in Japan (as we saw above), France, and Italy, and was about the same as Spain’s. We suspect that U.S. productivity levels would look even worse compared to these countries in the early 1980s, since, as Figure 4 showed, U.S. labor productivity was not growing from the middle 1970s through the early 1980s.

In summary, then, the United States cement industry became a productivity laggard relative to other cement industries over the 1960s and 1970s. In the 1980s, it erased some of its productivity deficit, as its productivity grew very fast.

C. Comparison of U.S. cement and other U.S. manufacturers

The productivity pattern in the U.S. cement industry seen in Figures 1 and 4, of very weak growth in the 1970s, followed by strong growth in the 1980s, was not typical of U.S. manufacturing industries as well. To show this, we have, for each of the approximately 450 manufacturing industries in the NBER manufacturing database, calculated industry TFP growth from 1980 to 1990 and subtracted from this industry TFP growth from 1970 to 1980. In terms of this difference, the

\textsuperscript{3} The Japanese data comes from the Japan Cement Association.
\textsuperscript{4} Australia has the same pattern as Japan, though not as striking. Many thanks to David Prentice for the Australian data.
cement industry had a value of 33.1% (which was the difference of 1980-90 TFP growth of 22.7% and the 1970-80 TFP growth of -10.4%). This difference of 33.1% ranked 42 out of 459 industries.\(^5\)

Consider next labor productivity growth. Following the same procedure, we calculated industry labor productivity growth from 1980 to 1990 and subtracted from this labor productivity growth from 1970 to 1980. The cement industry had a value of 61.7% (which was the difference of 1980-90 growth of 58% and the 1970-80 growth of -3.7%). This difference of 61.7% ranked 45 out of 459 industries.

D. U.S. Cement Productivity Growth Primarily “Within” Growth

We saw in Figures 1, 2 and 4 that U.S. cement productivity rose significantly in the 1980s. In this section, using a standard productivity decomposition, we show that the industry productivity gains in the 1980s and 1990’s were primarily due to within plant improvements and that reallocation effects (changing plant shares, entry and exit) were relatively small in comparison.

For this version of the paper, we examine labor productivity growth decompositions. To construct the decompositions, we use plant-level data from the US Census Bureau for the Census years of 1972, 1977, 1982, 1987, 1992 & 1997. Plant production, which we denote \(n_{it}\), is in tons of cement. Plant labor input, which we denote \(n_{it}\), is constructed using three alternatives – total plant employment; total plant hours where non-production workers are assumed to work, on average, the same number of hours as production workers; and the Olley-Pakes approach where total salary wages of a plant is divided by the production worker average hourly wage rate. Plant labor productivity is then \(y_{it}/n_{it}\), while industry labor productivity is \(Y_t/N_t\), where \(Y_t = \sum y_{it}\) and \(N_t = \sum n_{it}\).

We define the growth in industry productivity as the difference in log labor productivity, that is, \(\Delta \ln(Y_t/N_t)\). For disclosure reasons, we can decompose the growth in industry productivity into

\(^5\)If instead we calculated industry TFP growth from 1979 to 1989 and subtracted from this industry TFP growth from 1969 to 1979, the difference would have been 32%, a rank of 40 out of 459. If instead we calculated industry TFP growth from 1981 to 1991 and subtracted from this industry TFP growth from 1971 to 1981, the difference would have been 33.2%, a rank of 28 out of 459.
only two terms, the “within-plant” term and “everything-else” (or reallocation), or as

$$\Delta \ln(Y_t/N_t) = \text{“within”-term} + \text{“reallocation”-term}$$

where we construct the within-plant productivity term (say, $\Omega$) as the weighted sum of the differences in the log of labor productivity ($\Delta \ln(y_{it}/n_{it})$) at the plant level between two census years. The weight is the average of the labor input shares ($s_{i,t}$’s) of the plant in the two census years. Hence, we have that

$$\Omega = \sum (\frac{1}{2} \cdot (s_{i,t} + s_{i,t+5}) \cdot (\Delta \ln(y_{it}/n_{it})))$$

We also use output shares as weights in place of the labor shares to check sensitivity of weighting choice. Our choice of labor input and weighting method has little affect on the estimate of the within term.

Table 2 presents the overall growth in labor productivity between Census years in column 1 and the within component in column 2.\(^6\) Industry productivity growth is relatively flat in the period prior to 1982 and rises sharply thereafter. In both periods of high productivity growth, 1982-87 and 1992-97, the within component is large, accounting for over 70% of aggregate productivity growth.

3. Candidates For the 1980s Productivity Surge

In this section, we’ll discuss the possible candidates for the productivity surge, and discuss how we can measure them.

A. Foreign Direct Investment

Foreign ownership of U.S. cement plants has been tracked by the Portland Cement Association. From 1960-75, foreign ownership of U.S. clinker capacity was roughly 5% of U.S. capacity (see figure on p. 20, PCA, 1992). By 1980, the foreign ownership had jumped to 22.8%. By 1985, it was 46.8% (p. 2), and by 1990 it was 64.4% (p. 11).

\(^6\) The results presented use labor shares and the Olley-Pakes construction of hours.
Below, we’ll analyze plant level data for the U.S. Census years 1972, 1977, 1982, 1987, 1992 and 1997. We are able to determine if a plant changed ownership between these Census years. While we won’t know if the new owner is a domestic or foreign firm, we are fairly confident that over this period 1972-97 most of the acquisitions of U.S. plants were by foreign owners.

B. Imports and Competitive Pressure

In Figure 7 we plot the U.S. imports of cement (and cement plus clinker) as a fraction of U.S. cement production from 1918 through 2003.7 For most of the 20th century, imports of cement were very small as compared to domestic production. Imports increased somewhat in the early 1970s, the increase often attributed to the wage and price controls of that period. There was a large increase in imports in the 1978-79 period. In the 1980s, imports increased further still, reaching nearly 25 percent of production in some years.8

Not all plants faced the same increase in “competitive pressure” from imports. While cement is shipped long distances over water, it is typically not shipped very far over land, 300 miles or less. So, plants that are close to ports face a greater increase in competitive pressure from imports than those far from ports.

In defining the “competitive pressure” faced by a plant from imports, we begin by calculating the distance of the plant to the closest deepwater port (that received cement during our period of analysis). The distance is calculated as the distance in miles (as the crow flies) between the county centroid of where the plant is located and the county centroid of the port location.9 We then define how close a plant is to a port in a “competitive pressure” sense by the index “close,” where

\[ \text{close}_i = -\exp(-\lambda \times \text{distance}_i) \]

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7 Again, in making cement, huge kilns are used to make clinker, an intermediate product. Grinding machines then grind the clinker into finished cement. Since clinker can be shipped, we include imports of clinker with imports of finished cement.

8 The sharp drop in imports in the early 1990s was the result of anti-dumping duties being levied on imports from some countries and the recession in that year.

9 The county centroid is the population weighted geographic center of a county.
where $\lambda$ is a parameter equal to .005 and distance is the plant distance to the port measured in miles. This creates a variable bounded in the (0,1) interval. A plant “at the port” will be assigned a value close to one. As the distance from a port increases, this index falls rapidly, so that by 300 miles it is only 0.22.

In our regression analysis below, we interact this index with time. That is, in the 1970s, being a short distance from a port may not have added to competitive pressure, while in the 1980s it may have.

C. Growth and Collapse of the Union

Just as we did with FDI and competitive pressure from imports, we want to measure changes in the extent of work rules at the plants. Since this is actually a big part of the analysis, we’ll discuss this in the next section. Here, let us simply give a brief overview of the history of the union. A very nice historical study of labor relations in the U.S. cement industry is developed by Northrup (1989), whose work we’ll use throughout.

Unionization in the U.S. cement industry predates WWII. As of 1949, nearly all U.S. cement plants were unionized (only 6 out of 149 were non-union). The vast majority of the unionized plants (about 85 percent) were locals of the Cement, Lime and Gypsum Workers (CLGW) union.\textsuperscript{10}

The CLGW was a weak union in the period just after WWII. Beginning in the mid 1950s, the CLGW began to expand its market power. A major milestone occurred in 1957. In that year, the CLGWU called a national cement strike that idled 79 plants (about half the plants in the country).\textsuperscript{11} As a result of the strike, the CLGW was successful in introducing pattern bargaining in the industry. A CLGWU history described the new bargaining as one where “A pattern is set in early negotiations, and locals, through tight discipline, force cement-producing companies to follow this economic blueprint.” (Voice, October, 1978, p. 13). The goal of the union, which was largely


\textsuperscript{11}This is from the Voice, the monthly publication of the CLGWU (Voice, October, 1978, p. 13)
achieved by the middle 1960s, was to have uniform pay and work rules throughout the country.

The union continued to extend its market power during the 1960s and 1970s. Wages were pushed up to the highest levels in manufacturing (on par with auto workers) and contracts were greatly extended in order to limit the rights of management to control plants. Then, the union so strong in the late 1970s, collapsed in the early 1980s. We’ll discuss this collapse in detail below.

Before describing the work rules and when they were introduced, its instructive to consider wages in the U.S. cement industry. Figure 8 plots the hourly wage paid to production workers in cement relative to the average production worker wage in U.S. manufacturing. In the late 1940s and early 1950s, production worker wages in cement were roughly equal to that in overall manufacturing. Starting in the middle 1950s, cement wages began to grow significantly relative to the average wage. By the early 1980s, cement wages were 50 percent higher than the average.\textsuperscript{12} Wages came down very quickly in the 1980s.

Another way to gauge the power of the union is to look, within the cement industry, at hourly wages of production workers (all of whom are unionized) relative to hourly wages of non-production workers (most of whom are not). Figure 9 plots this ratio. From the late 1940s until 1960, the ratio bounces between 0.6 and 0.7.\textsuperscript{13} The ratio grows from 1960 to 1980, reaching a value of about 0.9.\textsuperscript{14} There is little movement in this ratio for overall manufacturing until the mid 1980s. The wage evidence is clearly consistent with the union gaining strength in the 1960s and 1970s.

\section*{4. Union Control of the Workplace and Productivity}

In this section, we want to measure changes in work rules at the plants. Work rules were extensive at these plants. In 1978, the president of the CLGW was able to boast: “No other industrial workers in the country can point to contracts that impinge on and restrict the rights of

\textsuperscript{12}By 1980, cement wages ranked in the top 10 of all 459 U.S. manufacturing industries in the NBER data base.

\textsuperscript{13}One reason the ratio bounces around is that most cement plants have between 100 and 200 workers, and hence data may be “noisy” in ASM (non-Census) years. In fact, in the Census years 1947, 1954 and 1958, the ratio is 0.7.

\textsuperscript{14}By 1980, this ratio in cement ranked in the top 10 of all 459 U.S. manufacturing industries in the NBER data base.
management as much as cement contracts do.”

We begin by describing some of the work rules at the plants. We then discuss when the rules were introduced into the contracts, and when the work rules were dropped.

The evidence in this section comes from contracts we have collected for over 100 plants. The vast majority of the contracts are from CLGW locals. However, there are a few contracts from the other few unions that had locals in the cement industry, for example, the United Stone and Allied Workers Union and the U.S. Steelworkers of America.

A. Work Rules: Those That Reduce Productivity

We’ll discuss three types of work rules that reduced productivity.

1. Rules that led to idle machinery, and wasted energy

Union contracts gave groups of workers the “right” to certain jobs in plants. For example, a subset of repair workers at plants would be given the right to repair a particular machine. No workers outside this group were allowed to repair the machine, or help repair it, though they were capable of doing so. This means machines were idle, or in non-production mode, longer than necessary. Because capital is not operating, no output is produced. This reduces productivity, capital productivity, energy productivity, and labor productivity.

Here are some examples from a 1969-contract for a Michigan plant. On p. 86, “.. when the Finish Grind Department is completely down for repairs, the Company will not use Repairmen assigned to the Clinker Handling Department on repairs in the Finish Grind Department.” This type of work rule meant that machinery (the grinding machinery) was idle, when it need not be.

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15 This quote is from the Voice, October, 1978.
16 As reported in the Voice, when U.S. cement workers visited cement plants in Germany in 1980, they were struck by the difference in how repair was conducted in the two countries. As one U.S. worker noted, “We were also told that if they have a breakdown during a shift, they use the people on that shift to make the repairs, if possible ...” while another stated that “They have breakdowns, as we do. The big difference is that almost anyone pitches in to fix it.” These workers also noted that they liked the U.S. system better.
17 In fact, this plant is not a CLGWU local but a United Stone and Allied Products Workers of America local, Local 135.
18 On pages 64-65, it’s stated that “The work of balancing fans .... will be performed by the General Repair Department.”
That is, though repair workers in clinker handling could have helped bring the grinding machinery back into operation, they were not allowed to.

Such rules obviously waste capital. But they waste energy as well. When machinery is idle, this slows the rate at which output is produced in the plant. Yet the plant typically does not decrease its energy use much. So, energy is also wasted with such rules.

Consider another, in some ways more extreme, example of such rules. Again, the above contract states (p. 86), “In cases where repair work on Mobile equipment (other than structural work or welding) is required at times when Mobile Department Mechanics are not scheduled to work, the Repair Foreman will first attempt to contact the Mobile Mechanics to perform the work on an overtime basis. Should all of the Mobile mechanics refuse the overtime or be otherwise unavailable to report to work, a General Repair crew will be assigned to do the job in conformity with past practices as to the nature of the repair work involved.” In this case, there was actually no one in the plant that had the right to fix the machine. So, the right extends beyond who is in the plant.

2. Rules that preclude trade with outside not allowed

Given contract clauses put restrictions on how work could proceed in the plant, managers had an incentive to outsource work. To stop this, the union succeeded in prohibiting outsourcing, or contracting out. In particular, contracts had this clause:

“All production and maintenance work customarily performed by the Company in its plant and quarry and with its own employees shall continue to be performed by the Company with its own employees.”

This obviously is a strong clause. Having this clause means the plant has a very large tariff on goods and services provided by producers outside the plant’s gates.

3. Rules that allow workers to be in jobs they cannot do.

\[19\text{note there are people at the plant that can fix it, but are not used.}\]
Union contracts typically give senior workers more rights than junior workers. Cement contracts took this to an extreme. For example, in many contracts, the seniority unit was “plant-wide.” That meant that if a worker’s job was eliminated, that worker could take the job of any less senior person in the plant (i.e., it was not restricted by department, etc). Moreover, the senior worker who “bumped” the junior worker did not initially have to be able to perform the job, but only in a reasonable amount of time. A common clause was

“In the event an employee’s job is eliminated because of temporary cessation of his job or the operation, or the reduction in production or forces, or because he has been displaced by another employee, such an employee may apply his seniority by bumping any junior employee in point of seniority in any department, provided he has the skill and ability to perform the job within a reasonable period of time.”

B. Work Rules: Those That Reduce Innovation

There were other clauses that likely led to a drag on new innovation and new investment. We mention one rule here, a clause providing job protection, namely

“Employees will not be terminated by the Company as the result of mechanization, automation, change in production methods, the installation of new or larger equipment, the combining or the elimination of jobs.”

C. When Were Rules Adopted?

In this section, we characterize the extent of restrictive work practices in the industry over time. For each contract, we take a simple approach to characterizing how restrictive it is. We focus on two of the clauses above, the job protection clause and the contracting out clause. We focus on these clauses since a contract will either have these clauses or not. We then ask what fraction of the contracts have each of these clauses, and show how the fraction varies over time.
As we said, we have at least one contract for about 100 plants in the post WWII period. But the number of contracts varies over time. For the periods where we have fewer contracts, we have supplemented the contract data with other sources.

Before 1963, we have only four contracts. For 1963 and 1964, we have 36 contracts. In 1965, we have 49 contracts. For each year in 1966-84, we have 84 contracts. After 1984, have 18 contracts. We have fewer contracts in the 1980s, in part, because the national union splintered into a few, weaker, competing unions whose archival record is less complete, and in part because some plants went non-union. As mentioned, we supplement this contract information for the years before 1963 and after 1984 with other sources of information on union contracts.

Consider first the contracting out provision (that banned contracting out). In figure 10, we plot the fraction of contracts that have this clause. None of the contracts have the clause before 1963, then 55% have the clause in 1963 and 1964, then 100% have the clause in 1965. During the period 1966-84, 98.8% of the contracts had the clause, and then none had the clause after 1984.\footnote{Before 1963, none of the four contracts have the clause. In 1963 and 1964, the clause appears in 20 of 36 contracts. In 1965, the clause appears in 49 of 49 contracts. During the period 1966-84, the clause appears in 83 of 84 contracts. After 1984, none of the 18 contracts had the clause.}

From this figure, we firstly conclude that the contracting out clause was not introduced into contracts until the early 1960s. There is other evidence that backs this up. When discussing the nationwide cement strike of 1957, Northrup states that the union wanted strong contracting out language but failed in obtaining it (p.347). So, clearly, the strong clause was not achieved in the 1957 round of contract negotiations. The next round would have been a few years later.

We secondly conclude that nearly all plants had the clause from the middle 1960s until 1984, and then very few had the clause after 1984. While we have far fewer contracts after 1984, from Northrup’s work we know that the new, smaller unions had much less bargaining power than the pre-1984 CLGWU, giving us confidence that the estimate for after 1984 is fairly accurate.

Consider the job protection clause next. In figure 11, we plot the fraction of contracts that
have this clause. Before 1965, no contract had the job protection clause (e.g., none of the 36 contracts in 1963 and 1964). In 1965, 96% of the contracts had the clause (47 of 49). In the 1966-84 period, 96% of the contracts had the clause (81 of 84). After 1984, only 22% of the plants had the clause (four of 18).

From this figure, we firstly conclude that the job protection clause was introduced into contracts in 1965. There is other evidence that backs this up. In the March 1965 issue of the Voice (p.1), the CLGWU lists its new agenda for bargaining that year, and this job protection clause was on the new agenda. This was the year the union first attempted in putting this clause into contracts.

From the analysis of the contracts above, at this point we are left with the conclusion that there is not much variation across plants in work rules changes. So, in effect, changes in work rules are going to be picked up in “time” dummies below. We’ll discuss later how we might be able to get more variation across plants.

5. Dismal Productivity Performance Spurs Entry, Collapse of Monopoly

Because we argue that FDI and imports played a role in the collapse of the union, we think its important to cover the history of the union collapse. In this section, we’ll highlight some of the forces that led to the union collapse.

Given the industry’s dismal productivity record in the 1960s and 1970s, one would expect that profit opportunities were growing (1) to make cement in the United States with labor not supplied by the CLGW (and its work rules), either through entry of domestic or foreign producers (FDI) and (2) to import cement for sale. And, in fact, these channels began to be exploited in the late 1970s. We’ll briefly describe how these threats to the CLGW slowly built from the late 1970s through the early 1980s. The CLGW did not bend as these forces gathered (i.e., it did not budge on changing work rules), and it finally snapped and collapsed in a few week period in early 1984.
A. Period before 1980

Regarding FDI, in 1977, a West German firm, Heidelberger Zement, purchased a major U.S. firm, Lehigh Portland Cement. The German firm thought they could convince the CLGW to pursue a more cooperative approach, and that Heidelberger could change work rules in this manner. As part of the process, Heidelberger invited union leaders to Germany in the fall of 1979. While CLGW leadership took the trip, they rejected any changes in work practices.

A new U.S. firm, Moore McCormak, which had been in the liner shipping industry, also entered the industry in the late 1970s. As part of a larger deal, it acquired one of the few non-union cement plants (in Brooksville, Florida). According to Northrup, “Moore McCormak officials were impressed with the Brooksville operation, its productivity, and its human relations program.” Given its experience in Brooksville, Moore McCormak was soon to look for other cement plants to purchase.

Clearly, the dismal performance of the industry was spurring developments never seen before. A German firm had entered with the hope, though it had not yet succeeded, of changing work rules. A U.S. firm had entered the industry that very soon would attempt to change work rules. And, as we mentioned, imports increased significantly in the 1978-79 period, and were now coming from all over the world.

B. 1980-1984

In November, 1980, Moore McCormak purchased plants in Kosmosdale, Kentucky and Glens Falls, New York, both of which were CLGW locals. Its aim was to change the work rules in the plants. Talks between the firm and the CLGW began in Kosmosdale. The CLGW leadership was resistant to any changes in how the plant operated. In May, 1981, Moore McCormak declared an impasse at Kosmosdale, and imposed its final offer. The CLGW local went on strike, and Moore

21 (give the issue of the Voice)
hired replacement workers to operate the plant. So, for first time, work rules were changed at a CLGW plant. Though there was a year-long bitter strike once the replacement workers entered the plant, Moore McCormak ultimately prevailed, and the CLGW was decertified in May, 1982.

Significant financial problems also began to emerge for the union in the early 1980s. Because of plant closings and layoffs, resulting from the recession and the continuation of imports, union membership was shrinking, and the revenues from membership fees were way down. The CLGW was always a very small union (on the order of 30,000 members), so the loss in membership meant it was having trouble covering fixed costs of operation.

Cement companies called on the CLGW to offer concessions during this period, on both wages and work rules. There were some concessions on wages, though there was disagreement among the CLGW leadership on this strategy. But the CLGW leadership took a position of “no concessions” on work rule changes.

C. 1984 and beyond

As 1984 began, and its financial crisis continuing, the CLGW leadership agreed to be merged into the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers (IBB) on April 1, 1984.22

The CLGW contracts were for three years, and the contracts of all its cement locals were set to expire on May 1, 1984. The CLGW (as a division of the IBB) chose to negotiate initially with Lone Star cement. It often chose Lone Star as its initial target in the pattern. Lone Star signed a contract for May 1, 1984 with little changes in work rules.

But the pattern did not hold. Lehigh was the next firm up, and it refused to follow the pattern. It wanted significant work rule changes. Ten Lehigh plants went on strike. Though replacements were not being used, the union locals, fearing replacements might be used, and (presumably) recalling

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22 The merger had been proposed by IBB in 1981. (see cornell paper, (in plant))
Kosmosdale, went back to work after 4 weeks.23

The return of the Lehigh workers broke the back of the union. The rest of the companies in the cement industry followed Lehigh in demanding company imposed work rules. “By early July, 1984, cement workers found themselves in a position where 70 percent of their cement lodges were working without contracts.” (Cornell paper, p. 17). As Northrup described, the situation for unions did not improve throughout the 1980s (“today [1988] unionism, once so strong, is weak and divided as management imposes or forces acceptance of its conditions.” (from abstract of paper).”).24

D. Forces Behind the Collapse

Clearly, a lot of forces led to the collapse of the union, and to the weak position of the multiple unions that replaced the CLGW in some of the plants after 1984. It would be difficult to “assign” an importance to one force over another, or a ranking of imports, FDI and domestic entry (with Moore McCormak), but in some sense they are the same force, the force of competition acting on the union’s monopoly.

6. Plant-Level Productivity Regressions

In this section, we’ll run some regression models.

In the section of the paper, we examine the sources of labor productivity growth using plant-level data from the US Census Bureau. The data are constructed from the Census of Manufactures which contains data on every plant’s outputs and input usage every five years. For this application, we use data from the 1972, 1977, 1982, 1987, 1992 and 1997 Census of Manufactures. The census data contain information on plant production measured as current dollar shipments plus adjustments for changes in plant inventories. As we did earlier, we use state-level prices ($ per ton) to convert

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23 see cornell paper, (in-plant paper, p. 16).
24 The full quote from Northrup is: “Cement, Lime, and Gypsum Workers Union won not only high wages and benefits, but imposed restrictive rules as severe as those in any industry. Eventually, however, foreign competition and economic realities forced the companies to revolt ... and today [1988] unionism, once so strong, is weak and divided as management imposes or forces acceptance of its conditions.” (from abstract of paper).
the dollar production data into an estimate of the tons of cement produced by a plant in a year and construct labor hours for a plant using the method described in Olley and Pakes (1996). Labor productivity is real plant production in tons divided by total plant hours expressed in logs.

We estimate a labor productivity growth regression of the following form:

\[ \Delta l_{p_{it}} = \beta \Delta X_{it} + \delta_{it} + \mu_{it} \]

where \( \Delta l_{p_{it}} \) is the log difference in labor productivity of plant \( i \) between period \( t-1 \) and \( t \), \( \Delta X_{it} \) includes a set plant-level control variables that are measured mostly as changes in plant characteristics, \( \beta \) is a vector of coefficients, \( \delta_{it} \) is a set of time effects and \( \mu_{it} \) is the error is the log difference model. The difference form of the specification controls for time-invariant plant-level heterogeneity.

The set of control variables in \( X_{it} \) include technological features of the plant, market-level variables, and an indicator variable that controls for changes in ownership. The plant technology variables include measures of the growth in kiln size and growth in the number of kilns over the period, control variables for whether the plant adopted new kilns or shed its oldest kilns, and for the change in the extra cement grinding capacity a plant has on hand. This last variable controls for the fact that some plants may have the capacity to grind significantly greater amounts of clinker than they can produce. Such plants could purchase clinker for grinding and thus might have higher measured labor productivity, since grinding only is less labor intensive than integrated production (clinker and cement production). These data on kiln and grinding technologies come from the Portland Cement Associations Plant Information Summary publications and are matched to the Census Bureau data.

The market-level variables include the growth population within 200 miles of a plant and the initial number of competitors within 200 miles of the plant. These are measured by drawing a 200-mile radius around each plant using the population centroid of the county the plant resides in and counting both the population and the number of competitors in counties whose centroid is
within 200 miles of the plant's county centroid. The ownership change variable measures changes in a plant’s firm identification number in the Census data over the prior five-year period. The Census identifies all plants owned by the same firm in each year and assigns them a common ownership identification code. One can use changes in this variable to measure ownership changes for a plant. For the vast majority of cases in our data, the ownership variable will be picking up changes due to plant sales/purchases and mergers/acquisitions (M&A). M&A activity in the industry is relatively high during our period of study as the industry consolidated and a significant number of plants were purchased by foreign firms.

In order to examine the role of foreign competition in affecting plant-level productivity, we estimate a specification that includes controls for plants distance to ports. Imported cement and clinker comes into the United States through deep-water ports on the East, Gulf and West Coasts and from Canada through the Great Lakes and through a number of land crossings from Mexico and Canada. The source of new foreign imports that we are concerned with here are the imports to US deepwater ports and the Mexican crossings that began to occur in the late 1970's and accelerated sharply in the 1980's. While Canadian plants certainly act as a potential source of supply for US consumers, they are not as new a source of supply as Japanese, Mexican or European producers. In order to gauge the potential competition faced by a plant from deep-water imports, we measure the minimum distance of a plant to a non-Canadian port of entry that received cement during our period of analysis. The distance is calculated as the distance (as the crow flies) between the county centroid of where the plant is located and the county centroid of the port location. We then form a distance index based on the function \(-\exp(-\lambda*\text{distance})\) where \(\lambda\) is a parameter equal to .005 and distance is the plant distance to the port measured in miles. This creates a variable bounded in the (0,1) interval where a value close to 1 indicates the plant is nearby the port and as distance increases the index moves toward zero. The index has a convex shape –dropping sharply and then flattening as the distance to the port rises.
We augment the labor productivity model with the distance measure. If foreign competition differentially affects nearby plants, then plants closer to ports should have experienced higher gains in productivity. However, this effect should vary over time as import competition is greater in the later years of the sample. Hence, we interact distance with time in our specifications below, creating 5 time-distance interactions in the difference model.

The regression results are presented in Table 3. Column 1 of the table reports the results from a model that only includes the time dummies, column 2 presents the results from the model without the port-distance controls, and column 3 contains the results from the model with all the controls. All regressions are estimated with robust standard errors. The first column shows the general pattern of productivity growth for our sample of plants. The periods 1982-1987 and 1992-1997 show higher growth rates relative to the base period 1972-1977 while 1977-1982 period shows a relatively sharp drop, especially in comparison to weighted changes reported in the decomposition. Hence, there appears to be a somewhat stronger cyclical effect when looking at the average plant data. The 2nd column includes plant technology control variables along with market-level controls. The inclusion of the controls does not change the parameters on the time dummies nor do they add much explanatory power to the model. A reduction in the number of kilns leads to somewhat higher productivity growth (though the magnitude of this effect is small) and the adoption of new kilns variable is positive and marginally significant. This lack of overall significance in the plant technology variables might be somewhat surprising. However, in results not reported here, a cross-sectional regression of the level of productivity on plant technology would find strong positive correlations between kiln size, kiln age and number kilns and labor productivity. It is just that the changes in these variables at the plant level explain little of the within-plant growth in labor productivity.

The next column of the table includes the port-distance variables. The coefficients and statistical significance of the plant technology variables are quite similar across columns (2) and (3). The time dummies shift as they interact with the port distance-time variables.
In order to look at the overall time effects, we use the time dummies and port interaction variables to plot the change in the average productivity levels over the period 1972-1997 controlling for plant and market-level characteristics. This is done in Figure 12. Productivity in 1972 is set to 1 and we use the growth rates implied by the time dummies and port distance interactions to construct the change in the labor productivity index. The line labeled “base” is a plot using the coefficients in column 2 of table 3. For the models with the port variable, we include a line (port_close) assuming the distance to a deepwater port is 100 miles and, alternatively, a line (port_far) assuming a relatively far distance (500 miles). The graph shows that plants closer to ports had, on average, higher productivity growth over the entire time period, though the specific pattern of growth varies across the periods. Plants closer to ports experienced little change in average labor productivity during the 1982 recession, whereas plants farther from ports had a marked decline. All plants productivity improved sharply over the period from 1982 to 1987. Finally from 1992 to 1997, plants closer to ports again experienced higher productivity growth.

While these general results are consistent with the view that it was something other than the measurable plant characteristics driving the productivity change, there are clearly a number of concerns with the analysis. First, there remains some cyclicality in the labor productivity at the plant level. Our demand measure (population) is clearly not a variable that will move much with the cycle, it is included to control for longer term changes in the market size. (we have used capacity utilization, and done some instrumental variable regressions, which I can give you Monday)

7. Direct Evidence for Work Rules

In this section, we present some direct, corroborating evidence that the change in work rules in the industry was the major source of productivity gains in the industry.
A. Canada versus U.S. Productivity

The CLGW had also organized most the Canadian cement plants. We have collected these contracts for 14 Canadian cement plants (about half the total). We have contracts with a starting date prior to 1984 for six of these plants, and contracts with a starting date after 1984 for 14 plants (that is, all the plants).

As for contracting out, before 1984, there are no plants in Canada that have the total ban on contracting out that we found in U.S. contracts (the clause above). Five plants allow contracting out, though it should not result in layoffs. And the sixth plant has no restrictions at all. After 1984, things do not change much. Of the fourteen plants we have, none have the total ban on contracting out. All fourteen allow contracting out, though it should not result in layoffs.

As for the job protection clause, before 1984 only one plant of the six has the clause, and five do not. Again, after 1984, things do not change much. Of the fourteen plants we have, no plant has the job protection clause.

The conclusion, then, is that work rules changed much more in the United States than in Canada after 1984. As for contracting out, work rules were much more restrictive in the United States prior to 1984, and now they are less restrictive. As for the job protection clause, the relaxation of restrictive work practices is again much greater in the United States. Hence, we should expect to see faster productivity growth in the United States than Canada in the 1980s.

Let’s now turn to comparing productivity in Canada and the United States in the 1980s. Again, we expect to see greater productivity gains in the United States than in Canada. In Figure 13, we compare U.S. and Canadian labor productivity. We normalize productivity to a year shortly before the increase in competition, and then also choose a year where there was not a downturn. We normalize both labor productivities to 1978=1. One can see that U.S. labor productivity did grow more significantly than Canada’s in the 1980s.

After 1984, the CLGWU also disappeared in Canada. There were now many different unions
that represented Canadian cement plants, and no longer one dominant union. This is likely why
Canadian productivity grew in the 1980s.

B. Employment Pattern in U.S. Cement Industry

Recall that labor productivity stopped growing in the mid to late 1960s. One possible cause
for this is the job protection clause introduced in 1965. In Figure 14, we plot (log) employment in
the industry. Employment was growing after WWII, but in the middle 1950s it stopped growing,
and began falling. The job protection clause in 1965 did not stop employment from falling the next
few years, but clearly employment did not fall much more from the late 1960s until 1980. The clause
may well have stabilized employment.

In Figure 15, we add the output of the cement industry to the figure, and it now appears
to be a bit stronger case. While output was increasing from the mid 1950s to the mid 1960s, the
industry was able to cut employment. Given that output did not grow much from the mid 1960s
until 1980 (though it was volatile), one might have expected the industry to have cut employment
even more than it did in the late 1950s and early 1960s.

8. Related Literature

gains from trade

x-inefficiency
References


Borenstein and Farrell,


Clark, Kim


Dumez, Herve and Jeunemaitre, Alain, *Understanding and regulating the market at a time of globalization: the case of the cement industry*. 2000


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Table 1
U.S. Cement Energy Productivity, 1978
(kg of clinker per kcals)
Relative to Some Developing Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>U.S. Relative Productivity</th>
<th>Wet Kiln Share of Capacity (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>1</td>
<td>53</td>
</tr>
<tr>
<td>Ecuador</td>
<td>.73</td>
<td>11</td>
</tr>
<tr>
<td>Brazil</td>
<td>.71</td>
<td>30</td>
</tr>
<tr>
<td>Morocco</td>
<td>.74</td>
<td>36</td>
</tr>
<tr>
<td>Malaysia</td>
<td>.76</td>
<td>51</td>
</tr>
<tr>
<td>Nigeria</td>
<td>.77</td>
<td>57</td>
</tr>
<tr>
<td>Panama</td>
<td>.92</td>
<td>73</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.11</td>
<td>85</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1.14</td>
<td>85</td>
</tr>
<tr>
<td>Gabon</td>
<td>.99</td>
<td>100</td>
</tr>
</tbody>
</table>
### Table 2

**Labor Productivity Growth Decomposition**

<table>
<thead>
<tr>
<th>Census Years</th>
<th>Aggregate Productivity Growth</th>
<th>Within Component</th>
<th>Within Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-1977</td>
<td>0.055</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>1977-1982</td>
<td>-0.028</td>
<td>-0.058</td>
<td></td>
</tr>
<tr>
<td>1982-1987</td>
<td>0.386</td>
<td>0.280</td>
<td>72.5%</td>
</tr>
<tr>
<td>1987-1992</td>
<td>-0.012</td>
<td>-0.035</td>
<td></td>
</tr>
<tr>
<td>1992-1997</td>
<td>0.164</td>
<td>0.125</td>
<td>76.2%</td>
</tr>
</tbody>
</table>
Table 3. Log Difference in Labor Productivity: Plant Level Regressions

<table>
<thead>
<tr>
<th></th>
<th>Year Only Model</th>
<th>With Plant Controls</th>
<th>With Plant and Port Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.020 (0.029)</td>
<td>.037 (0.066)</td>
<td>.034 (0.072)</td>
</tr>
<tr>
<td>1977-1982</td>
<td>-.142* (0.046)</td>
<td>-.124* (0.051)</td>
<td>-.207* (0.071)</td>
</tr>
<tr>
<td>1982-1987</td>
<td>.324* (0.059)</td>
<td>.330* (0.061)</td>
<td>.351* (0.094)</td>
</tr>
<tr>
<td>1987-1992</td>
<td>-.014 (0.058)</td>
<td>.002 (0.065)</td>
<td>.078 (0.095)</td>
</tr>
<tr>
<td>1992-1997</td>
<td>.091 (0.052)</td>
<td>.107 (0.055)</td>
<td>-.004 (0.079)</td>
</tr>
<tr>
<td>Δ kiln size</td>
<td>-.190 (0.145)</td>
<td>-.164 (0.143)</td>
<td></td>
</tr>
<tr>
<td>Δ number of kilns</td>
<td>-.445* (0.148)</td>
<td>-.398* (0.150)</td>
<td></td>
</tr>
<tr>
<td>Δ Grinding Capacity</td>
<td>-.103 (0.099)</td>
<td>-.107 (0.093)</td>
<td></td>
</tr>
<tr>
<td>Adopt a New Kiln</td>
<td>.107 (0.068)</td>
<td>.120 (0.065)</td>
<td></td>
</tr>
<tr>
<td>Remove Oldest Kilns</td>
<td>-.110 (0.089)</td>
<td>-.093 (0.084)</td>
<td></td>
</tr>
<tr>
<td>Population Growth</td>
<td>-.114 (0.501)</td>
<td>-.306 (0.524)</td>
<td></td>
</tr>
<tr>
<td>Number of Domestic Competitors</td>
<td>-.013 (0.019)</td>
<td>-.015 (0.019)</td>
<td></td>
</tr>
<tr>
<td>Δ Ownership</td>
<td>-.005 (0.071)</td>
<td>.004 (0.069)</td>
<td></td>
</tr>
<tr>
<td>Port Distance*(1972-1977)</td>
<td></td>
<td>.039 (0.080)</td>
<td></td>
</tr>
<tr>
<td>Port Distance*(1977-1982)</td>
<td></td>
<td>.263* (0.112)</td>
<td></td>
</tr>
<tr>
<td>Port Distance*(1982-1987)</td>
<td></td>
<td>-.017 (0.132)</td>
<td></td>
</tr>
<tr>
<td>Port Distance*(1987-1992)</td>
<td></td>
<td>-.169 (0.180)</td>
<td></td>
</tr>
<tr>
<td>Port Distance*(1992-1997)</td>
<td></td>
<td>.343* (0.149)</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>.147</td>
<td>.172</td>
<td>.203</td>
</tr>
</tbody>
</table>

* indicates 5% significance level.
Figure 1.
Total Factor Productivity
U.S. Cement Industry
(NBER Manufacturing Database, 1987=1)
Figure 2.
Energy Productivity
U.S. Cement Industry
NBER, in logs
Figure 3.
U.S. Cement Energy Productivity

kg of clinker per kcal
U.S. relative to country


UK
Japan
France
West Germany
Figure 4.
Labor Productivity and Total Production
U.S. Cement Manufacturing
(Tons per hour and tons, log scale, 1968=1)
Figure 5.
U.S. Cement Labor Productivity

Tons of cement per employee
U.S. relative to Japan
Figure 6.
U.S. Cement Labor Productivity
Tons of cement per employee
U.S. relative to country


Italy
Japan
France
Spain
Mexico
Figure 7.
U.S. Cement Imports
(Relative to U.S. Production)

Cement Plus Clinker
Cement

(1918 to 2006)
Figure 8. Cement Production Worker Wage
Relative to All Manufacturing: 1947-1997
Figure 9. Production-Nonproduction Worker Relative Wage:
Annual Data 1947-1997

Relative Wage

Years


Cement Industry All Manufacturing
Figure 10.
Fraction of Contracts That Banned Contracting Out
U.S. Cement Industry
Figure 11.
Fraction of Contracts with Job Protection Clause
U.S. Cement Industry
Figure 12.
Labor Productivity
Plants "Close to" and Plants "Far From" a Port
(1972=1)
Figure 13.
Labor Productivity
U.S. and Canadian Cement Industry
(1978=1)
Figure 14.
Log Employment
U.S. Cement Industry
(NBER Manufacturing Database)
Figure 15.
U.S. Cement Industry Output and Employment
(in logs)