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

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ABSTRACT

In the mid 1980s, the U.S. cement industry faced a large increase in foreign competition. Foreign cement producers began offering cement at very large discounts on U.S. prices. We show that productivity (measured by TFP) in the industry was falling during the 1960s and 1970s, but that following the increase in competition, productivity has reversed course and is growing strongly. When foreign competition was weak, then, productivity fell. When it was strong, productivity grew robustly. We explore the reasons for the large productivity increase. We argue that a large share of the productivity gains resulted from significant changes in management practices at plants.

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1. Introduction

Does competition spur productivity? And if so, how does it do so? These are old and important questions. The questions are, of course, central to many policy debates, like what is the impact of liberalizing trade (say by cutting tariffs).

We address these two questions, Does competition spur productivity? And if so, how?, in the context of the post-WWII U.S. cement industry. This industry faced a large increase in competition from foreign cement producers in the early to mid 1980s. It was not that U.S. tariffs against foreign producers were cut in this period but rather foreign cement producers, like those in Japan, Italy, Colombia, Spain and Mexico (and those in many other countries), offered to sell cement in the United States at large discounts to U.S. cement producers. This increase in competition threatened the survival of many U.S. cement plants.

In this industry, increased competition was followed by a large increase in industry productivity. Following the increased foreign competition in the 1980s, industry TFP grew rapidly. This was in contrast to the previous two decades when TFP was falling. In Figure 1, we plot industry TFP. From the late 1950s until the early 1980s, TFP dropped over 10 percent. After the increased competition in the mid 1980s, TFP grew about 35 percent (from the mid 1980s until 1996). When foreign competition was weak, then, productivity was stagnant or falling. When it was strong, productivity grew robustly.

What drove these productivity gains? In our estimation, the primary source of the productivity gains were changes in work rules at the industry's plants. In particular, prior to the foreign competition threat, there was a strong national union that placed significant restrictions on management in running plants. After the increase in competition, many of the work restrictions were removed, and industry productivity grew robustly. In the word of Northrup (1989), who wrote a history of labor relations in this industry, the "Cement, Lime, and Gypsum Workers Union [the national 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 rest of the paper proceeds as follows. In Section 2 we show that the industry faced a large increase in competition from foreign producers in the 1980s, as they offered deep discounts on cement. We also argue that foreign producers were able to offer such discounts because many of these producers had become more productive than U.S. cement producers.

In Section 3, we show that the increase in productivity in Figure 1 in the 1980s was primarily a "within" plant phenomena. That is, using standard productivity decompositions, we show that the productivity gains due to reallocation (which include gains from closing plants) was only a small part of the overall gain, while the gain due to within plant productivity growth accounted for the majority of the overall gain. To understand what was driving the industry productivity gains in Figure 1, then, we need to understand what drove plants to become more productive.

The remaining sections of the paper present a series of arguments to buttress the view that the within plant productivity gains in the 1980s were primarily due to management regaining control over many plant decisions.[1] We take two approaches. In the first approach, the *direct* approach, we present direct evidence that changes in work practices were correlated with changes in industry productivity. In the second approach, the *indirect* approach, we compile a list of other factors that may have driven TFP, like changes in technology. We'll show that changes in these factors seem to have played only a limited role.

The direct evidence on work practices is from union contracts. We have contracts from 96 U.S. cement plants over time.[2] In Section 4 we discuss some of the work rules in these contracts,

[1] We are not the first to argue that relaxing work rules in the cement industry had important productivity consequences (see, e.g., Northrup (1989)). Also, studies of other industries have shown that changes in work rules can lead to large productivity gains, such as that by Ichionowski and Shaw (1995) and Schmitz (2005). Bloom and Van Reenen (2007) have found, in a survey across firms and countries, that "poor management practices are more prevalent when product market competition is weak."

[2] There are on the order of 150 cement plants in the United States.

arguing that they likely had a negative impact on productivity. A common clause, for example, insured that no employee could be terminated as a result of purchases of new equipment or the introduction of new production methods at the plants. We'll show that most of these restrictive clauses were introduced in the 1960s, and that they were introduced in nearly all cement plants. We'll show that they were also dropped from nearly all the plants in the mid 1980s following the increase in foreign competition. This pattern is, of course, consistent with the time path of industry TFP, as well as the fact that the within component accounts for a large fraction of the observed productivity gains after the weakening of the union contracts.

Since the widespread introduction of these restrictive work practices was not until the 1960s, in Section 4 we also ask: Was industry productivity growing in the decade or so after WWII? The answer is yes, productivity was growing before the adoption of the practices, again consistent with the view that restrictive work practices were important. From an aggregate perspective, then, there is a close correlation between the extent of restrictive work practices and the performance of industry productivity.

How about variation across plants in work practices? Unfortunately for us, there was not much variation across U.S. plants in the extent of restrictive work practices. As suggested above, most plants adopted the practices at the same time, and then dropped them at the same time as well. However, there is a source of variation we can exploit across cement plants in the United States and Canada. The national union in the United States also organized most cement plants in Canada. We have contracts for 14 Canadian cement plants.[3] We show that in the 1980s restrictive work practices were reduced much more in U.S. plants than in Canadian plants. We then show that U.S. TFP, and U.S. labor productivity, increased significantly faster than their Canadian counterparts in the 1980s.

Now to the indirect evidence. We take two tacks. As we mentioned above, one tack is to

[3] There are on the oder of 25 Canadian cement plants.

compile a list of factors that may have led to the within plant productivity growth, like changes in technology and plant ownership. Changes in these factors do not seem to account for much of the productivity growth.

The second tack recognizes that we might not be able to measure some factors that influence plant productivity.[4] But if changes in these unmeasured factors were important, then we might expect to see bigger changes in productivity in plants that faced the greatest (direct) increase in foreign competition. For example, plants in Southern California near deep water ports faced a greater (direct) increase in competition than those in, say, Colorado, Idaho and Montana. But these plants near deep water ports also do not seem to have had a greater increase in productivity than plants far from ports. This finding, too, is consistent with the view that it was primarily changes in work practices at plants that led to the productivity gains since the restrictive work practices were relaxed throughout the country.

In the conclusion we discuss, among other issues, the implications of our findings for policy, and the literature estimating gains from trade.

2. The Increase in Foreign Competition

In this section we show that there was a substantial increase in foreign competition in the early 1980s. We begin by arguing there was significant market power in the industry before the increased competition.

A. Tendency for Market Power

Most cement is not shipped very far over land. Hence, local consumption is often supplied by local production. If there is only "room" for a couple of plants in the local market, and if entry is "expensive," then there is a tendency for market power. For example, the few plants in the local area would recognize that if they could raise price above costs (somewhat), there would be little

[4] For example, workers in some plants may have been willing to let management make decisions that were not allowed in contracts, while workers in other plants may have been less willing to cooperate.

chance of imports coming into the local area (or of new entry). This is the logic which at various times led U.S. antitrust authorities to investigate the industry.[5]

Presumably recognizing this logic itself, and that it could push wages to "high" levels, a strong national union developed in the industry. Nearly all the plants in this industry in the post WWII period (prior to 1984) were union plants, and nearly all of these were locals of the Cement, Lime and Gypsum Workers Union (CLGWU).[6] At the time of the increase in foreign competition, it was a powerful union. First, the union had significant control over how the plants were operated. Union dominance was such that in 1978 the president of the CLGWU could boast: "No other industrial workers in the country can point to contracts that impinge on and restrict the rights of management as much as cement contracts do." This quote is from the *Voice*, the monthly publication of the CLGWU.[7]

Not only did the union have significant control over operations at the plants, but it was very successful in raising wages. During the 1960s and 1970s, the union pushed wages to the level earned by U.S. auto workers. The hourly wages of cement workers, relative to U.S. auto workers, were 81 percent in 1950, 90 percent in 1960, 100 percent (i.e., the same) in 1970, and 107 percent in 1980 (see Northrup (1989), Table 1).

B. Competition increases in early to mid 1980s: Foreign producers offer big discounts

In the early to mid 1980s, foreign cement producers began delivering cement to U.S. ports at prices (c.i.f.) that were substantially less than local factory-gate prices. To see this, Table 1 presents factory-gate prices, and port prices, for two production areas in the United States, Southern California and Southern Texas, for 1984.

The average factory-gate price per ton in 1984 in Southern California was $59.67. The price

[5] Studies of the cement industry such as MacBride (1983) and Rosenbaum (1994) suggest that market power was important in the industry and that markets characterized by fewer producers had higher prices.

[6] For a very nice history of the CLGWU see Northrup (1989).

[7] The date of the issue is October, 1978. We use information from the *Voice* throughout the paper.

per ton of imported cement (c.i.f.) from Japan, South Korea and Spain was, respectively, $32.29, $33.03, and $35.18. The average factory-gate price in 1984 in Southern Texas was $47.61. The price of imported cement (c.i.f.) from Columbia, Italy, Mexico and Spain was, respectively, $31.33, $33.96, $26.21 and $29.42.

The import prices in both locations were significantly below local factory prices. Local transportation charges have to be added to both the port prices and the factory-gate prices to arrive at delivered prices. Note the cement at the port may have been closer to many users of the cement than were the factories, so its not clear what price should be marked up more. Hence, the lower port prices represented a significant competitive threat to U.S. producers.

What were some of the consequences of the increased foreign competition? First, these low port prices put significant pressure on U.S. factory-gate prices to fall. This can be clearly seen in Texas. In Figure 2, we present average factory-gate prices in Southern Texas, over the period 1983-89, together with Houston port prices (c.i.f.) from Mexico and Spain. In the face of the increased competition, factories in Southern Texas dramatically reduced their (nominal) cement prices over the decade, from xx in 1983 to xx in 1989.[8] Second, these low port prices put significant pressure on the union. As managers sought ways to reduce costs, they often ignored the work rules in union contracts.[9] In fact, in May 1984 the CLGWU ceased to exist as a union. According to one estimate, in the mid 1980s, 70 percent of cement plants operated non-union, or under management imposed contracts. As the 1980s progressed, many plants were organized by different unions (the xx, xx and xx), but the new contracts put far fewer restriction on the rights of management.

As we mentioned, union contracts changed throughout the country in the 1980s. Of course, cement plants in, say, Colorado, did not face a direct increase in foreign competition during the 1980s. Rather our story is that the increase in competitive pressure faced by plants that were near

[8] The path of prices was likely influenced by a number of factors in addition to the threat of imports, like the state of local demand for cement, and the amount of local cement capacity.

[9] See, e.g., Northrup (1989) for discussion.

ports led to a significant weakening of the CLGWU, which as of 1980 was a pretty small union (35,000 or so members). This significant weakening meant the CLGWU could not sustain strikes and so on, and led managers of plants in location not near ports to also challenge the work practices that had prevailed in plants. The story is one where the initial increase in foreign competition had spillovers into areas that did not, in fact, have increases in imports.[10]

An alternative explanation is that the 1980s was a period when many unions came under pressure following the PATCO (air traffic controllers) strike. While the history of the union in Northrup suggests that foreign competition played a crucial role in the change in work practices, it's clear that the political climate had it's role too. If Jimmy Carter was still President (and not Ronald Reagan), perhaps we would only have seen contract changes in plants near ports, and the spillover effects would have been smaller.

C. Why the Big Discounts by Foreign Producers?

How were producers in the various countries in Table 1 (and many more) able to deliver cement to the United States at prices substantially below U.S. prices? Many factors are cited but likely the most important reason is that many of these producers had become more productive at making cement than U.S. producers. In Figure 3, we plot the average labor productivity of producers from various countries that shipped cement to the United States relative to average U.S. labor productivity. The data are available only every few years, and then only for the period 1959 through 1975. By 1975 many of these countries had higher labor productivity than the United States. Relative to U.S. productivity, Japan's productivity was 2.2, France's 1.4 and Italy's 1.2. Spain was about as productive as the United States, and Mexico was about three-fourths as productive.[11]

How did average U.S. labor productivity compare in, say, 1983, to the average productivity

[10] This story is essentially from Northrup (1989). Its also interesting to note that a very few plants were able to maintain their restrictive contracts, and these plants were in areas that had a strong union tradition.

[11] Two things to note here. First, on a unit labor cost basis, it's clear that the U.S. would look even worse since U.S. wages were high, especially relative to Mexico and Spain. Second, it is widely known that the U.S. had very low energy productivity relative to European countries (source: xxx).

of producers in these other countries? Its very likely that the U.S. productivity position had deteriorated further by 1983. That's because, as we show below, labor productivity in the United States was not growing in the late 1970s and early 1980s.[12]

D. Imports

Because foreign producers were offering deep discounts on U.S. cement, U.S. producers faced a substantial increase in competition regardless of whether cement imports increased or not.[13] Still, in this section we present evidence on imports. In Figure 4, we plot the imports of cement (and cement plus clinker) as a fraction of U.S. cement production from 1918 through 2003.[14] For most of the 20th century, imports of cement were very small as compared to domestic production. Imports increased somewhat in the 1970s. The increase in the early 1970s is often attributed to the wage and price controls of that period. The increase in 1979 was (in retrospect) the start of a new era, when imports would come from Australia and Japan (as they did in 1979), and other far-flung nations. In the 1980s, imports increased to nearly 25 percent of production. 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.

[12]The data in Figure 3 are from Cembureau. The data are, in fact, plant level data. For this paper we have simply presented the average productivity of the national industry. In later versions we'll discuss the productivity of the foreign plants that were exporting to the United States, which we conjecture was higher than the national average.

[13]On this issue, there is an interesting story that begins with Victor Rios Rull. In 1985, he was flying from Spain to Minneapolis and was seated next to a Spanish cement company executive. Victor was shocked that he was coming to Minneapolis to sell Spanish cement. The rest of this story is picked up by Dumez and Jeunemaitre (2000, p. 135). They relate that a joint venture to import cement was set up between the Spanish Company and concrete manufacturers in Minneapolis. The joint venture was quickly ended, so that no Spanish cement made it to the Port of St. Paul, but according to Dumez and Jeunemaitrethe the joint venture accomplished the goal of exposing the local cement producers to price competition (Cement was supplied to Minneapolis by Iowa cement plants near the Mississippi River. Average factory gate prices in Iowa dropped over 10 percent from 1984 to 1986, from $53.58 to $47.81). Presumably the Spanish company received a nice payoff when the joint venture was cancelled.

[14]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.

3. Increase in Industry Productivity Primarily Driven by "Within" Plant Gains

We saw in Figure 1 that industry TFP rose significantly in the 1980s.[15] Our conjecture that changes in labor contracts at plants (brought about by competition) were behind the TFP gains suggests an important role for within plant productivity changes. Clearly, changes in work rules and management control could also alter market shares; however, we would still expect to see substantial improvements in productivity at the plants. 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.[16]

For this version of the paper, we examine labor productivity growth decompositions; in the next version, we'll have TFP decompositions as well. 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. Real plant production, which we denote y_{it}, is calculated as the value of plant shipments (minus the change in finished goods inventories) deflated by state-level price indices which we constructed from data on unit values by state in the *Minerals Yearbook* of the United States Geological Society (USGS).[17] Plant labor input, which we denote n_{it}, is constructed using three alternatives – total plant employment; total plant hours where nonproduction 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

[15] The 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).

[16] Before starting, it's interesting to note that during the period of large productivity increases that industry output was not changing much, as is seen in Figure 5 where we plot industry output. This suggests that closing plants was not important for productivity growth (which the decompositions will verify).

[17] Note that it's important to use state prices in deflating revenue since there was significant differences in how state prices were changing in the 1980s.

$Y_t = \sum y_{it}$ 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 only two terms, the "within-plant" term and "everthing-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, Ω) 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

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

We also use output shares as weights in place of the labor shares to check sensitivity of weighting choice. For the most part, 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.[18] The growth in aggregate labor productivity is positive in the periods of 1972-1977, 1982-1987 and 1992-1997. Particularly strong labor productivity growth is observed in the 1982-1987 period, where labor productivity grew 38.6 percent. The industry experiences negative productivity growth in the 1977-1982 and 1987-1992 periods, though at small rates. Overall, productivity growth is relatively flat in the period prior to 1982 and rises sharply thereafter. In both periods of high productivity growth, the within component is large, accounting for over 70% of aggregate productivity growth.

Since the within plant gains were most of the industry productivity gains in the 1980s, we now turn to exploring what factors were behind these gains.

[18] The results presented use labor shares and the Olley-Pakes construction of hours.

4. Management Practices and Productivity

In this section, we start discussing the direct evidence that changes in work rules were likely a primary factor driving the productivity gains within plants in the 1980s.

A. Contract Clauses and Expected Productivity Consequences

In this section, we discuss union contract clauses and work rules that were in place in many plants before the surge in competition. We argue that some of the work rules were likely a drag on innovation (and, hence, productivity growth), while others likely led to falls in productivity. While individual contracts contain many provisions, we focus on four clauses than imposed significant restrictions on management.

Some of the work rules put great restrictions on management. The reader may wonder whether the firms actually followed the letter of the law on them. There was, in fact, widespread adherence to them (at least until 1984), and we present some evidence (e.g., arbitration decisions) that the rules were enforced.

Job Protection (No Termination As Result of Increased Efficiency)

Contracts contained a clause providing job protection to all employees, 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."

This is a strong clause. A worker cannot lose a job because of gains in efficiency at the plant. This clause obviously dulls the incentives to find new production methods, etc..

The job protection clause dulled incentives to innovate and invest in new equipment. The next class of clauses likely led to falling productivity, since the clauses reduced the amount of time that machinery and capital operated at the plants.

Jobs "Belong" to Departments

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, though they were capable of doing so. Here are some examples from a 1969-contract for a Michigan plant.[19] On pages 64-65, its stated that "The work of balancing fans ..... will be performed by the General Repair Department." 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."

Adopting such rules obviously affects productivity. First, plant managers want to minimize situations where machines are down for long periods of time because there are not enough repair workers in a department to get to the job. Hence, this concern leads to overstaffing, and low labor productivity. In the example above, the Finish Grind Department may be forced to hire more repair workers knowing it cannot "borrow" repair staff from other departments.

But, in any case, there will be situations when a department cannot get to a job for a period of time when another department could be helping. Hence, machines remain down longer than necessary.[20] As a result, output is smaller and so is productivity, capital productivity, energy productivity, and labor productivity.[21]

[19] In fact, this plant is not a CLGWU local but a United Stone and Allied Products Workers of America local, Local 135.

[20] Sometimes there were provisions so that if a department could not get to a job, other departments could be called. A cash-penalty would be paid by the Company but, very importantly, procedures had to be followed (and time lost) before the provisions were implemented. For example, on p. 86 of the contract above, "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."

[21] 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.

Contracting out protections

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.[22]

Job Seniority Rights and Job Bumping

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."

[22] A relevant arbitration case involves a Pennsylvania plant. The plant purchased clinker from another firm and planned to grind it at the plant. The Union argued that this violated the contracting out clause. Purchasing outside clinker obviously violated the agreement, and the arbitrator ruled that the company must compensate the workers for the number of hours it would have taken to produce the clinker (from the *Voice*).

Consider productivity consequences of this clause. First, there may be people in jobs that cannot perform them (at least temporarily). And then the only requirement is that the person be able to do the job, not do it as well. Second, experience is lost as people switch and are bumped from jobs. Third, management loses rights to assignment. Lastly, such clauses also permit cascading job bumping. Person A loses his job and bumps person B, then person B bumps person C, and so on.

B. Management Practices and Productivity: 1960s/1970s versus 1980s

In this section, we show in a formal way that (1) many of the work practices above were first introduced in contracts in the 1960s, (2) that by the end of the 1960s, the provisions were widespread (i.e., in nearly all contracts), and (3) that the provisions were dropped from most contracts after 1984. Hence, this evidence is consistent with both the time path of TFP at the industry level, and with the fact that productivity gains within plants were widespread.

We have collected contracts from 96 U.S. cement plants thus far. For some plants we have only one contract, for other plants we have many over time. In our analysis of contracts, we have chosen to examine work rules that are very easy to measure at the plant. In particular, a plant contract either has the job protection clause above or not. Similarly, the contracting out clauses are also simple. A contract has one of three types of contracting out protection. First, it might state that contracting out is not allowed, as in the clause directly above. Or it may say that contracting out is allowed, but no layoffs will result from it. Third, it may state that a plant can contract out with no restrictions. There is a clear ranking in clauses, with the first more restrictive than the second, and the second more than the third. Its pretty clear though that the first clause, the total ban on contracting out, is much different than the other two.

Table 3 presents the information on work rules in U.S. cement plants. The first row presents the number of plants for which we have a contract for the specified period of time. For example, we have a contract dated earlier than 1963 for four plants. We have a contract dated 1963 (i.e. whose beginning date is within 1963) for 36 plants. We have a contract dated in 1965 for 49 plants. We have at least one contract that is dated between 1966 and 1984 (inclusive) for 84 plants, and 18 contracts with a date beyond 1985.

Consider contracting out. Before 1963, there are no restrictions on contracting out in the four contracts we have. In 1963, in 20 of our 36 contracts, there is a ban on contracting out. In the other 16 contracts, there are no restrictions on contracting out. In 1965, contracting out is not allowed in each of the 49 contracts we have. During the period 1966-84, of the 84 plants for which we have contracts, 83 did not allow contracting out, while one contract put no restriction on it. After 1984, work rules were significantly relaxed. Of the eighteen plants we have, none prohibited contracting out. Six allowed contracting out, with the provision that no employee be laid off as a result. And 12 put no restrictions on contracting out at all. Recall that some plants went non-union after 1984, so the loosening of contracting out is understated by looking at union contracts.

Consider the job protection clause next. Before 1965, no contract had the job protection clause. In 1965, nearly all contracts had the clause (47 had the clause, and two did not). It would seem that 1965 was the first year that this clause was in any contract. To check this, we examined the issues of the *Voice* for 1965. In the March issue, on p.1, the CLGWU lists its new agenda for bargaining that year, and this job protection clause was on the new agenda. This is more evidence that 1965 was the first year where the union imposed job protection on a wide-scale basis.[23] In the 1966-84 period, 81 plants had the clause (of the 84 total). After 1984, only four of the 18 plants had the job protection clause. Again, this likely understates the extent to which work rules were

[23] There were agreements before 1965 that protected jobs from increased efficiency. But these were often implicit or oral agreements, and we are not sure how widespread they were. But its interesting to note that arbitrators were enforcing these oral agreements against job loss from new production methods. For example, at a cement plant in New York, there was a kiln operation that was run by a crew of six before 1958. Crew size was not set in writing, but in an oral agreement. The kiln operation was shut down in 1958 and restarted in 1963. When it was restarted, the company manned the operation with a four man crew on two shifts, and a five man crew on one shift. The union filed a grievance and the arbitrator ruled for the union. The operation was to be run by a crew of six. The arbitrator argued, "Agreements may, in the course of time and technological change, become antiquated or inconvenient, or more costly than anticipated. They do not, by virtue thereof, lose their force." This is from an aribtration decision that was summarized in the *Voice*, October, 1965, p. 3.

loosened.

C. Management Practices and Productivity: 1950s versus 1960s/1970s

As we said above, from the end of WWII until 1984, nearly all plants in the industry were unionized, and the vast majority of these unionized-plants were locals of the CLGWU. But the union was not always strong. A watershed year for the union was 1957, when the CLGWU called a national strike that idled over half the plants in the country. Before the strike, bargaining at cement plants was on a plant-by-plant basis. There was no coordination among plants. After the strike, the union instituted pattern-bargaining, whereby contracts would be set for a few plants and then the rest were to follow.[24] That the no contracting out clause and job protection clause became so widely adopted in a very short period of time suggests the CLGWU's goal of using pattern-bargaining to get uniform contracts was working.

The union in the 1960/1970s was, then, very different than the pre-1957 union (See Northrup (1989) on this point as well). Given this history, its natural to ask: Was productivity in the industry initially growing after WWII? The answer is yes. Recall that the NBER TFP series in Figure 1 runs from 1957-96. While there is no published TFP series prior to 1957, it is possible to construct various measures of industry productivity from the end WWII until 1957. We'll show that energy productivity, capital productivity, and labor productivity were all growing in this period after WWII.

In Figure 6, we plot energy productivity over the period 1946-96. The index from 1946-57 is constructed from data in the Minerals Yearbook of the United States Geological Society (USGS). The index from 1957-96 is constructed from the NBER data. Energy productivity is increasing from the end of WWII until 1957. From 1957-96, the energy productivity series looks like the NBER TFP series. In Figure 7, we plot capital productivity over the period 1946-96. The index from

[24] As the Wall Street Journal reported, "Some company officials privately concede that results of the strike marked the end of the industry's usual bargaining technique of plant-by-plant negotiations since the union's international headquarters coordinated strike efforts, and laid down basic demands to be followed by individual plant locals." From "Universal Atlas, Cement Workers Agree on Contract; Union Will Seek Similar Pacts With Other Companies," Wall Street Journal, July 29, 1957.

1946-57 is constructed from data in the Minerals Yearbook of the USGS. The index from 1957-96 is constructed from NBER data. Capital productivity is increasing from the end of WWII until 1957. From 1957 onward, the series also looks like the NBER TFP series.

In Figure 8, we plot labor productivity over the period 1946-96. From 1946-57, we calculate labor productivity from the Census of Manufacturers and Annual Survey of Manufacturers (the series labeled "Census"). From 1957-96, we use the NBER labor productivity series (also from the Census of Manufacturers). As with energy and capital productivity, labor productivity is increasing in the period after WWII.

In sum, all three productivity series are growing after WWII, so that a measure of TFP would also be growing.[25]

An interesting feature of labor productivity is that it continues to grow after 1957. Of course, after the union victory in 1957, wages in the industry were rising very rapidly (recall they were approaching those of auto workers) and plants would want to substitute other inputs for labor (thereby raising labor productivity). But note that labor productivity also stops growing in the mid to late 1960s, and productivity in the late 1970s is same as in the late 1960s. Labor productivity stops growing even earlier in the labor productivity series compiled by the Portland Cement Association (PCA). This is also in Figure 8. The PCA series grows between 1960-1965. Then it shows little growth from 1965 until the early 1980s.

There is, of course, a good candidate explanation for why labor productivity stopped growing: the job protection clause was inserted into most contracts during 1965. Plants now could not reduce employment if they purchased new machinery or figured out better ways to organize production. In Figure 9, we plot employment in the industry. Starting in 1957, employment begins to fall, but the trend is mostly stopped in the late 1960s.

Another interesting fact that suggests the job protection clause likely had an impact on labor

[25] We do not have a material's productivity series prior to 1957.

productivity growth concerns technology at the plants. If one examines a cross section of plants, those with larger kilns will have significantly higher labor productivity.[26] The industry moved to using larger kilns in the 1970s and 1980s through both adopting new, larger kilns, and the shedding of smaller kilns. However, the growth in average kiln size was actually greater in the period before the foreign competition than in the period after the increase (From 1970-83, average kiln size grew at annual rate of 0.95 percent; From 1983-96, average kiln size grew at annual rate of 0.35 percent). This contrasts with the corresponding rises in labor productivity where labor productivity was stagnant in the 1970 and grew rapidly in the 1980s.

D. Management Practices Across Plants

In this section, we discuss the variation across plants in work rules. As we mentioned, from the 1957 strike onwards, it was the goal of the CLGWU to have a standard contract across plants. In this goal, it seems the union largely succeeded. Hence, there was likely not much variation in work rules across plants in the 1960s and 1970s.

Next, consider the 1980s. As argued above, the loosening of work rules was widespread, and happened throughout the country. There was some variation across plants to be sure, but it has proven difficult to characterize it. Finding contracts has been more difficult for this period than for earlier periods. Moreover, we know that managers at plants were sometimes ignoring the contracts during the crisis period.

But there is another way to examine variation across plants in work rules. It turns out that the CLGWU had organized nearly all the cement plants in Canada as well. In the next section we argue that work rules in U.S. plants changed much more in the 1980s than did those in Canadian plants.

[26] Kilns are rated as to how many tons of clinker they can produce in a day.

5. Management Practices and Productivity in Canada vs. United States

By the end of the 1970s, the CLGWU represented workers at nearly all Canadian cement plants. In this section, we show that (1) Canadian contracts had less restrictive work practices than U.S. plants in the 1960s and 1970s and (2) in the 1980s, the loosening of work practices was significantly greater in the United States than in Canada. Then we show U.S. TFP increased faster in the 1980s than did Canadian TFP (and the same is true of labor productivity).

A. Canadian Work Rules

We have contracts for 14 Canadian cement plants. Table 4 shows that 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 that have the total ban on contracting out. Five plants allow it, though it should not result in layoffs. And one plant has no restrictions. 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 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.

B. Changes in Canadian and U.S. Work Rules in the 1980s

Comparing Tables 3 and 4, we see 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.

C. Canada versus U.S. Productivity 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 10, we compare U.S. and Canadian TFP. We normalize both TFPs to a year shortly before the increase in competition, and then also choose a year where there was not a downturn. We normalize both TFPs to 1978=1. One can see that U.S. TFP did grow more significantly than Canadian TFP in the 1980s. Figure 11 shows that the same was true for labor productivity.

A few remarks are in order.

Remark 1. While Canadian work rules were less restrictive than U.S. work rules in the 1960s and 1970s, the CLGWU was still a significant force, and we are not surprised that Canadian TFP did not perform well in the 1960s and 1970s.[27]

Remark 2. 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

Remark 3. While U.S. productivity grew more rapidly than Canadian productivity in the 1980s and 1990s, it seems U.S. productivity still lagged Canadian productivity in the 1990s. The United States was, in effect, just catching up to Canadian levels.[28]

6. Other Possible Sources of Within Productivity Gains

Thus far we have been showing direct evidence that changes in work practices were likely an important source of the within plant productivity growth in the 1980s. In this section, we present indirect evidence as well.

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[27] Estimates of TFP in the Swedish cement industry over the period 1955-79 have been calculated by Forsund and Hjalmarsson (1983) and Kumbhakar, Heshmati and Hjalmarsson (1999). These papers have found strong productivity growth in Swedish cement production over this period.

[28] The best source for this is data from the Portland Cement Association. In 19xx, Canadian labor productivity was 1.xx U.S. productivity, and Canadian energy productivity was 1.xx U.S. productivity.

We estimate a labor productivity growth regression using plant-level data of the form

$$\Delta \ln(y_{it}/n_{it}) = \beta \Delta X_{it} + \delta_t + \mu_{it}$$

where $\Delta \ln(y_{it}/n_{it})$ is the log difference in labor productivity of plant i between period t-1 and t, ΔX_{it} includes a set of plant-level control variables that are measured mostly as changes in plant characteristics, β is a vector of coefficients, δ_t is a set of time effects and μ_{it} is the error in the log difference model. The difference form of the specification controls for time-invariant plant-level heterogeneity.

The growth in plant labor productivity, $\Delta \ln(y_{it}/n_{it})$, are the measures we discussed above in Section 3 on productivity decompositions. The measures are constructed from the Census of Manufactures. The set of control variables in ΔX_{it} include changes in technological features of the plant, changes in market-level variables, and changes in ownership. The plant technology variables include measures of the growth in average kiln size and growth in the number of kilns at the plant 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 at the plant. 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 of purchased clinker is less labor intensive than integrated production (clinker and cement production). These data on plant technology variables come from the Portland Cement Association's Plant Information Summary publications and are matched to the Census Bureau data.[29]

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-

[29] The data on kiln technology is matched to the Census plant-level data – we do not match either all plants in the Census of Manufactures data to the Portland Cement Association, nor do we match all plants in the Portland Cement Association to the Census of Manufactures data. The imprecise nature of the match insures that plants cannot be identified in the analysis sample from the publicly available information. In addition, the information on plant kiln size, age and type for 1972 comes from the 1974 Plant Information Summary, as prior data were unavailable.

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.[30] 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.

Some regression results are presented in Table 5. Column 1 of the table reports the results from a model that only includes time dummies, while column 2 presents the results from the model with time dummies and the plant 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 high growth rates relative to the base period 1972-1977, while the 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 second 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.

The lack of overall significance in the plant technology variables might be somewhat surpris-

[30] The initial number of firms is used to proxy for domestic competition and the level is included to simply capture differences in market structure in regional markets.

ing. 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, 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. This is consistent with the aggregate evidence discussed above where average kiln size was growing faster in the 1970s than the 1980s, yet labor productivity was growing faster in the 1980s than the 1970s.[31]

The second tack recognizes that we might not be able to measure some factors that influence plant productivity. But if changes in these unmeasured factors were important, then we might expect to see bigger changes in productivity in plants that faced the greatest (direct) increase in foreign competition (which we measure here as how far the plant is from a port). In order to examine the direct role of foreign competition in affecting plant-level productivity, we estimate a specification that includes controls for a plant's 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 a number of land crossings. The source of new foreign imports that we are concerned with here are the imports to US deepwater ports 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. Nor had there been a sharp change in the productivity of Canadian plants compared to US plants (as shown earlier). 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 deepwater port 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.[32] We then form a distance index based on the function $-\exp(-\lambda * \text{distance})$ where

[31] One can imagine lots of plants that were not purchasing or discarding kilns (and hence had no change in average kiln size) experienced large labor productivtiy gains as they reduced their workforce (since the job protection clause was no longer in effect).

[32] The county centroid is the population weighted geographic center of a county.

λ 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 five time-distance interactions in the difference model. The last 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 dummy for 1982-87 does not change much, though the other dummies shift as they interact with the port distance-time variables. Consider the port-distance variables. For 1972-77, labor productivity growth is greater for plants closer to ports, though the coefficient is only 0.039. For 1977-82, the impact of being close to a port is much larger. This is very likely picking up the fact the recession was worse in the Midwest than in the Far West and the South (see discussion of cyclical effects below). Port-distance is not important in 1982-87, the years in which the impact of foreign competition is likely the greatest. Finally, plants closer to ports appear to have experienced higher productivity growth in the 1992-97 period.

In Figure 12, 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. 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 solid line in Figure 12 is plotted using the coefficients in column 2 of Table 5. For the model with the port variable (column 3), we include a line (port_close) for a plant that is 100 miles from of a deepwater port and a line (port_far) for a plant that is relatively far from a port (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.

Let's summarize the regression results. The general results are consistent with the view that it was something other than the measurable plant characteristics driving the productivity change over the 1982-87 period. Also, its consistent with the view that the factor driving the gains was widespread, and not limited to plants close to ports.

There are several caveats worth noting. 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. In future work, we can use the demand measures (fluctuations in regional construction spending) suggesting by Collard-Wexler (2008) to control for regional cycles. In addition, we could construct a plant-level capacity utilization using the mill capacity and output; however, a measure like this is clearly endogenous (as it depends on plant output) and we will need to develop a set of suitable instruments. Second, our distance measure to ports is admittedly crude and does not control for the level of activity with respect to the importation of cement products across ports. We have collected information on both the quantities and the unit prices of imports and can potentially utilize these as additional characteristics to gauge the importance of foreign competition. Finally, we can be more precise with our measurement of ownership structure and change of the firms in our data (e.g., Perez-Saiz (2009)).

7. Conclusion

To be added.

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Table 1

U.S. Cement Prices – 1984
(Dollars Per Ton)
Factory-Gate Prices and Port Prices (c.i.f.) by Country of Import

		Port Prices						
		Port of Los Angeles			Port of Houston			
Production Area	Factory-Gate Prices	Japan	South Korea	Spain	Columbia	Italy	Mexico	Spain
Southern California	59.67	32.29	33.03	35.18				
Southern Texas	47.61				31.33	33.96	26.21	29.42

Source: Minerals Yearbook, 1984, United States Geological Society

Table 2

Labor Productivity Growth Decomposition

Census Years	Aggregate Productivity Growth	Within Component	Within Share
1972-1977	0.055	0.019	
1977-1982	-0.028	-0.058	
1982-1987	0.386	0.280	72.5%
1987-1992	-0.012	-0.035	
1992-1997	0.164	0.125	76.2%

Table 3

Union Contract Provisions
U.S. Cement Industry

Numbers of plants for which	Before 1963	1963	1965	1966–1984	1985–
We have contract in specified time period	4	36	49	84	18
Contracting Out					
No contracting out	0	20	49	83	0
Contracting out allowed, no layoffs	0	0	0	0	6
Contracting out, no restrictions	4	16	0	1	12
Job Protection					
Job protection	0	0	47	81	4
No job protection	4	36	2	3	14

Total number of plants = 96

Table 4

Union Contract Provisions
Canadian Cement Industry

Numbers of plants for which	Before 1984	After 1984
We have contract in specified time period	6	14
Contracting Out		
No contracting out	0	0
Contracting out allowed, no layoffs	5	14
Contracting out, no restrictions	1	0
Job Protection		
Job protection	1	0
No job protection	5	14

Total number of plants = 14

Table 5. Log Difference in Labor Productivity: Plant Level Regressions

	Year Only Model	With Plant Controls	With Plant and Port Controls
Intercept	.020	.037	.034
	(.029)	(.066)	(.072)
1977-1982	-.142*	-.124*	-.207*
	(.046)	(.051)	(.071)
1982-1987	.324*	.330*	.351*
	(.059)	(.061)	(.094)
1987-1992	-.014	.002	.078
	(.058)	(.065)	(.095)
1992-1997	.091	.107	-.004
	(.052)	(.055)	(.079)
Δ kiln size		-.190	-.164
		(.145)	(.143)
Δ number of kilns		-.445*	-.398*
		(.148)	(.150)
Δ Grinding Capacity		-.103	-.107
		(.099)	(.093)
Adopt a New Kiln		.107	.120
		(.068)	(.065)
Remove Oldest Kilns		-.110	-.093
		(.089)	(.084)
Population Growth		-.114	-.306
		(.501)	(.524)
Number of Domestic		-.013	-.015
Competitors		(.019)	(.019)
Δ Ownership		-.005	.004
		(.071)	(.069)
Port Distance*(1972-			.039
1977)			(.080)
Port Distance*(1977-			.263*
1982)			(.112)
Port Distance*(1982-			-.017
1987)			(.132)
Port Distance*(1987-			-.169
1992)			(.180)
Port Distance*(1992-			.343*
1997)			(.149)
R^2	.147	.172	.203

* indicates 5% significance level.

Figure 1.
Total Factor Productivity
U.S. Cement Industry
(NBER Manufacturing Database, 1987=1)

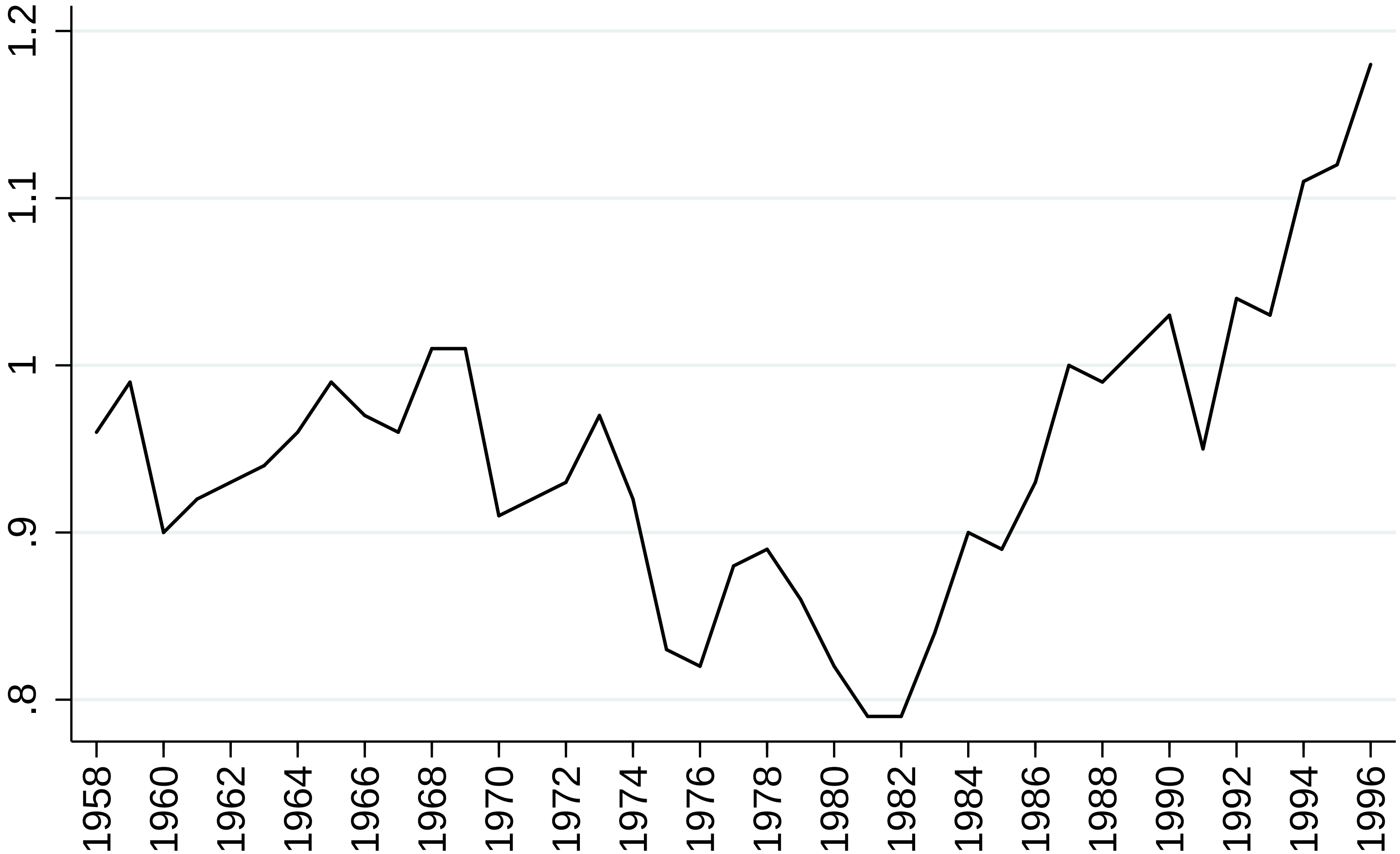

Figure 2. Texas Cement Prices

(Dollars per ton)

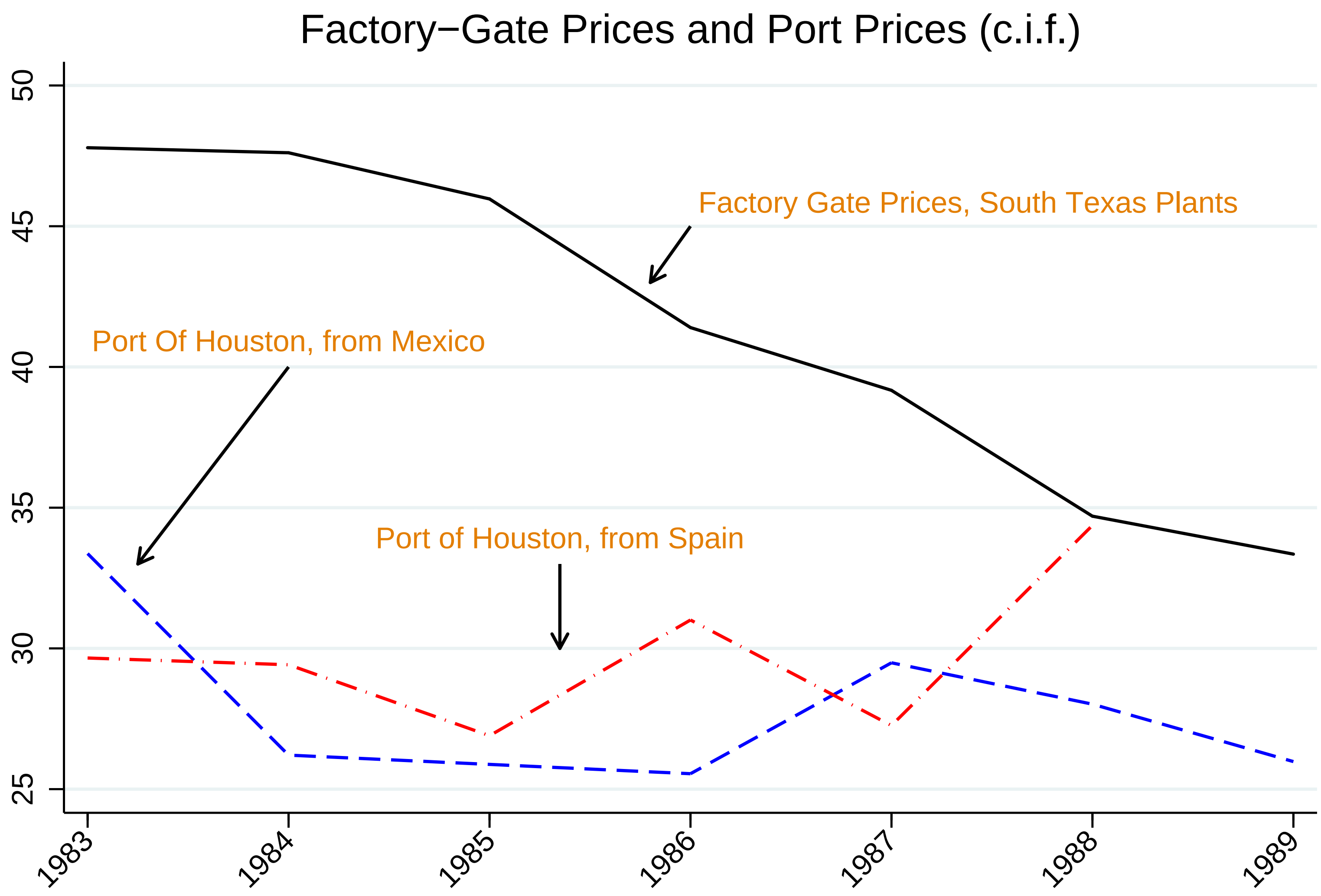

Figure 3. Labor Productivity

Tons of Cement per Employee (log scale)

Various Countries Relative to United States

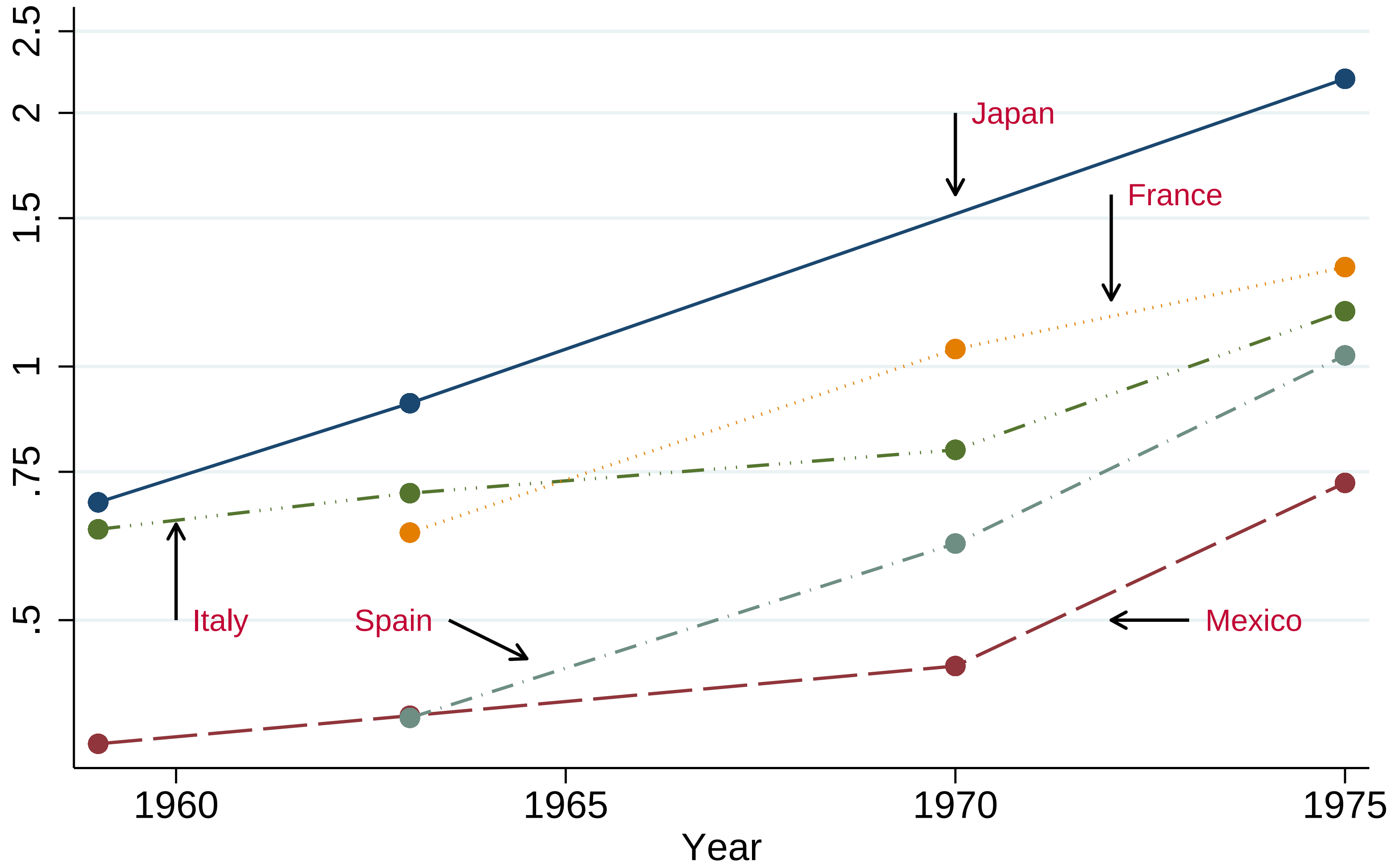

Figure 4.
U.S. Cement Imports
(Relative to U.S. Production)

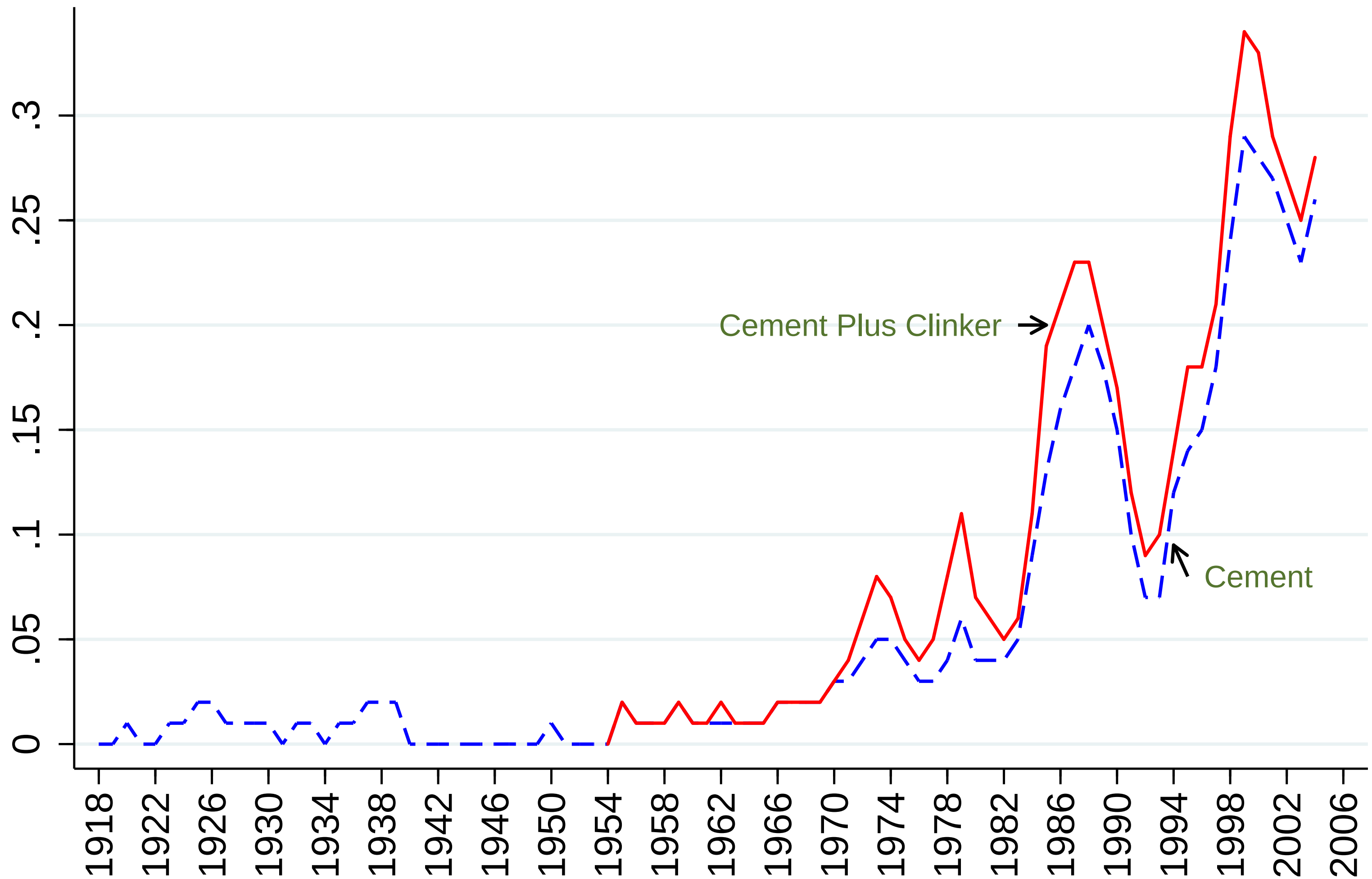

Figure 5.
U.S. Cement Production

(Million Metric Tons, log scale)

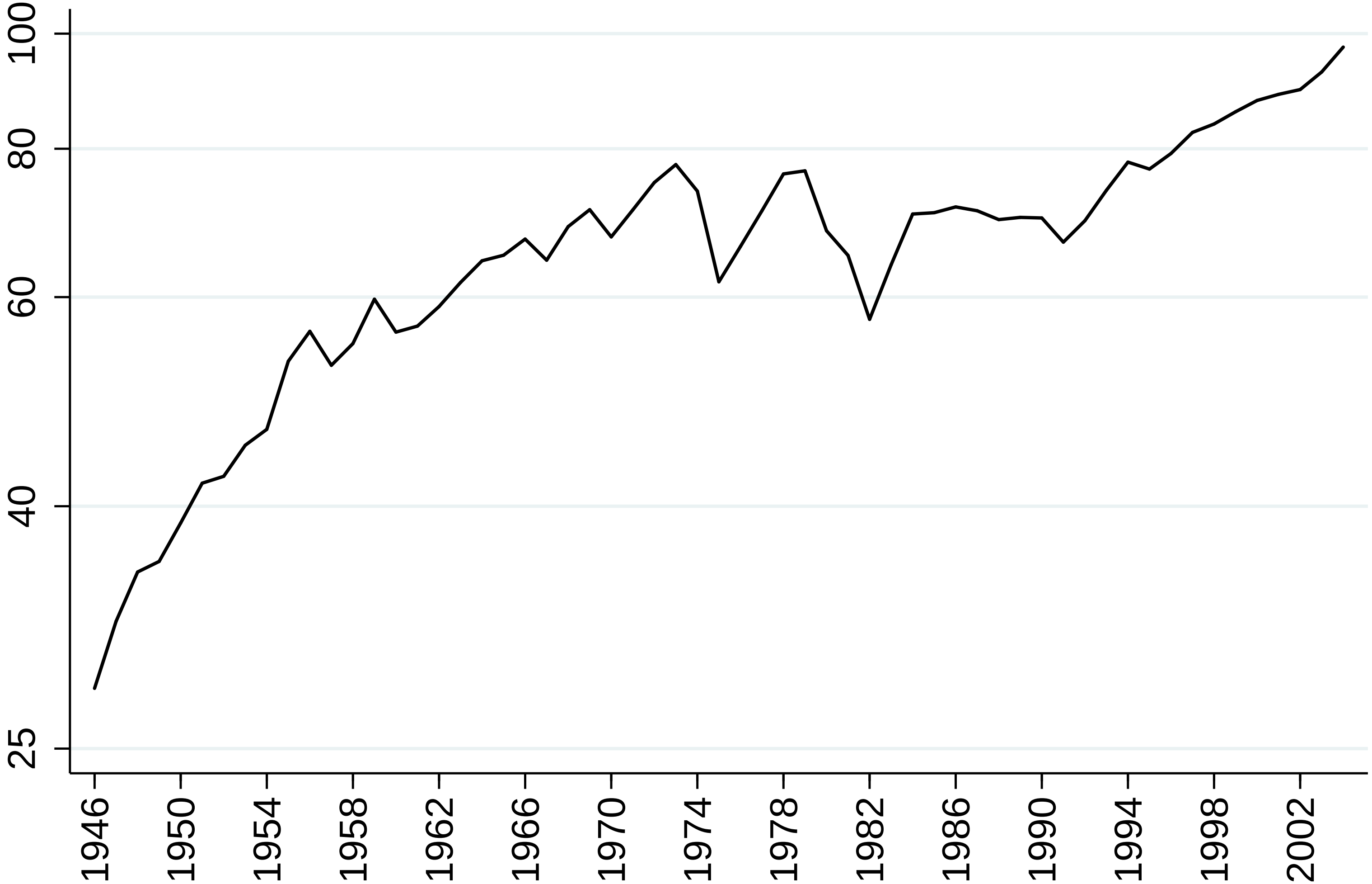

Figure 6.
Energy Productivity
U.S. Cement Industry

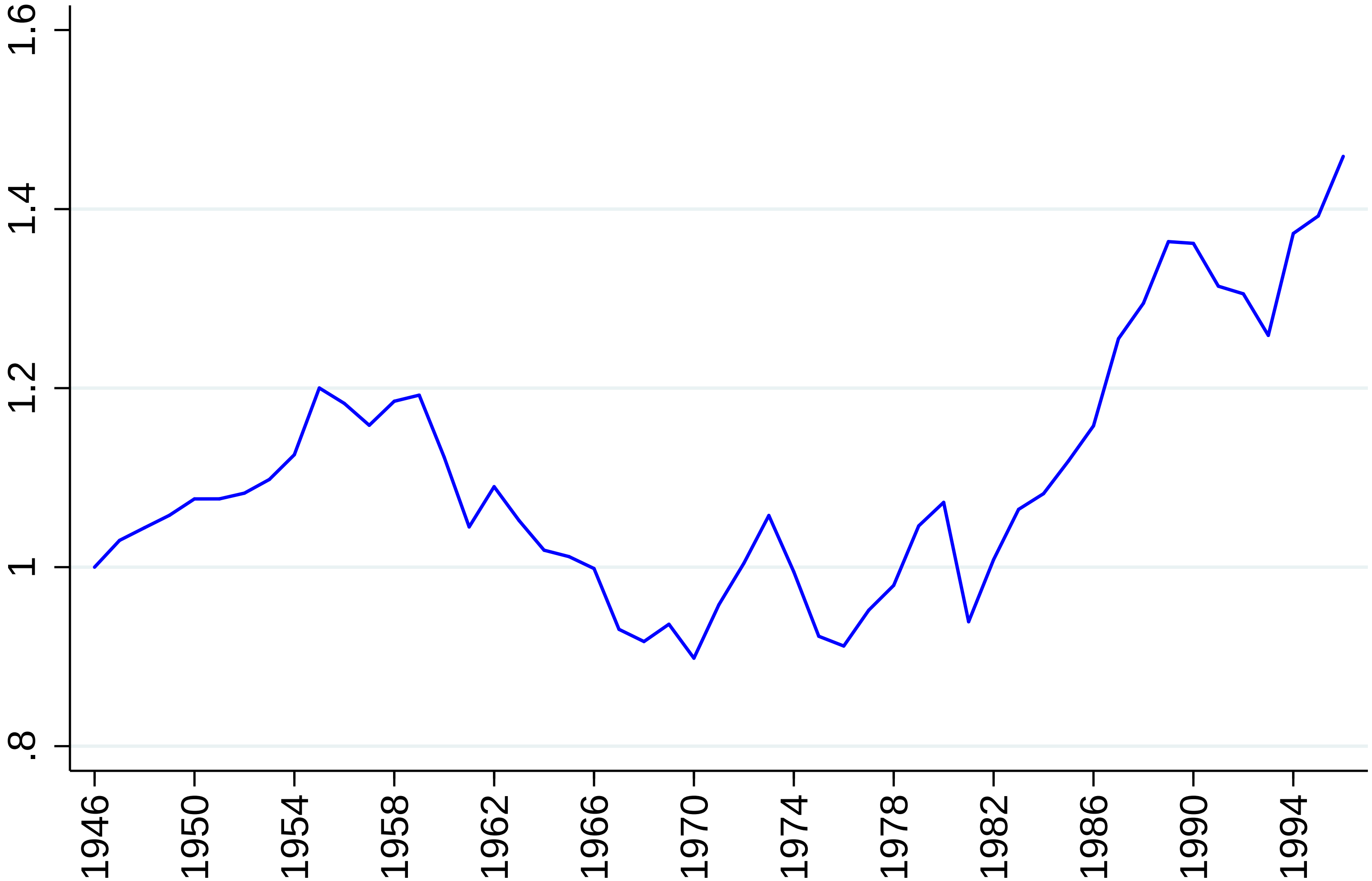

Figure 7.
Capital Productivity

U.S. Cement Industy

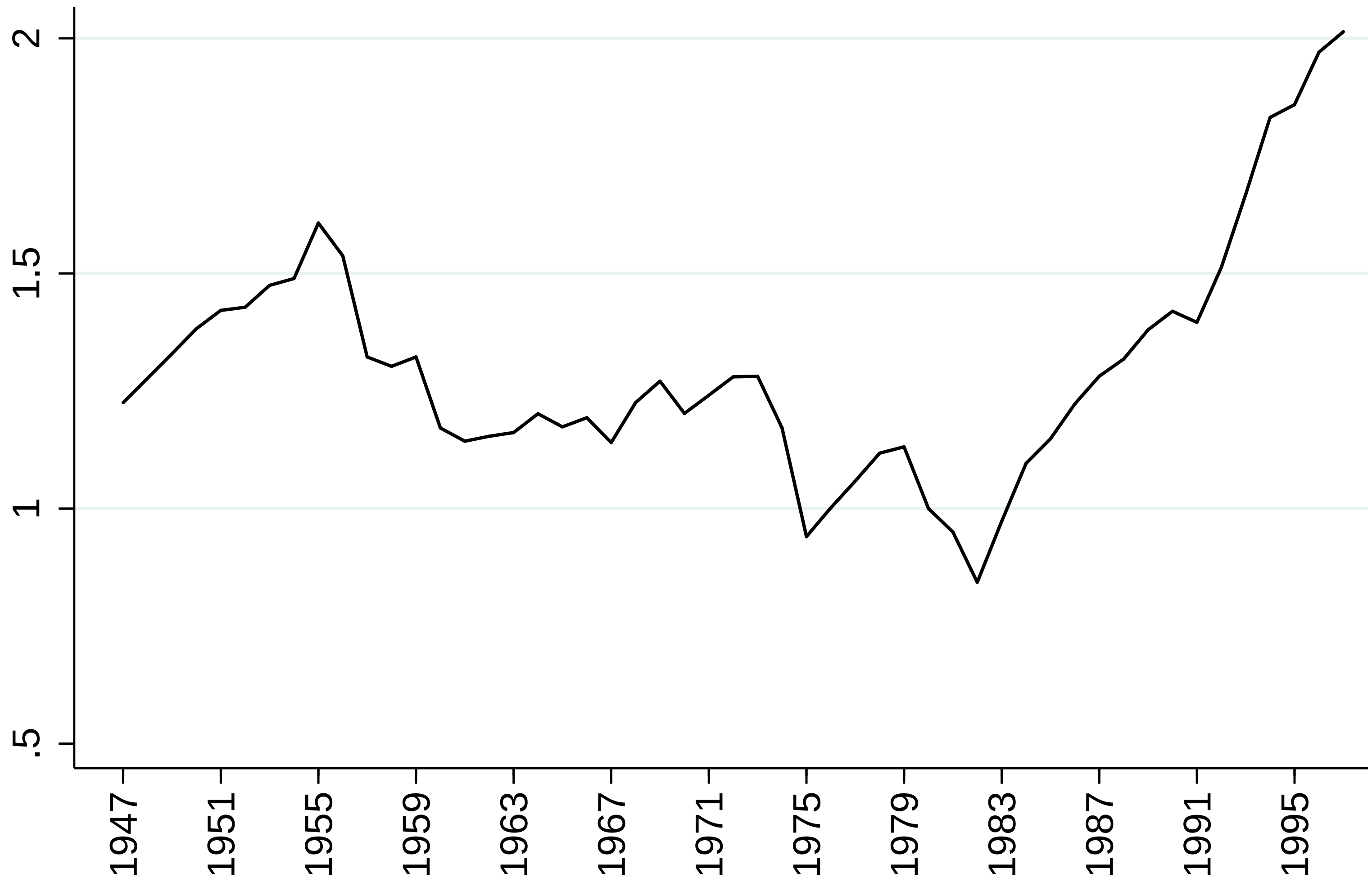

Figure 8. Labor Productivity
U.S. Cement Manufacturing

(Tons per hour, log scale, 1968=1)

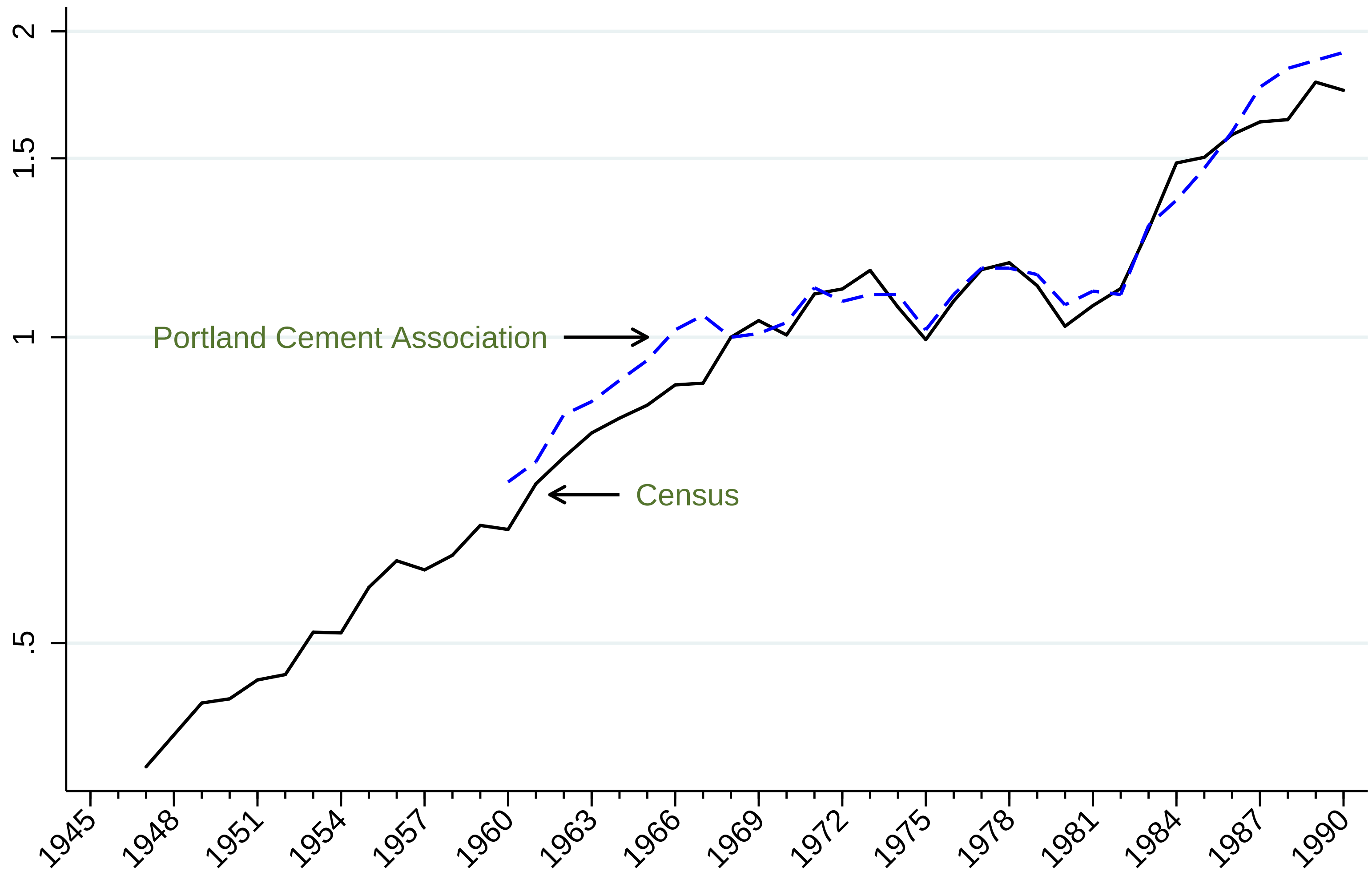

Figure 9.
Total Employment, US Cement Industry
(in logs)

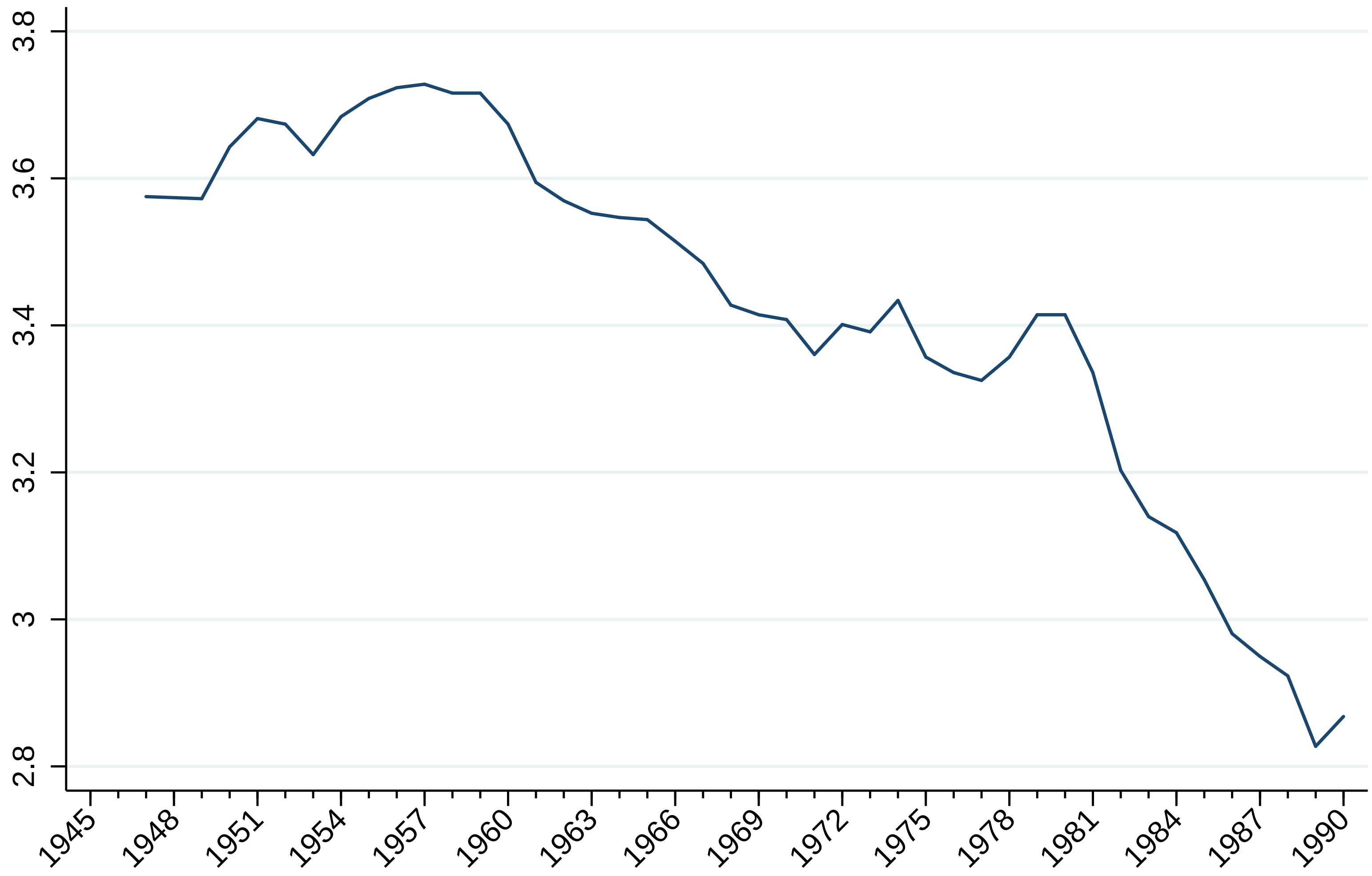

Figure 10.
Total Factor Productivity
US and Canadian Cement Industry
(1978=1)

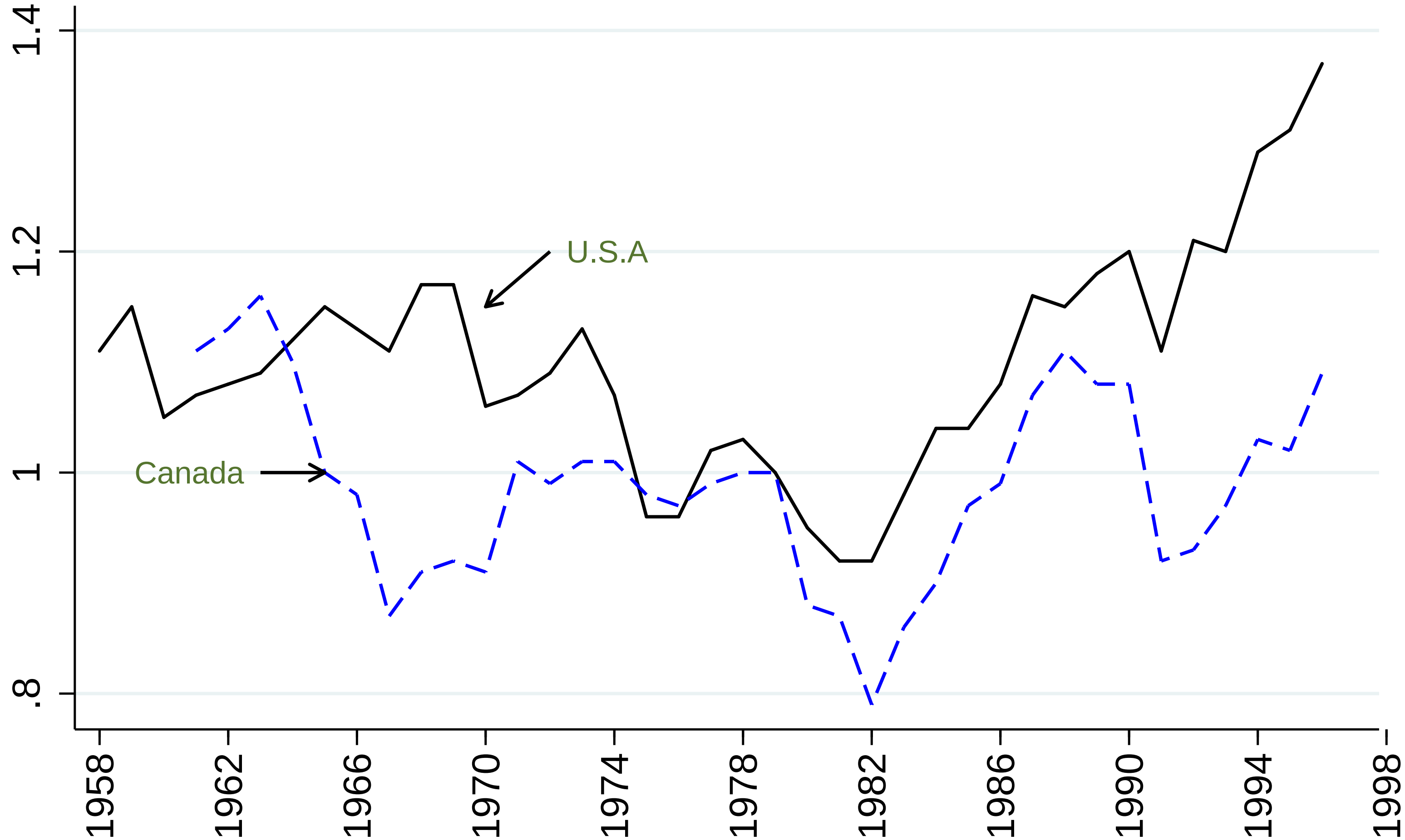

Figure 11.
Labor Productivity
US and Canadian Cement Industry
(1978=1)

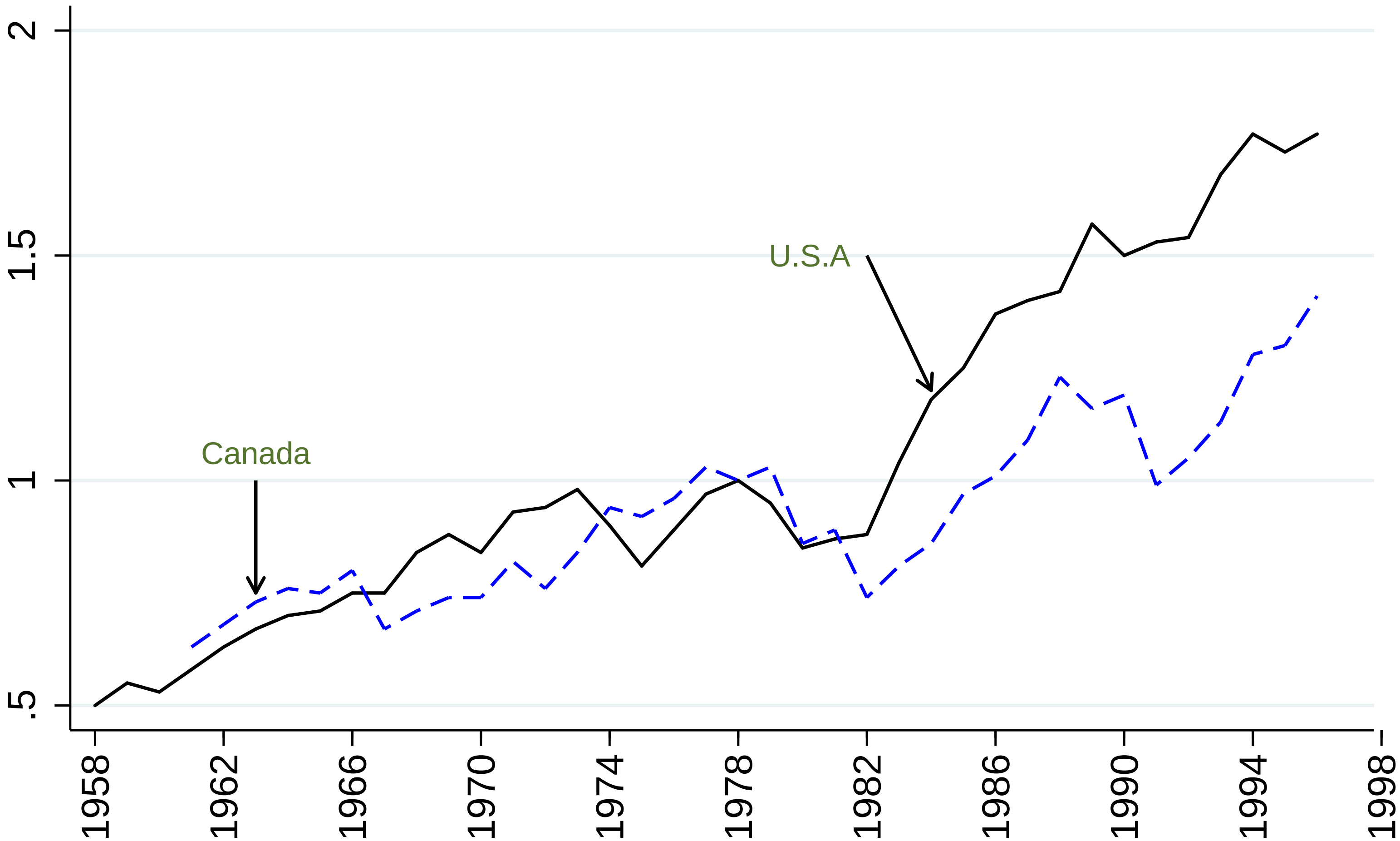

Figure 12.
Labor Prodictivity
Plants "Close to" and Plants "Far From" a Port
(1972=1)