COMPETITION AND PRODUCTIVITY: EVIDENCE FROM THE POST WWII U.S. CEMENT INDUSTRY

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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, 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? If so, how does it do so? These are old and important questions. The questions are central to many policy debates, like what is the impact of liberalizing trade (e.g. 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 foreign competition in the 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.

From the late 1950s until the early 1980s, there was very little foreign competition in the industry, and industry TFP dropped over 10 percent, as shown in Figure 1. After the increased foreign 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, a 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.[1] With these work restrictions removed, industry productivity, as we'll show, was able to grow robustly.

The rest of the paper proceeds as follows. In Section 2, we compare the productivity of the U.S. cement industry (e.g., Figure 1) to that of foreign cement industries. We show that the poor productivity of the U.S. cement industry before 1980 was not common, so that by the middle 1970s the productivity of many foreign cement industries had caught, and passed, U.S. cement productivity. We also show that U.S. cement industry productivity

[1] In the words of Northrup (1989), who wrote a history of labor relations in this industry, during the 1960s and 1970s the 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 the abstract of paper).

growth in the 1980s outstripped that of other foreign cement producers.

In the next two sections we show, respectively, that market power increased in the U.S. cement industry over the 1960s/70s, and then that foreign competition significantly increased in the 1980s. Section 3 discusses market power in the industry, and focuses on the market power held by input suppliers in the industry. In particular, it shows that the market power of the union was greatly extended over the 1960s/70s by analyzing cement worker wages. We show, for example, that the ratio of cement production worker wages (the unionized group) to non-production worker wages rose significantly in the 1960s/70s. Section 4 shows foreign competition increased using evidence on, among other things, imports into the United States. Since cement is much cheaper to transport over water than land, the direct impact of competition hit plants near ports. However, we argue that there was also a large, indirect impact of foreign competition that hit plants throughout the country.

Productivity performance, then, was dismal when market power was increasing in the industry, and it was good when competition increased in the industry. Foreign competition worked not through reallocation but by making plants more productive. Section 5 shows that the increases in productivity in Figure 1 in the 1980s were primarily a "within" plant phenomena. Productivity gains due to reallocation (which include gains from closing plants) were only a small part of the overall gain.

How, then, did plants become more productive in the 1980s? As mentioned, in our estimation a primary source of gain was that management regained control over many plant decisions. To show this, we take two approaches. In the first approach, the *direct* approach, we present 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.

Much of the evidence on work practices is from union contracts. We have contracts from about 100 U.S. cement plants over time.[2] In Section 6 we discuss some of the work rules in these contracts. 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 argue that on *a priori* grounds that these practices would

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

reduce productivity. Section 6 also presents a quantitative analysis of the restrictive practices. We show that these restrictive clauses were introduced in the 1960s, and at nearly all plants. We'll also show that most plants dropped them in the mid 1980s. Here, then, was a large, indirect impact of competition: contracts were changed not only near ports, but in the interior of the country as well.

This pattern of restrictive work practices is, of course, consistent with the time path of industry TFP, of it stagnating upon adoption, and growing after removal. It's also consistent with the within component accounting for a large fraction of productivity gains.

How about variation across plants in work practices? In the 1960s, nearly all plants adopted the practices at the same time, so there was very little variation. In the 1980s, most plants also dropped the restrictive work practices at the same time, though there was some variation. But 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. Given this, we have explored other ways to study cross plant variation. One successful approach has been to compare work practices across Canadian and U.S. cement plants. We have collected contracts for cement plants in Canada. 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 have compiled a list of other 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.

A few words about related literature. An old idea, often associated with Leibenstein (1966), and often given the name "X-inefficiency," is that if producers in an industry acquire market power, then their productivity will suffer. While there is little theory for such an idea, there is also little factual evidence either. In this paper we show that this seems to have happened in the U.S. cement industry over the 1960s/1970s.

The paper is also related to the literature on the gains from openness. Two decades of stagnant productivity meant the U.S. cement industry had become a productivity laggard. Given that the United States is a fairly open economy, it was only a matter of time before foreign cement producers began to exploit that vulnerable position. When they did, the U.S. cement

industry responded by increasing its productivity. This productivity increase is a "gain from openness," though it is one seldom discussed in the literature.

There is a growing literature that shows management practices can have important impacts on productivity. Ichionowski and Shaw (1995) show changes in human resources practices influence productivity. Bloom and Van Reenen (2007) study management practices more generally, and have found, looking across firms and countries, that "poor management practices are more prevalent when product market competition is weak." (see also Bloom, et al (2010)).

2 U.S. Cement Productivity Compared

In Figure 1, we showed TFP in the U.S. cement industry was stagnant or falling over the 1960s and 1970s and increasing from the mid-1980s on.[3] In this section, we compare the industry's productivity performance to foreign cement producers and to other U.S. manufacturing industries.

2.1 Comparison of U.S. cement and foreign cement

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.

Figure 2 plots U.S. labor productivity over 1947-1996. Two series are presented, one from Census, and one from the Portland Cement Association. Labor productivity growth was strong in the United States until the middle 1960s, and then there was little growth until the 1980s. So, while industry TFP stopped growing in the late 1950s, labor productivity did not stop growing until the mid 1960s.[4] Below we discuss why labor productivity grew in the early 1960s (as opposed to TFP).

In Figure 3, we plot labor productivity of foreign cement industries (each of which shipped cement to the United States) relative to U.S. labor pro-

[3] 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).

[4] The other partial productivities, materials, energy, and capital, have the same pattern as TFP.

ductivity. 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. We suspect that U.S. productivity levels would look even worse compared to these countries in the early 1980s, since, as Figure 2 showed, U.S. labor productivity was not growing from the middle 1970s through the early 1980s.[5]

We also have labor productivity for a few countries for years beyond 1975. In Figure 4, we plot the labor productivity of the Japanese cement industry relative to the U.S. cement industry over 1970-1990.[6] The Japanese data is only available every five years. Japanese productivity increases significantly relative to U.S. productivity from 1970 to 1975, as with the Cembureau data (Figure 3). It continues to grow much faster than U.S. productivity from 1975 to 1980. Then Japanese productivity declines significantly relative to U.S. productivity over 1980-85. Over the five years 1985-90, productivity grows similar amounts in both countries.[7]

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.

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

The TFP and labor productivity patterns in Figures 1 and 2, of very weak growth in the 1970s, followed by strong growth in the 1980s, was not typical of U.S. manufacturing industries.

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

[5] It is well known that the U.S. cement industry had very low energy productivity relative to European countries (source: xxx). Hence, U.S. TFP was likely very low compared to the countries in Figure 3.

[6] The Japanese data comes from the Japan Cement Association.

[7] Australia has the same pattern as Japan, though not as striking. Many thanks to David Prentice for the Australian data.

from 1970 to 1980. In terms of this difference, the 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.[8]

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.

In sum, then, the productivity patterns in the U.S. cement industry were not a very common pattern among U.S. manufacturing industries.

2.3 Technology Upgrading in U.S. Cement Industry: 1970s Compared to the 1980s

As one last piece of evidence to show that the behavior of U.S. cement productivity during the 1960s/1970s stands out, we'll argue that the industry's investment in new technology was greater in the 1970s than the 1980s, though the pattern of productivity was just the opposite.

There are good measures of the technology used in the U.S. cement industry collected by the Portland Cement Association (PCA). In particular, the major pieces of capital in a cement plant are its cement kilns. Starting in the early 1970s, the PCA has surveyed each U.S. cement plant regarding its kilns. For each kiln, the PCA asks about its (1) age, (2) size (how much clinker it can produce per day), and (3) its type (wet or dry).

New kilns are, everything else equal, less likely to break down and more likely to incorporate the newest advances in technology. Big kilns produce more output per unit of labor than small ones (since there is a large fixed-labor component in operating kilns).

Regarding the age of kilns, the (weighted) average age of the industry's kilns was falling in the 1970s and increasing in the 1980s.[9] As another metric,

[8] 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.

[9] If we let $K(a)$ denote the industry's capacity that is a years old, and K its total

the share of capacity less than x years old was increasing in the 1970s, and decreasing in the 1980s (where x=10, 20 and 30). Regarding kiln size, growth in average kiln size and average plant size was greater in the 1970s than the 1980s. From 1970-83, average kiln and plant size grew .95% and .37% percent per year, respectively. From 1983-96, average kiln and plant size grew .35% and .21% percent per year, respectively.

3 Increases in Market Power in U.S. Cement Industry in 1960s/70s

In this section, we'll argue that there was a big increase in market power in the U.S. cement industry in the 1960s/1970s. In particular, we argue that the market power of input suppliers to the industry increased over the 1960s/70s.

Producers have market power if they have the ability to raise price above costs. Producer market power can emerge, for example, in markets where transport costs are large relative to the value of the product – such as in cement markets. If this is the case, local producers may be able to raise price above costs without fear of increased competition (particularly if the scale of production is big relative to the market and entry is expensive).[10]

Input suppliers can also have market power, that is, the ability to raise their input prices above "competitive" prices. Input suppliers will have an incentive to raise prices in markets where producers have market power. In such markets, raising input prices, and presumably firm prices, may not lead to increased competition from outside producers.

Unions had organized cement workers going back at least to the 1930s. By the late 1940s, nearly all U.S. cement plants were unionized, and the vast majority of these were locals of the Cement, Lime and Gypsum Workers Union (CLGWU). An historical study of labor relations in the U.S. cement industry by Northrup (1989) shows that this union was able to greatly extend its market power during the 1960s and 1970s. As Northrup describes, there was a national strike by this union in 1957 which marked a turning point in its bargaining strength versus cement producers. Before 1957, bargaining had been done on a plant by plant basis, but the strike set the precedent of

capacity, then the (weighted) average age of capacity is $(\sum aK(a))/K$.

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

company-wide, and then industry-wide, bargaining. The goal of the union, which was largely achieved by the middle 1960s, was to have uniform pay and work rules throughout the country.

Quantitative evidence regarding this gain in market power comes from an analysis of wages in the industry. Figure 5 plots the hourly wages paid to production workers in cement as compared to other U.S. manufacturing industries. In the late 1940s and early 1950s, hourly production worker wages in cement were roughly equal to that of average hourly wages in manufacturing. Starting in the middle 1950s, cement wages began to grow significantly relative to the average production worker wage, so that by the early 1980s cement wages were 50 percent higher than the average.[11]

Another way to gauge the power of the union is to look 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 6 plots this ratio. From the late 1940s until 1960, the ratio bounces between 0.6 and 0.7.[12] The ratio grows from 1960 to 1980, reaching a value of about 0.9.[13] There is little movement in this ratio for overall manufacturing until the mid 1980s. The wage evidence suggests, as Northrup argued, that the power of the CLGWU greatly expanded in the 1960s and 1970s.

When labor unions extend their market power, they nearly always push for greater control of the workplace (in addition to greater wages). This was the case with the CLGWU. Below we provide extensive evidence that during the 1960s that union contracts put greater and greater restrictions on the rights of management to run plants. Here let us simply provide a quote from 1978 from the president of the CLGWU who boasted: "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."[14]

[11] By 1980, cement wages ranked in the top 10 of all 459 U.S. manufacturing industries in the NBER data base.

[12] 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.

[13] By 1980, this ratio in cement ranked in the top 10 of all 459 U.S. manufacturing industries in the NBER data base.

[14] This quote is from the *Voice*, the monthly publication of the CLGWU. The date of the issue is October, 1978. We use information from the *Voice* throughout the paper.

4 Increase in Competition in U.S. Cement Industry in 1980s

In this section, we'll argue that there was a big increase in foreign competition in the U.S. cement industry in the early 1980s. We'll also discuss the extent to which competition varied by region in the United States. Finally, we'll discuss what led to the increased competition.

4.1 Increased competition

There is no precise definition of "competition" (see, e.g., Holmes and Schmitz (2010)). Our approach instead will be to present a wide range of historical evidence to argue competition increased, and by a lot, in the early 1980s. One potential way to measure the competition faced by a *plant* is by the elasticity of it's demand curve. If over time a plant faces new potential competitors from abroad, and this makes the plant's demand curve more elastic, we could say the competition it faces increased. Though there has been no attempt in this industry to show that plant demand curves became more elastic over time, Miller and Osborne (2010) have estimated elasticities of demand for cement plants in the Southern California cement market, taking into account foreign competitors, during a period (1983-2003) when imports were very large (see below). They estimate a median plant elasticity of demand of -5.70 for this period. They do argue that imports make the *industry* demand curve more elastic.[15]

Another approach is to look at imports of cement (and the price of those imports) into the United States. One problem with imports is that foreign competition can increase without imports increasing, as when foreign firms offer discounts which are quickly met by domestic firms.[16] The opposite

[15] That is, the elasticity of industry demand if all plants (domestic and imports) change price is -0.11, while the elasticity of demand for changes in all domestic prices is -1.11.

[16] 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 ultimately cancelled, so that no Spanish cement made it to the Port of St. Paul, but according to Dumez and Jeunemaitre the joint venture accomplished the goal of exposing the local cement producers

concern is that imports increase though competition does not, as when a domestic industry is near full capacity in a year, and imports are simply to "top off" local production.

Recognizing these caveats, in Figure 7 we plot the imports of cement (and cement plus clinker) as a fraction of U.S. cement production from 1918 through 2003.[17] 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. That is, U.S. cement plants were forced to import cement since they lacked the materials to make it. There was a large increase in imports in the 1978-79 period. Then in the 1980s, imports increased further still, reaching nearly 25 percent of production in some years.[18]

There are three reasons why the cement imports in the 1980s likely represented a bigger competitive threat than did the imports in the 1970s. First, the level of imports (relative to production) was much higher in the 1980s. Second, the late 1970s were a period when U.S. cement capacity utilization was fairly high, particularly in those areas where imports were high. So, to some extent the imports in the late 1970s were to "top off" local production. During the 1980s, U.S. capacity utilization was often very low, so imports were no longer the "topping-off variety" but were displacing U.S. capacity.[19] Lastly, its very likely that the impact of competition is "non-linear." If we think that competition forces producers or input suppliers to make some fundamental changes in their operations, then we expect only big changes in competition to do this. A small increase in competition may well have no impact.

Further evidence that these imports provided a real competitive threat to U.S. producers comes from import prices. Foreign producers sold cement at big discounts to prices of U.S. producers. Consider, for example, 1984. The average factory-gate price per ton in 1984 in Southern California was $59.67.

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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.

[17] 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.

[18] 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.

[19] For example, Texas capacity in 1970s, 1980s.

The price per ton of imported cement (c.i.f.) in Southern California 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.) in Southern Texas 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, and represented a significant competitive threat to U.S. producers.

Another indirect price of evidence that competition increased is, of course, the behavior of wages in the 1980s. Increased foreign competition led to a great weakening of union power, and to a fall in wages.

4.2 Regional Competition

Since cement is typically shipped only short distances over land, the *direct* impact of foreign competition was likely felt by plants only within a few hundred miles of a deep-sea port, or a few hundred miles of a navigable river (like the Mississippi River) that flows into a deep-sea port. So, for example, cement plants in Colorado were not directly influenced by the imports. At first glance, then, this regional difference in the direct impact of competition would seem to offer a great opportunity to study the impacts of competition. But, as it turns out, the *indirect* effects of foreign competition were large and spread throughout the country.

The direct impact of the foreign imports was that plants near (many) ports had to cut prices to sell cement. To stay in business after such price decreases, managers in these plants had to also cut costs. This can be done by decreasing input prices (like wages) and increasing productivity. In many of these plants, management imposed their own work agreements with workers (after bargaining to impasse). That is, many of the restrictive work practices (which we discuss below) were eliminated.

But management insisted that the same contract changes made in plants near ports be made throughout the country as well. Just as the union had successfully imposed uniform contracts across the country in the 1960s and 1970s, management of cement firms now were imposing the same company contracts across the country. According to one estimate, in the summer of 1984, "70 percent of cement workers nationally were without a contract or under company-implemented contracts."[20]

[20] From the website of the United Steelworkers, http://www.usw.org/our_union/who_we_are?id=0004.

Summarizing the labor relations situation in the industry in the late 1980s, Northrup stated: "Today [1988], the cement bargaining system ... is in shambles with employees operating under company-instituted conditions ...., continuing rival unionism, extensive litigation, and a clear determination by the companies ... to maintain their newly found bargaining strength." (p. 338)

The conclusion, then, is that there was a large *indirect* impact of the foreign competition on the industry.[21] This indirect impact was mostly through its changes on industrial labor relations in the industry. As a consequence, for example, contracts changed in Colorado as much as they did in California.

4.3 Why the increase in competition?

Why did foreign competition increase so significantly in the 1980s? A number of factors are mentioned, including a reduction in (ocean) transportation rates and a strong U.S. dollar. But likely the most important reason is that the U.S. cement industry had become a productivity laggard. Two decades of stagnant productivity had put the industry in a vulnerable position.

While we have emphasized the key role of foreign competition in changing the labor relations environment in the industry, other factors were at work as well. First, potential domestic entrants clearly saw the growing potential to operating plants without these restrictive work practices. While any entrant knew that changes in work practices would be fought by the CLGWU, the gains from winning any such conflict were increasing. Northrup relates how a U.S. firm, Moore McCormack, purchased a few cement plants in the early 1980s with an aim to running them on a more efficient basis. At one such plant, at Kosmosdale, Kentucky, there was a bitter, year-long strike as the company instituted less restrictive work practices. Second, Ronald Reagan was President of the United States, and his appointments to key labor posts appeared to favor management in labor relations disputes. So, even if the

Because so many cement plants were without contracts in 1984, the CLGWU had large revenue reductions, and ran into deep financial problems. In 1984, it was merged into the Boilermakers union (also a declining union). This merger soon ran into problems, and CLGWU officials that had opposed the merger broke off to start another union, the IWNA (Independent Workers of North America), which itself lasted just a few years.

[21] In the April, 1984 issue of *Rock Products*, the CEO of Atlantic Cement stated that "There was a time not too long ago when only coastal companies had to contend with imported cement. Not so today, for no one is insulated."

industry had been more successful at blocking imports, pressure would have mounted for more entrants to attempt changes in work practices.

5 Productivity gains mostly within plant

We saw in Figure 1 that industry TFP rose significantly in the 1980s. 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.

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).[22] 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 only two terms, the "within-plant"

[22] 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.

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 1 presents the overall growth in labor productivity between Census years in column 1 and the within component in column 2.[23] 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. What drove the within gains? We turn to that next.

6 Work Restrictions Grow in 1960s/70s, Dropped in 1980s

In this section, we start discussing the direct evidence that changes in restrictive work practices were likely a primary factor driving the productivity gains within plants in the 1980s. We first describe the practices, then quantify how they changed over time.

6.1 Restrictive Work Practices

Union contracts contained many provisions that imposed significant restrictions on management. Here we discuss four such provisions.

6.1.1 Job Protection (No Termination As Result of Increased Efficiency)

Contracts contained a clause providing job protection to all employees, namely

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

> "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."

A worker, then, could not lose their job because of gains in efficiency at the plant, a significant restriction.

The job protection clause dulled incentives for productivity improvement. The next class of clauses likely reduced productivity, since the clauses reduced the amount of time that machinery operated at the plants.

6.1.2 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.[24] 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."

In many instances, the contracts required that employees not in the plant be called back to work to repair machinery. 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."

Such rules reduce productivity. When the plant must wait for repair staff to arrive to fix machines, capital is not operating, and no output is pro-

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

duced. This reduces productivity, capital productivity, energy productivity, and labor productivity.[25]

6.1.3 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.

6.1.4 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

[25] 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.

> 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."

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.

6.2 Extent of Restrictive Work Practices Over over time

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. 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 described below, we supplement this contract information for the years before 1963 and after 1984 with other sources of information on union strength.

Consider first the contracting out provision (that banned contracting out). In figure 8, 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.[26]

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 9, 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 (and succeeded) in putting this clause into contracts.

6.3 Restrictive Work Practices and Productivity

The time series pattern of restricted work practices is, of course, consistent with the pattern of industry TFP. As work restrictions were introduced in

[26] 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.

the 1960s/70s, industry TFP stagnated and then fell.[27] As the restrictions were removed, industry TFP began to grow.

Consider next industry labor productivity. While industry TFP was stagnant in the early 1960s, industry labor productivity continued to grow until the mid to late 1960s. There is a reasonable explanation for the pattern in labor productivity. After the union victory in 1957, the union was successful in raising wages. This would lead plants to substitute other inputs for labor, leading to labor productivity growth. To forestall this process, the union pushed for, and succeeded, in implementing the job protection clause in contracts in 1965. If one looks at the pattern of industry employment, it was falling sharply from the late 1950s to the middle 1960s, and then did not change much until the early 1980s, consistent with the view that the clause was largely responsible for stopping labor productivity growth.

Another way to see that the clause had a significant impact on industry employment is to consider the pattern in production workers per kiln. We'll discuss this in terms of an example. Imagine a plant with two kilns, each of size 100, each run by a crew of size 10. Suppose the plant replaces the two kilns with one kiln of size 200, that requires a crew of size 15. Then workers per kiln increases from 10 to 15. Now imagine the same situation where workers cannot be fired. Then workers per kiln increases from 10 to 20, a faster increase. If the ban on firing workers is removed, then workers per kiln would fall from 20 to 15.

This pattern in workers per kiln is roughly seen in Figure 10. Average kiln size was growing throughout the post WWII period, so we would expect to see growth in workers per kiln. But the growth accelerates in the 1970s. And then in the 1980s, there is a large drop in workers per kiln. Again, this is consistent with the clause having a significant impact on employment in the industry.

[27] Since the widespread introduction of these restrictive work practices was not until the 1960s, one might also ask: Was industry TFP growing in the decade or so after WWII? We have made calculations to show that the answer is yes, TFP was growing before the adoption of the practices, again consistent with the view that restrictive work practices were important.

7 Variation in Restrictive Work Practices Across Plants

At this point, we would like to use variation across plants in work practices to further strengthen the argument. In particular, we would like to run regressions of the form

$$\Delta \ln(y/n)_{it} = \alpha \Delta(job - prot)_{it} + \beta \Delta(cont - out)_{it} + ...$$

where $\Delta \ln(y/n)_{it}$ is growth in plant i's labor productivity, $\Delta(job - prot)_{it}$ is the change in job protection status, $\Delta(cont - out)_{it}$ is the change in contracting out status, and so on. In this section, we discuss what we are able to do.

7.1 Variation in Work Practices Across U.S. plants

As we mentioned, from the 1957 strike onwards, it was the goal of the CLGWU to have a standard contract across plants. As the 1960s progressed, the union largely succeeded. Figures 8 and 9 show that restrictive work practices were introduced at the same time. So, there is very little variation in $\Delta(job - prot)_{it}$ and $\Delta(cont - out)_{it}$ across plants in the 1960s. In the 1980s, there is more variation but not much. And, in any case, disclosure will always be an issue here. Given this state of affairs, we are exploring other options.

7.2 Variation in Work Practices: U.S. Plants Versus Canadian Plants

The CLGWU represented workers at nearly all Canadian cement plants. We have collected contracts at 14 Canadian plants. Before 1984, we have contracts for six plants. After 1984, we have contracts for 14 plants.

No Canadian contract has the contracting out clause before 1984, and none has the clause after 1984. As for job protection, one Canadian plant has the clause before 1984, and none have the clause after 1984. The conclusion then is that restrictive work practices were loosened much more in the United States in the 1980s than in Canada. So, we can compare 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 11, 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 12 shows that the same was true for labor productivity.[28]

8 Other potential sources of gain

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.

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

$$(1) \quad \Delta \ln(y_{it}/n_{it}) = \beta \Delta X_{it} + \delta_t + \mu_{it}$$

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 5 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.[29] These data on plant technology

[28] 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 productivity did not perform well in the 1960s and 1970s. 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.

[29] 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

variables come from the Portland Cement Association's Plant Information Summary publications and are matched to the Census Bureau data.[30]

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.[31] 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 2. Column 1 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.

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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).

[30] 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.

[31] 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.

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 surprising. However, in results not reported here, a cross-sectional regression of the level of productivity on plant technology finds strong positive correlations between kiln size, kiln age, number kilns and labor productivity. But 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.[32]

9 Coastal Plants and Non-coastal Plants

Lastly, we have explored whether plants near ports (and experienced the greatest direct increase in competition) had bigger productivity increases than plants not near ports. If they did not, then this would tend to support the view that the industry-wide change in industrial relations was a major factor in the industry's productivity resurgence. If they did, it would suggest there are some unmeasured factors influencing productivity that are important.

We define the potential competition faced by a plant from imports (into deep-water ports) by the minimum distance of the 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.[33] We then form a distance index based on the function –exp(-λ*distance) where

[32] One can imagine that in the 1980s 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). This is one reason why there would be little correlation between changes in avearge kiln size and changes in productivity.

[33] 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 in equation (1) with the distance measure. We ask if plants near ports had greater productivity gains. Since import competition is greater in the later years of the sample, we interact distance with time in our specifications below, creating five time-distance interactions in the difference model. The last column of table 2 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 13, 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 1 is plotted using the coefficients in column 2 of Table 2. 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. Productivity at all plants (near and far from ports) improved sharply over the period from 1982 to 1987, the period of intense foreign competition.

There does not seem to be a big difference between plants near and far from ports in the period of intense competition. Finally from 1992 to 1997, plants closer to ports again experienced higher productivity growth.

There are several caveats worth noting about our regressions. 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) suggested by Collard-Wexler (2006) 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 in our data (e.g., Perez-Saiz (2009)).

10 Conclusion

This paper wanted to answer two questions: Does competition spur productivity and if so, how? In the post-war U.S. cement industry, the answer is that competition from trade did increase domestic plant productivity in the 1980s, but through a suprising mechanism: a reduction in the power of the labor.union. We do this using a combination of micro data which includes details of many labor market contracts as well as industry level data.

References

Amiti, Mary and Konings, Jozef, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review*, 2007.

Bartelsman, Eric and Gray, Wayne, "The NBER Manufacturing Productivity Database," NBER Technical Working Paper # 205, October, 1996.

Bloom, Nicholas and Van Reenen, John "Measuring and Explaining Management Practices Across Firms and Countires," Quarterly Journal of Economics, 2007.

Bloom, Nicholas, Draca, Mirko, and Van Reenen, John, "Trade Induced Technical Change? The Impact of Chinese Imports on IT and Innovation," Working Paper, 2008.

Bloom, Nicholas, et al, "Management Matters: Evidence From India," Stanford working paper, 2010.

Borenstein and Farrell,

Bridgman, Benjamin, Gomes, Victor and Teixeira, Arilton, "The Threat of Competition Enhances Productivity," Working Paper, 2008.

Clark, Kim

Cohen-Meidan, Maya, "The Heterogeneous Effects of Trade Protection: A Study of U.S. Anti-Dumping Duties on Portland Cement," Mimeo, May 2009.

Collard-Wexler, Allan, "Plant Turnover and Demand Fluctuations in the Ready-Mix Concrete Industry", Center for Economic Studies, Working Paper, 2006.

Das, Sanghamitra, "Estimation of Fuel Coefficients of Cement Production: A Fixed-Effects Approach to Nonlinear Regression," *Journal of Business and Economic Statistics*, October, 1991.

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

Fabrizio, Kira, and Rose, Nancy, and Wolfram, Catherine, "Do Markets Reduce Costs? Assessing the Impact of Regulatory Restructuring on U.S. Electric Generation Efficiency," *American Economic Review* September, 2007.

Fernandes, Ana, "Trade Policy, Trade Volumes and Plant-Level Productivity in Columbian Manufacturing Plants," *Journal of International Economics*, 2007.

Forsund, Finn, and Hjalmarsson, Lennart, "Technical Progress and Structural Change in the Swedish Cement Industry, 1955-1979," *Econometrica*, September, 1983.

Galdon-Sanchez, Jose Enrique and Schmitz, James, A. Jr. "Competitive Pressure and Labor Productivity: World Iron Ore Markets in the 1980s," *American Economic Review* 2002.

Gullickson"Measurement of Productivity Growth in U.S. Manufacturing," PDF (1,034K) by William, Monthly Labor Review, July 1995, pp. 13-28.

Hay, Donald, "The Post-1990 Brazilian Trade Liberalisation and the Performance of Large Manufacturing Firms: Productivity, Market Share and Profits," *Economic Journal*, July, 2001.

Holmes, Thomas J. and Schmitz, James, A. Jr., "Competition at Work: Railroads vs. Monopoly in the U.S. Shipping Industry," *Federal Reserve Bank of Minneapolis Quarterly Review*, Spring, 2001.

Holmes, Thomas, Levine, David, and Schmitz, James, "Monopoly and the Incentive to Innovate When Adoption Involves Switchover Disruptions," NBER working paper, 2008.

Ichniowski, Casey and Shaw, Kathryn, "Old Dogs and New Tricks: Determinants of the Adoption of Productivity-Enhancing Work Practices," *Brookings Papers on Economic Activity*, 1995.

Kumbhakar, Subal, and Heshmati, Almas, and Hjalmarsson, Lennart "Temporal Patterns of Technical Efficieny: Results from Competing Models," *International Journal of Industrial Organization*, 1997.

Kumbhakar, Subal, and Heshmati, Almas, and Hjalmarsson, Lennart, "Parametric Approaches to Productivity Measurement: A Comparison among Alternative Models," *Scandanavian Journal of Economics*, 1999.

Lau, Lawrence, and Tamura, Shuji. "Economies of Scale, Technical Progress, and the Nonhomothetic Leontief Production Function: An Application to the Japanese Petrochemical Processing Industry," *Journal of Political Economy*, November-December, 1972.

Macbride, M. 1983. "Spatial Competition and Vertical Integration: Cement and Concrete Revisited," American Economic Review, 73, pp.1011-1022.

McGrattan, Ellen and Prescott, Edward, "Openness, Technology Capital, and Development," Federal Reserve Bank of Minneapolis, Staff Report, 2007.

Muendler, Marc-Andreas, "Trade, Technology, and Productivity: A Study of Brazilian Manufacturers, 1986-1998," Working Paaper, 2004.

Niefer, Mark, "Energy Price Shocks and plant level productivity: A study of teh Cement Industry," Ph.D. Dissertation, SUNY-Binghamption, 1994.

Northrup, Herbert, "From Union Hegemony to Union Disintegration: Collective Bargaining in Cement and Related Industries," *Journal of Labor Research*, Fall 1989.

Pavcnik, Nina, "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *Review of Economic Studies*, 2002.

Perez-Saiz, H. 2010. "Building New Plants or Entering by Acquisition? Estimation of an Entry Model for the US Cement Industry," Working Paper.

Prentice, David.

Prescott, Edward, "Needed: A Theory of TFP," *International Economic Review*, 1998.

Rosenbaum, D. 1994 "Efficiency vs. Collusion: Evidence Cast in Cement," Review of Industrial Organization, 9, pp 379-392.

Ryan, Stephan, "The Costs of Environmental Regulation in a Concentrated Industry," Working Paper.

Salvo, Alberto "Inferring Market Power under the Threat of Entry: The Case of the Brazilian Cement Industry" December, 2007.

Schmitz, James, "What Determines Productivity? Lessons from the Dramatic Recovery of the U.S. and Canadian Iron Ore Industries Following Their Early 1980s Crisis" , *Journal of Political Economy*,vol.113, issue 3, (June, 2005), pp582-625.

Symeonidis, George, "The Effect of Competition on Wages and Productivity: Evidence from the UK", *Review of Economics and Statistics*, vol. 90 (2008), pp. 134-146

Syverson, Chad. "Market Structure and Productivity: A Concrete Example," *Journal of Political Economy*, 2004.

Syverson, Chad. "," *Journal of Economic Perspectives*, 2008.

Trefler, Daniel, "The Long and Short of the Canada-U.S. Free Trade Agreement," *American Economic Review,* September, 2004.

Topalova, Petia, "Trade Liberalization and Firm Productivity: The Case of India," Working Paper, 2004.

Tybout, James and Westbrook, Daniel, "Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries," *Journal of International Economics*, 1995.

Tybout, James, "Plant- and Firm-Level Evidence on "New Trade" Theories," in *Golbal Integration and Technology Transfer*, Hoekman, Bernard and Javorcik, Beata, editors, Palgrave, 2006.

United States Department of Commerce, International Trade Association. *A Competitive Assessment of the U.S. Cement Industry.* July 1987.

Table 1

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 2. 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 Competitors		-.013	-.015
		(.019)	(.019)
Δ Ownership		-.005	.004
		(.071)	(.069)
Port Distance*(1972-1977)			.039
			(.080)
Port Distance*(1977-1982)			.263*
			(.112)
Port Distance*(1982-1987)			-.017
			(.132)
Port Distance*(1987-1992)			-.169
			(.180)
Port Distance*(1992-1997)			.343*
			(.149)
R^2	.147	.172	.203

* indicates 5% significance level.

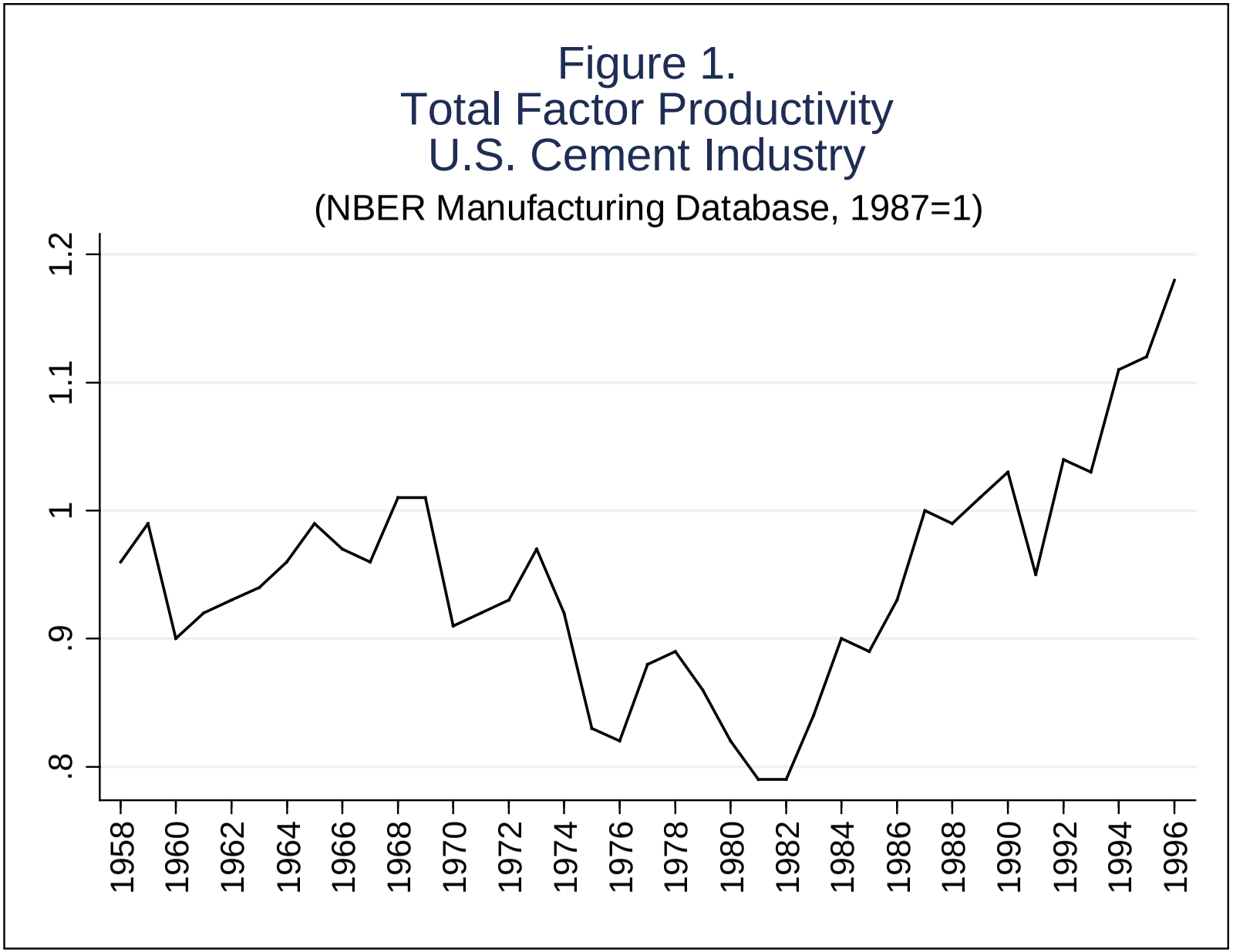
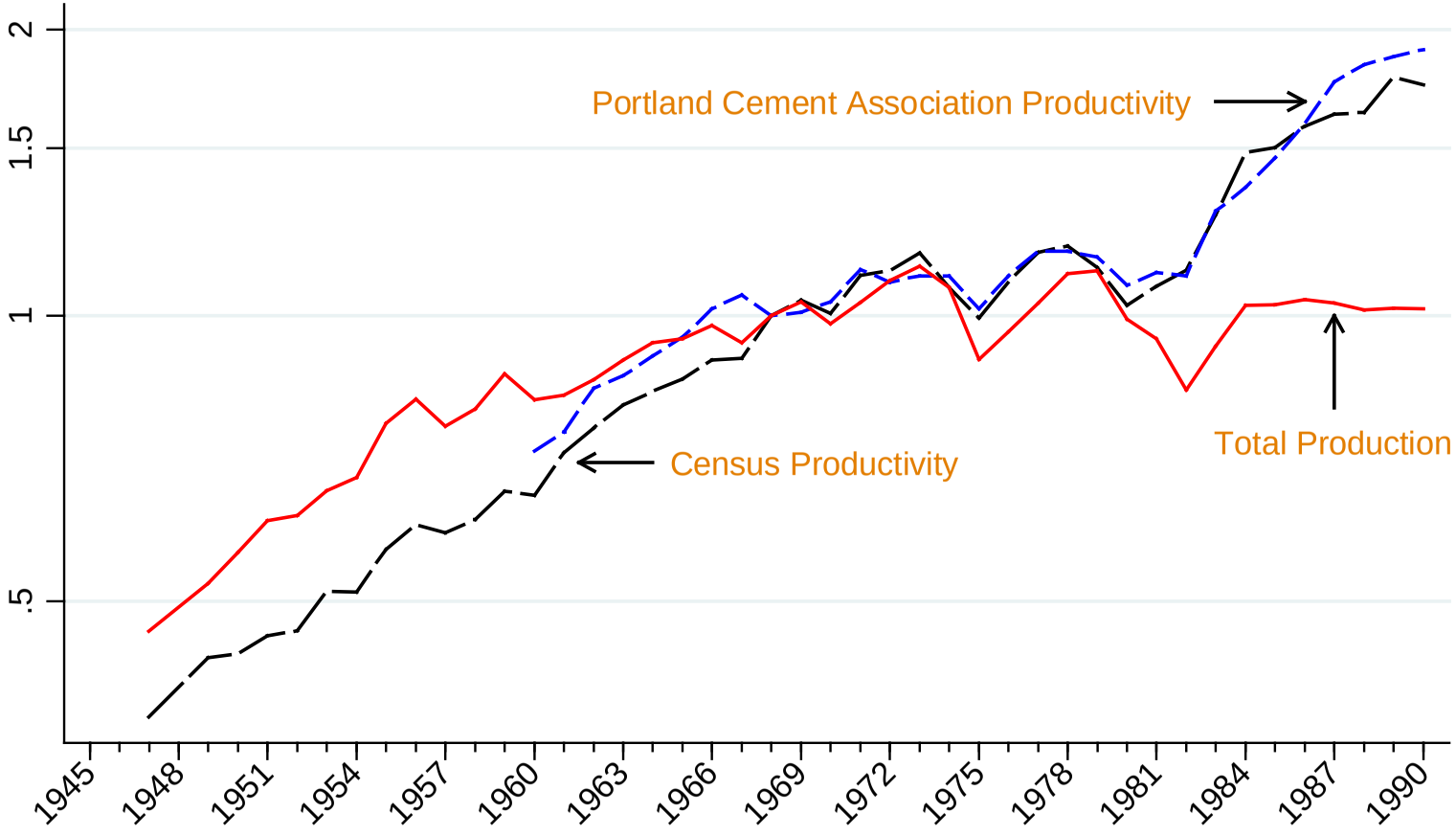


Figure 1.
Total Factor Productivity
U.S. Cement Industry
(NBER Manufacturing Database, 1987=1)
1.2
1.1
1
.9
.8
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Figure 2.
Labor Productivity and Total Production
U.S. Cement Manufacturing

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



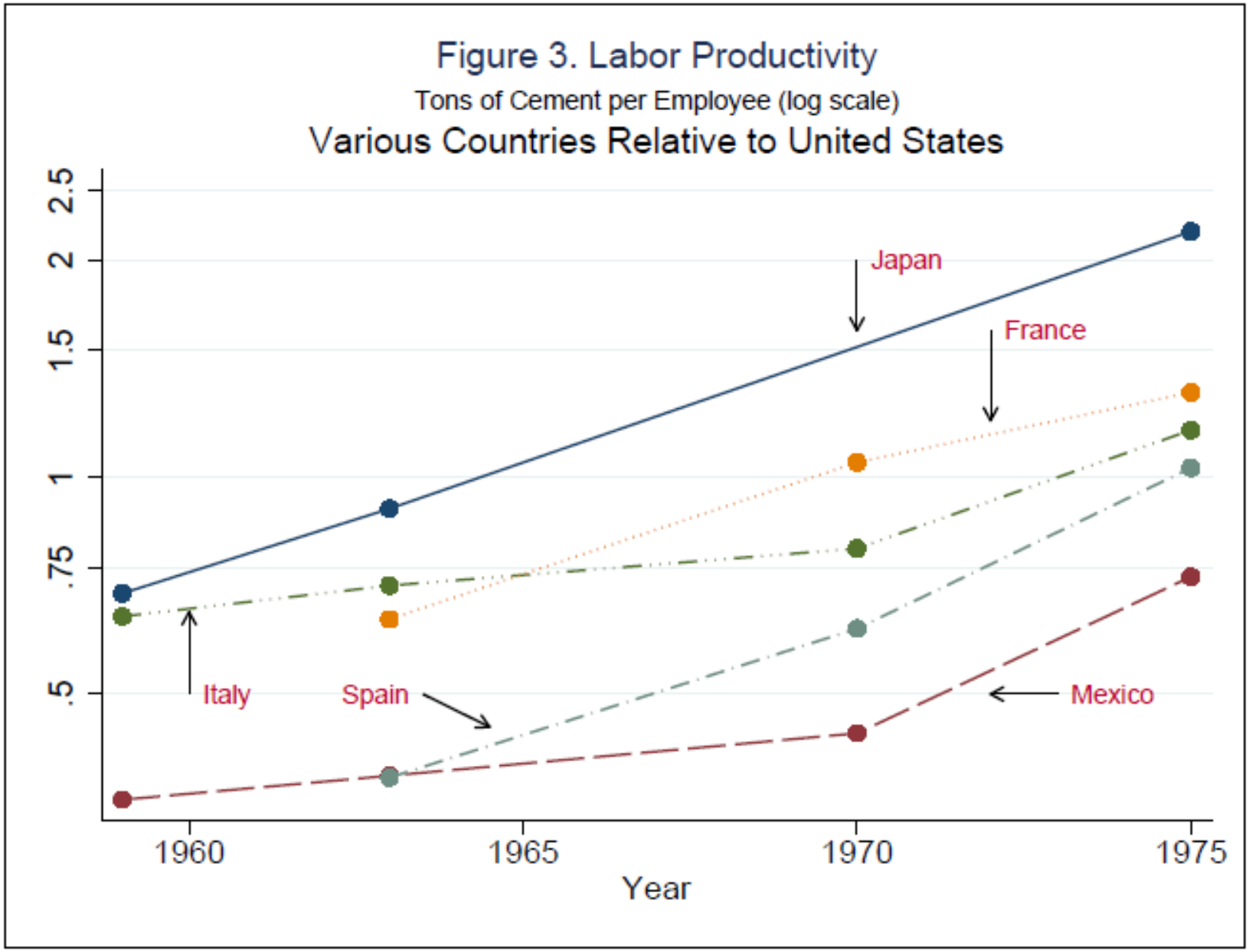


Figure 3. Labor Productivity
Tons of Cement per Employee (log scale)
Various Countries Relative to United States
2.5
2
1.5
1
.75
.5
Japan
France
Italy
Spain
Mexico
1960
1965
1970
1975
Year

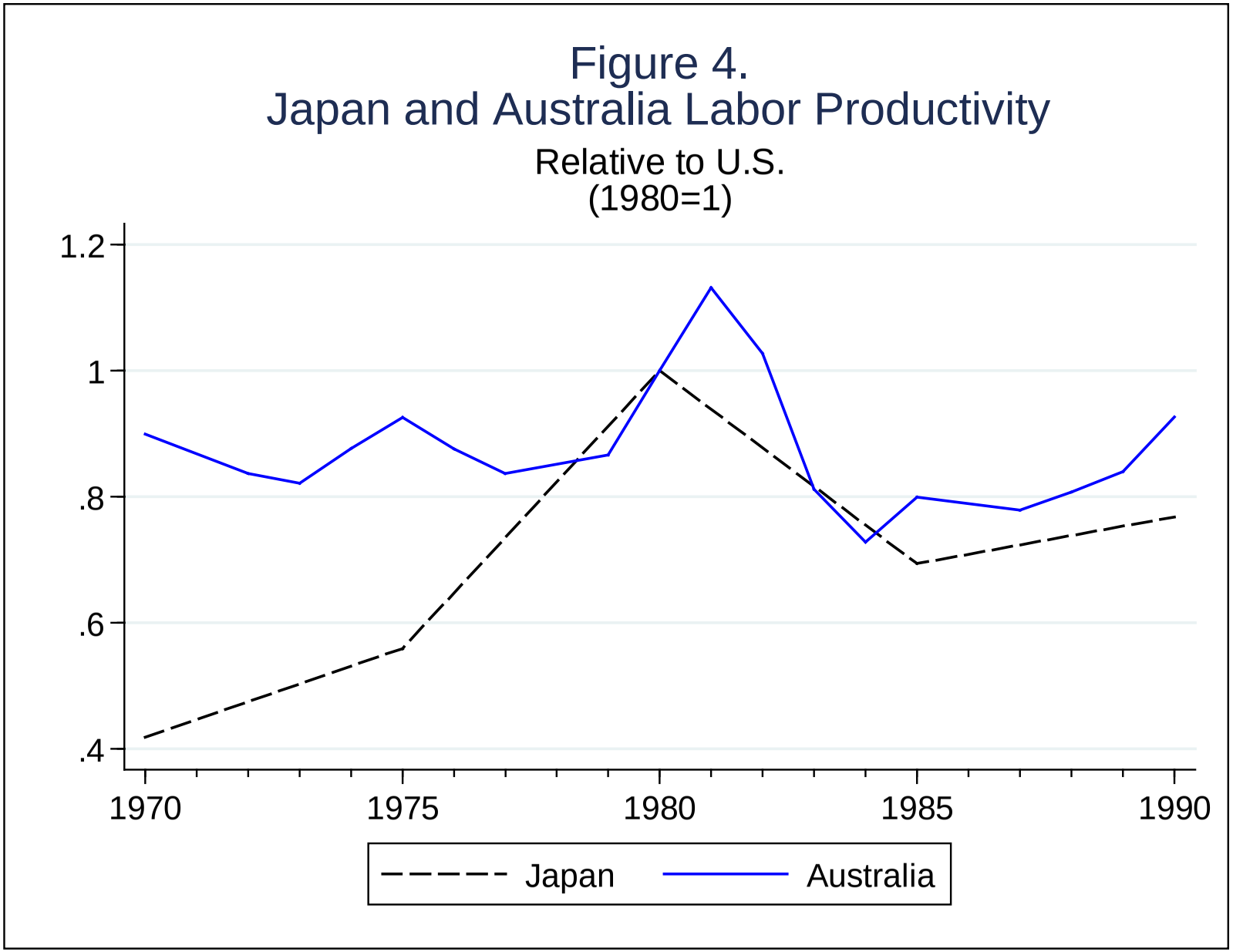


Figure 4.
Japan and Australia Labor Productivity
Relative to U.S.
(1980=1)
1.2
1
.8
.6
.4
1970
1975
1980
1985
1990
Japan
Australia

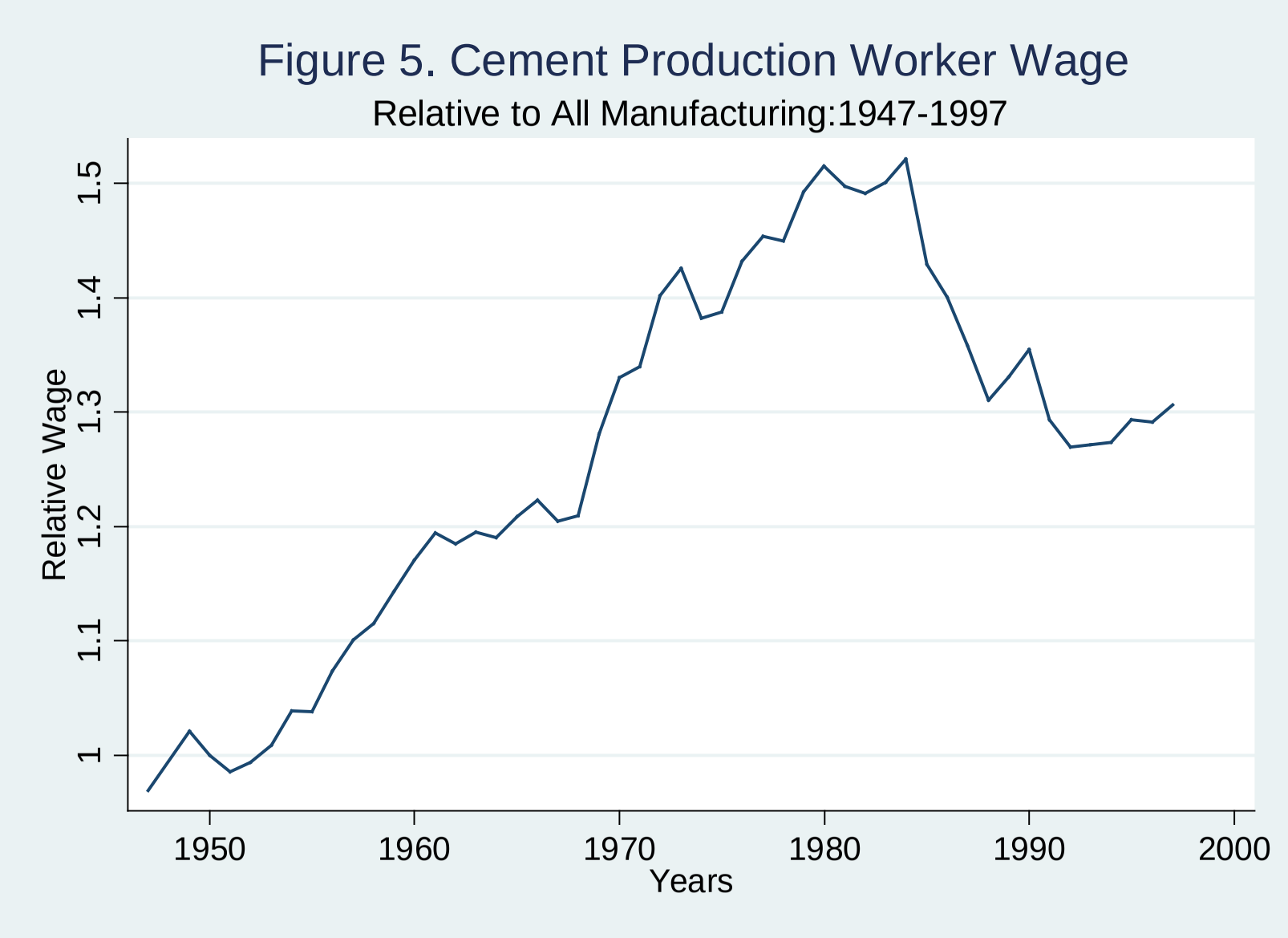


Figure 5. Cement Production Worker Wage
Relative to All Manufacturing:1947-1997
Relative Wage
1
1.1
1.2
1.3
1.4
1.5
1950
1960
1970
1980
1990
2000
Years

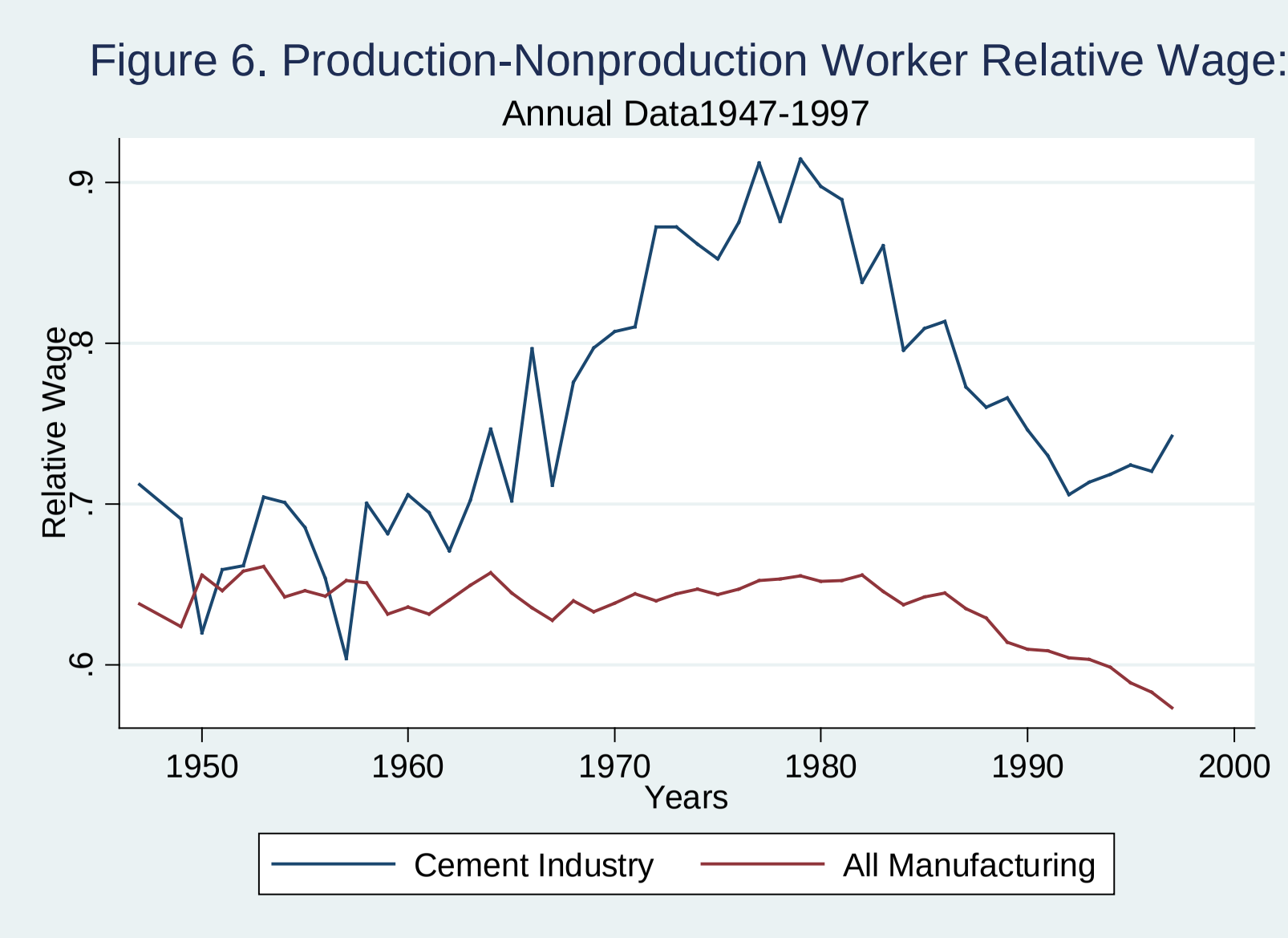


Figure 6. Production-Nonproduction Worker Relative Wage:
Annual Data1947-1997
Relative Wage
.6
.7
.8
.9
1950
1960
1970
1980
1990
2000
Years
Cement Industry
All Manufacturing

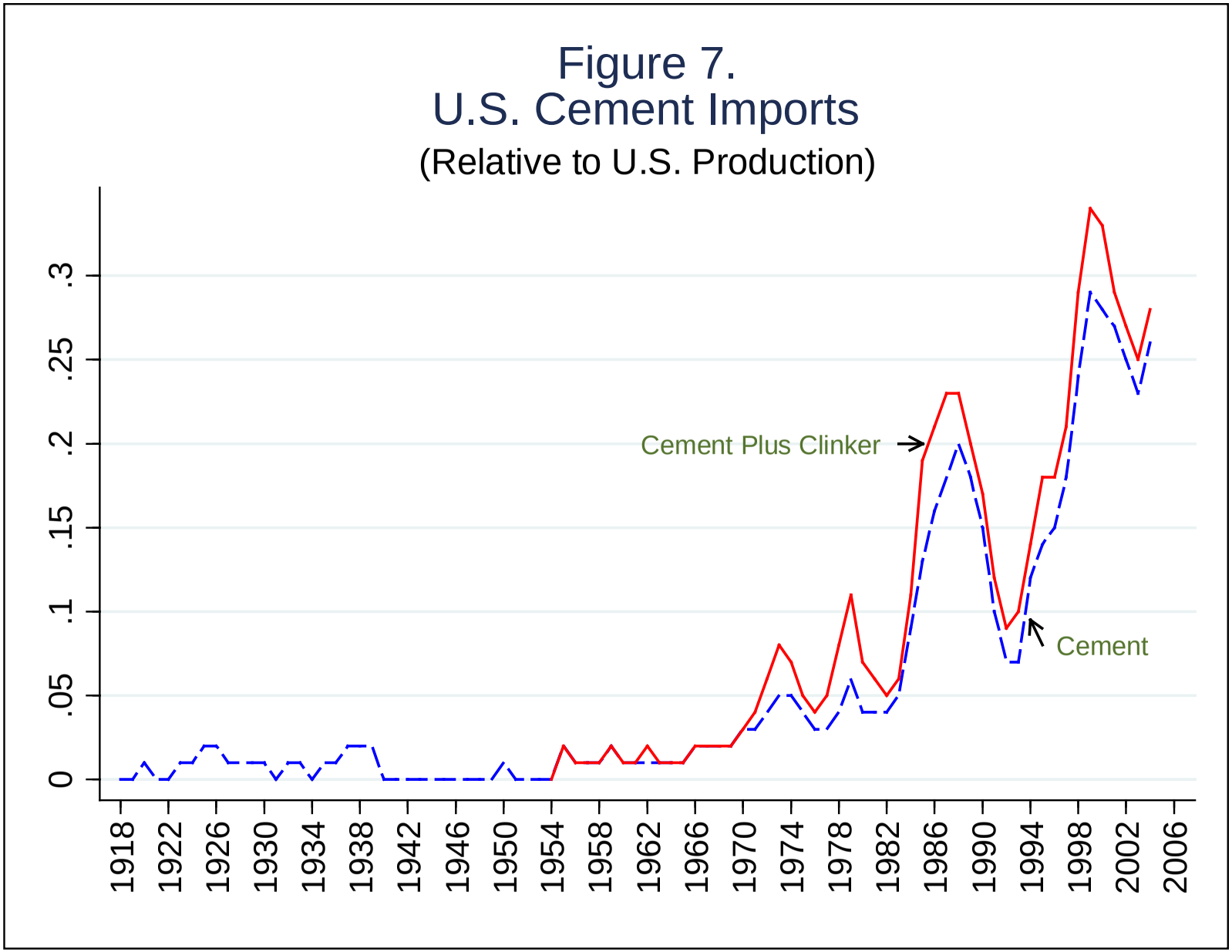


Figure 7.
U.S. Cement Imports
(Relative to U.S. Production)
Cement Plus Clinker
Cement
0
.05
.1
.15
.2
.25
.3
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006

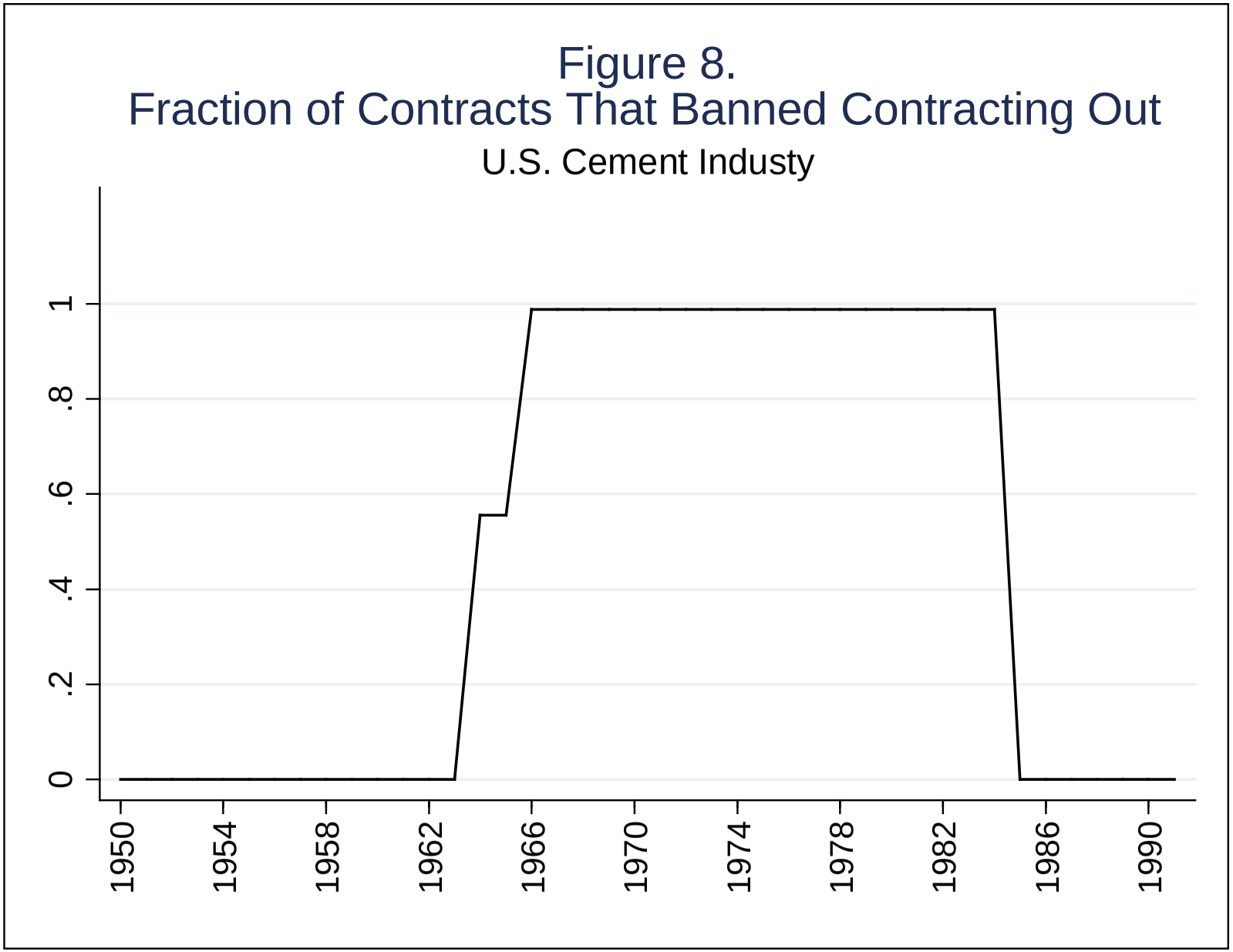


Figure 8.
Fraction of Contracts That Banned Contracting Out
U.S. Cement Industy
0
.2
.4
.6
.8
1
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990

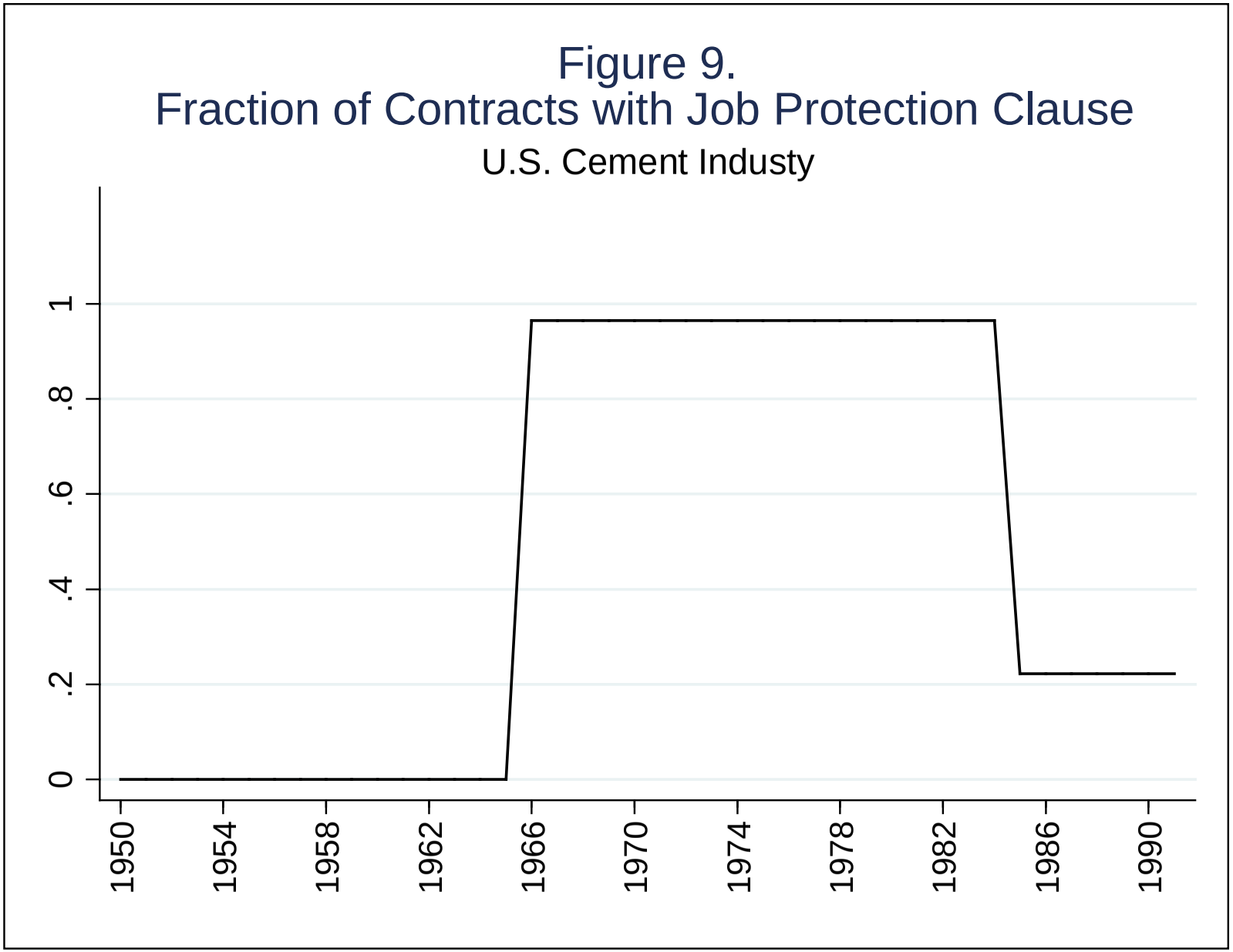


Figure 9.
Fraction of Contracts with Job Protection Clause
U.S. Cement Industy
0
.2
.4
.6
.8
1
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990

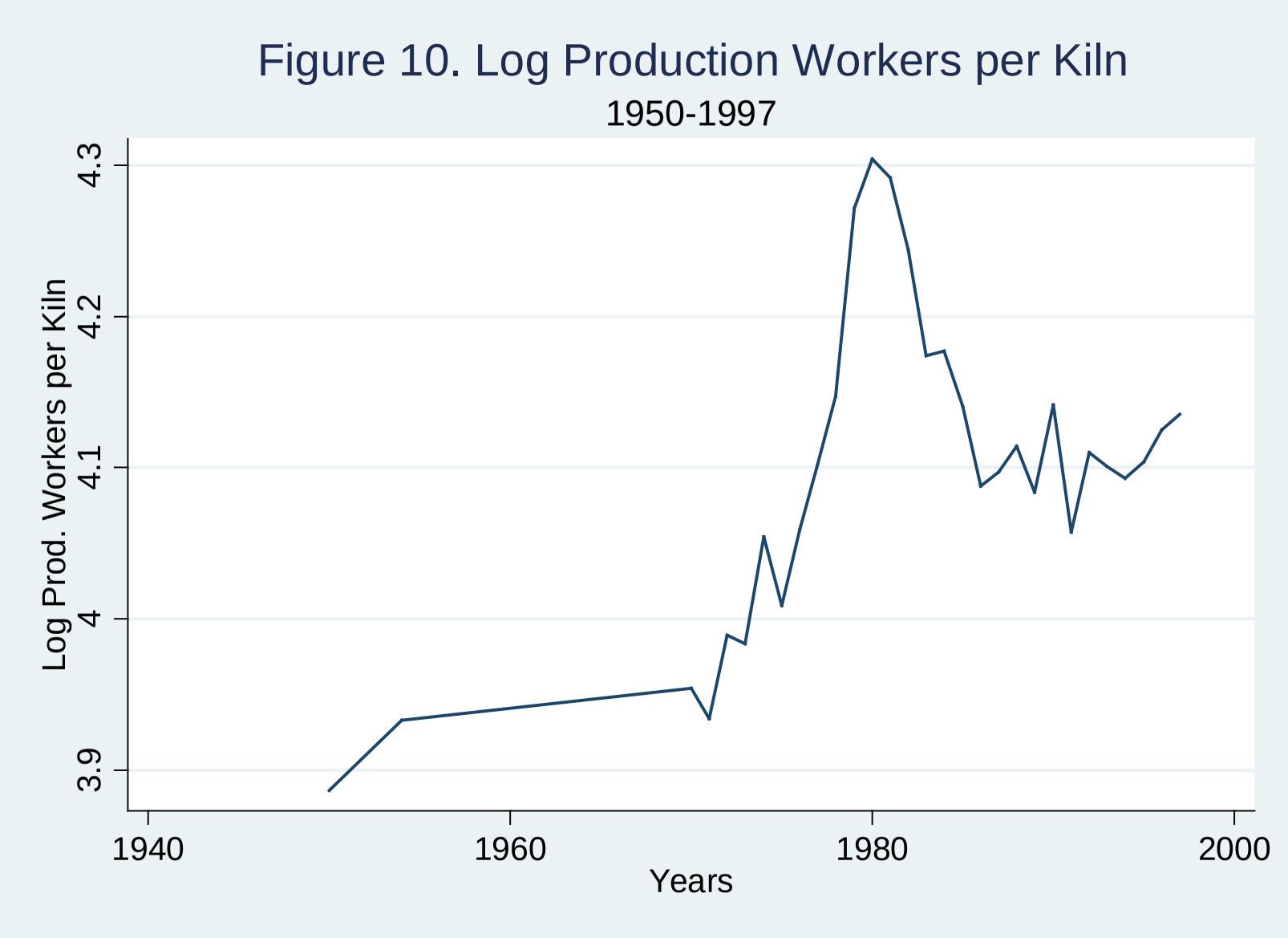


Figure 10. Log Production Workers per Kiln
1950-1997
Log Prod. Workers per Kiln
4.3
4.2
4.1
4
3.9
1940
1960
1980
2000
Years

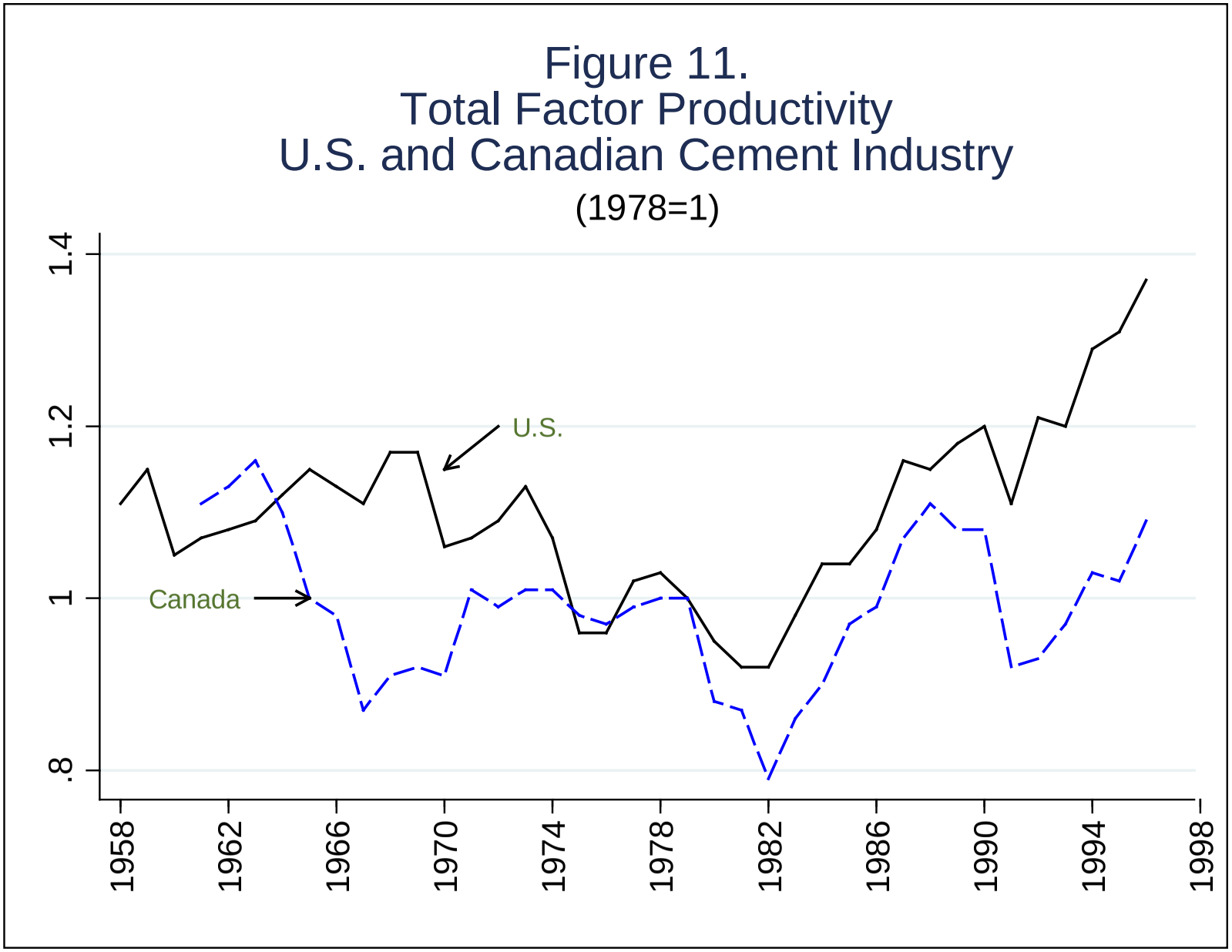


Figure 11.
Total Factor Productivity
U.S. and Canadian Cement Industry
(1978=1)
1.4
1.2
1
.8
U.S.
Canada
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998

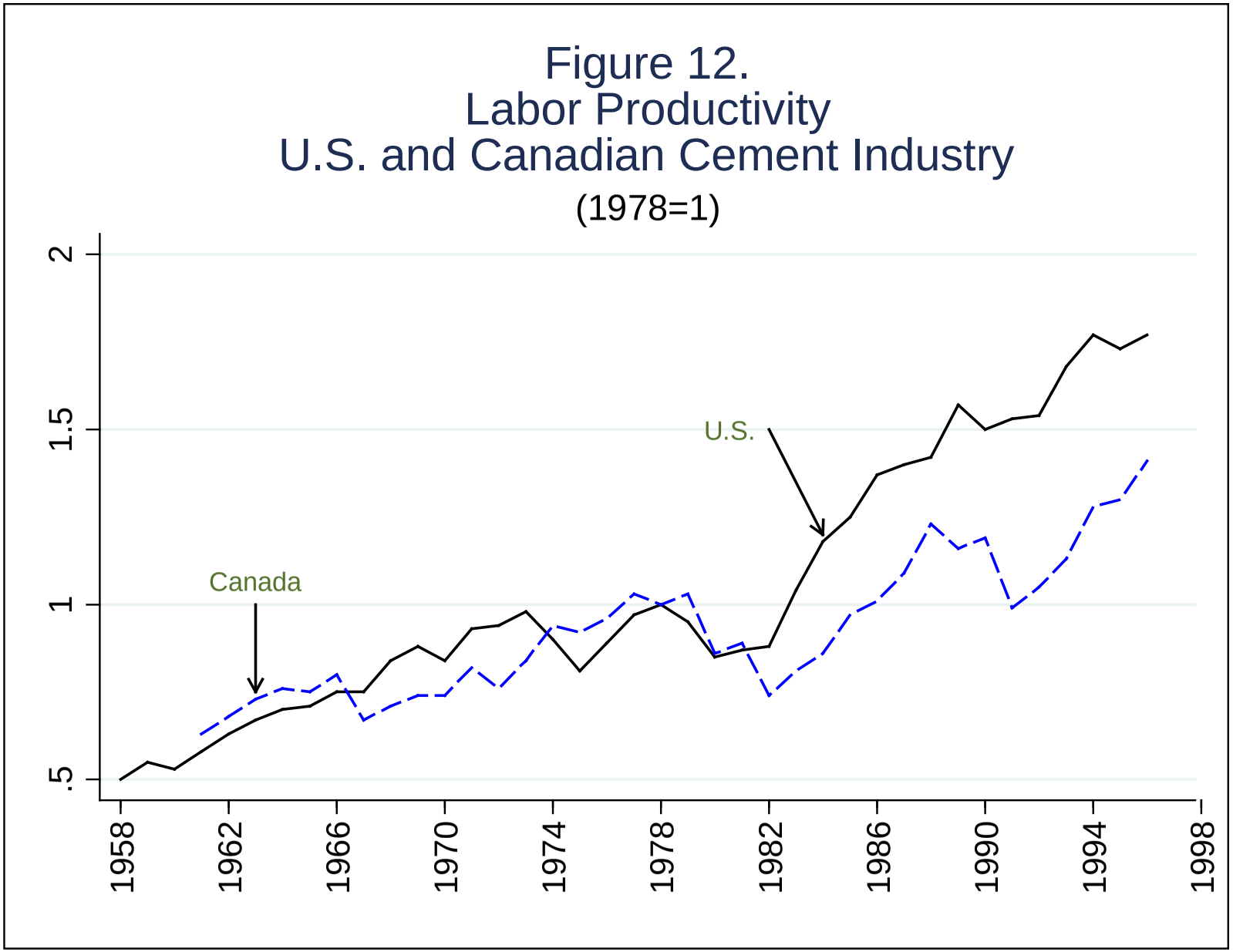


Figure 12.
Labor Productivity
U.S. and Canadian Cement Industry
(1978=1)
2
1.5
1
.5
U.S.
Canada
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998

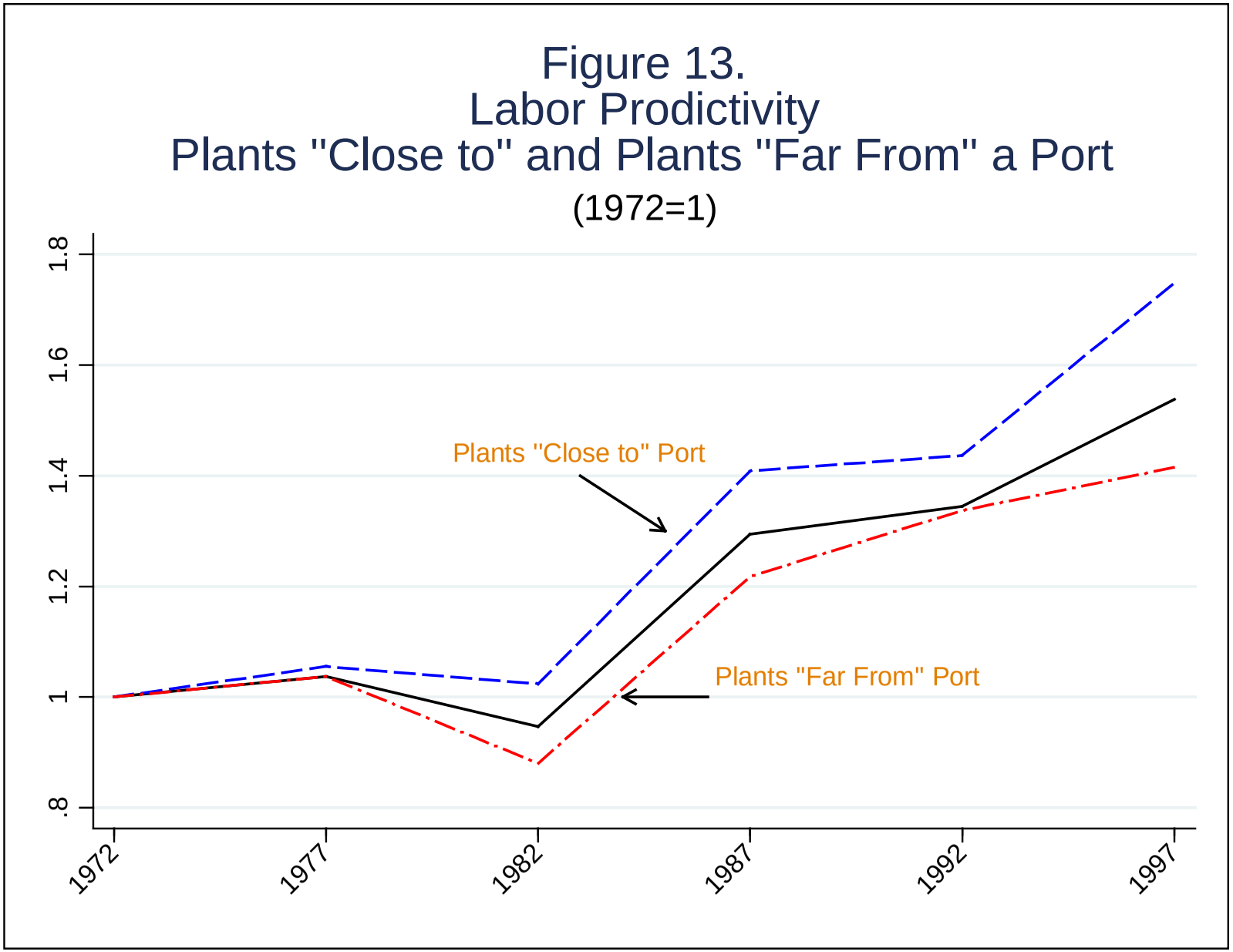


Figure 13.
Labor Prodictivity
Plants "Close to" and Plants "Far From" a Port
(1972=1)
1.8
1.6
1.4
1.2
1
.8
Plants "Close to" Port
Plants "Far From" Port
1972
1977
1982
1987
1992
1997