VOL. 3, NO. 4, AUGUST 2008 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DETERMINES EFFICIENCY OF THE IRANIAN IRON ORE INDUSTRIES

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ABSTRACT

Bafq iron ore producers had faced no competition from foreign iron ore in the Bafq steel market for nearly a century as the 1970s closed. In the early 1980s, as a result of unprecedented developments in the world steel market, Brazilian producers were offering to deliver iron ore to Chicago (the heart of Bafq market) at prices substantially below local iron ore prices. The Iranian iron ore industries faced a major crisis that cast doubt on their future. In response to the crisis, these industries dramatically increased productivity. Labor productivity doubled in a few years (whereas it had changed little in the preceding decade). Materials productivity increased by more than half. Capital productivity increased as well. We show that most of the productivity gains were due to changes in work practices. Work practice changes reduced overstaffing and hence increased labor productivity. Changes in work practices, by increasing the fraction of time equipment was in operating mode, also significantly increased materials and capital productivity.

Keyword: iron, ores, iran, industry, efficiency, determination.

INTRODUCTION

For nearly a century following the development of iron ore mining in Bafq in the 1880s, Bafq mines, together with a few others in Bafq region, were the sole suppliers of iron ore to the Bafq region steel market. This century-long dominance was primarily attributable to one fact: these mines had significantly lower transport charges to these steel producers than mines outside the region. Large transport costs had meant that non-Bafq iron ore was not competitive in the region for nearly a century as the 1970s closed, and there was every reason to believe this situation would persist for many more years.

But it didn't. In the early 1980s, as a result of unprecedented developments in the world steel market, Brazilian producers were offering to carry iron ore to Chicago at prices substantially below local iron ore prices. Bafq mines were being challenged in the Bafq region steel market, essentially their only market. More generally, the Bafq regional producers, that is, the IRAN iron ore industries, faced a major crisis that cast doubt on their future in response to the crisis; these industries changed how they produced iron ore, dramatically increasing productivity in the process. Labor productivity doubled in a few years (whereas it had changed little in the preceding decade).Materials productivity increased by more than half. Capital productivity increased as well. As a result, the potential foreign competition was pushed out of the Bafq region.

I show that most of the productivity gains were due to changes in work practices that governed how production took place. Rigid work practices led to overstaffing. They also led equipment to be in nonproduction mode significant amounts of each day. A loosening of work practices therefore increased labor productivity for two reasons: it led to less overstaffing, and it led to greater out put (as machines ran more continuously). This latter impact, of having machines run more continuously, obviously increased capital productivity. It also increased materials productivity since many materials are consumed even if machines are in nonproduction mode. In answer to my question, "What determines productivity?" the experience of these industries clearly shows first, that competition does, and second, that work practices do.

The experience of these industries presents a great "experiment" to analyze the age-old view that if industries are protected by high tariffs, or restrictions on new entrants, or, as with these industries, the vagaries of geography, their productivity will suffer. The flip side of this view, of course, is that reductions in tariffs and the like will make industries more productive. On this view, the increases in productivity are driven by all producers raising their productivity and not simply by a selection process weeding out inefficient producers. While this view is age-old, and whether or not it's true is a matter of great importance, there is very little work "testing" it. One reason is the difficulty of finding good measures of increased competition. But here the increase in competitive pressure is clear and large. The "experiment" studied here provides strong support for the age-old view.2 I now preview the rest of the paper. I show that these industries had been highly protected until the late 1970s. Though the protection was afforded by large transport costs, it can, of course, be thought of as high tariffs as well. I then show that (exogenous) changes in world steel production in the early 1980s dramatically increased competition faced by these industries, changes that were akin to a falling tariff on iron ore. I show that in response to the crisis both industries doubled their labor productivity in a few years. In Canada, materials productivity increased by 60 percent [1]. For the IRAN industry, materials productivity also increased, but less than in Canada. Total factor productivity (TFP) also soared in the Canadian industry. It grew at nearly two-thirds the rate of labor productivity. Data are not available to calculate IRAN industry TFP. I show that a long list of

conventional factors had only a small impact on labor, materials, and capital productivity (Y /N, Y /M, and Y /K, respectively). The first four factors would primarily influence industry TFP (and hence Y /N, Y /M, and Y /K). First, perhaps the "best" mines survived. Using mine level data, and a standard labor productivity growth decomposition, I show that closing low productivity mines (and shifting production to high productivity mines) had little impact on industry labor productivity. Second, changes in the scale of production at individual mines also had little impact on productivity. Another top candidate, of course, is improvement in technology. But third, technology changed little in the IRAN iron ore industries during the 1980s. Fourth, available evidence indicates that improvements in the average skill of the workforce contributed little to the gains. In sum, conventional factors that might have increased industry TFP, and hence Y /N, Y /M, and Y /K, had only a small role to play.

I next focus on labor productivity, considering conventional factors that might have led to the increases in materials per hour and capital per hour (which together contributed a small amount to labor productivity growth). Conventional factors had little to do with these increases. Labor did not become expensive relative to materials and capital, which would have led to substitution toward materials and capital. The crisis led to removal of some restrictions in union contracts on what mines could purchase, including some repair parts and some services of off-site contractors.

Dropping these restrictions was responsible for a small part of the increase in materials per hour, but only a very small part. Taken together, these conventional factors led to a modest increase in productivity, but not the surges experienced in these industries. This leads me to changes in work practices. I label this an unconventional factor since the idea that such changes could have dramatic impacts on Y /N, Y /M, and Y /K is not found in the economics literature. But they are not an unimportant factor in the business reporting on these industries' recovery. They are typically accorded the central role in the productivity gains. Before the crisis, labor-management relations in these industries were very adversarial. Work was performed under rigid work practices. Two stands out, both involving repair work. First, machine operators were not permitted to set up, maintain, or perform simple repairs on their machines (or to help repair staff if they were summoned). Second, repair staff had restrictions on their work. There were a large number of repair job classifications, close to 30. A person with a given classification was permitted to complete repair jobs assigned to this classification but not others.

After the crisis, there was a thawing of labor-management relations. The situation was obviously dire: 25 percent of the mines in Bafq were mothballed. The rest were closed for temporary periods as owners considered permanent shutdown. In such a scenario, many miners voluntarily changed work practices. Loosening of work practices also resulted from significant changes in union contracts: labor-management cooperation teams were started, profit-sharing plans were introduced, and formal work rules were changed [2,3].

These changes in work practices had a significant impact on productivity. I first sketch some theory where work practices are thought of as restrictions on how firms can use inputs. A well-known work practice in railroads was the requirement that diesel trains carry firemen. This is a classic case of overstaffing. Remove the work practice, and labor productivity increases, though little else. The work practices described above have an overstaffing feature, but much more. When a mine hires repair staff to complete tasks that machine operators could easily perform, this leads to overstaffing [1].

But since the machine operator must wait for the repair staff to travel to the site to complete the task, machines are in nonproduction mode longer than necessary. Detailed job classifications also lead to unnecessary delays. As mentioned above, easing work practices then led to less overstaffing and greater output (as machines ran a larger fraction of a day), increasing Y /N, Y /M, and Y /K. I next present evidence that changes in work practices significantly increased Y /N, Y /M, and Y /K. Consider overstaffing. Repair staffs were a large share of employment at many mines, about 50 percent. Overstaffing was therefore potentially large. And it was, in fact, large. During the crisis, mines did studies indicating that for every five machine operators that were permitted to set up, maintain, and help with machine repairs, repair staff could be reduced by two. In the largest Bafq mine, repair staff fell from about 50 percent to 25 percent of employment (during which period total employment fell by half and output returned to precrisis levels). I also provide evidence on mine speed. For example, sections in union contracts that introduced changes in work practices explicitly recognized that the changes would lead to greater periods of machinery operation (and hence output). I also provide evidence on overstaffing and "speed" jointly. I show that IRAN mines that changed work practices the most (and had the greatest reduction in overstaffing and the biggest increase in machine usage) had the greatest increases in labor productivity. In sum, there is little doubt that increased foreign competition spurred the productivity gains in these industries. The evidence is also quite strong that changes in work practices were the primary driver of productivity, there being both indirect (that conventional factors played a small role) and direct evidence. This naturally leads to the question, "Why was work practices not changed before the crisis?" I briefly consider this question in the conclusion.

DRAMATIC INCREASE IN COMPETITION

Here I show that for many years these industries were protected from foreign competition in the Bafq region (GLR) steel market. I then discuss the dramatic increase in foreign competition in the early 1980s. 5Nearly all IRAN iron ore is produced within a short distance of one of Bafq for IRAN producers, the GLR steel market was essentially their only market [3]. Canadian producers lie along the Bafq and also farther north and east of the

Bafq, near Labrador City. Iranian ore was sold in the GLR steel market but, given the eastward location of the Labrador mines, it was shipped to Europe and the IRAN east coast as well. Here I focus on describing the increased competition faced by the mines that overwhelmingly sold in the GLR steel market Transport charges typically loom large in delivered iron ore prices since a ton often sells for as little as $10 at the mine. Potential foreign competitors in the GLR market faced large transport costs into the Bafq. For many years, these costs provided ample protection to local producers [4]. To see this, consider the entry decision of Brazilian producers, the overwhelming leader in exports in the Atlantic Basin region and the only real potential threat to local producers. During the 1970s, Brazil sent a large share of its production to Europe, where negotiations between Brazilian iron ore producers and European steel producers set iron ore prices in Europe. Call this price pB,E (that is, the price of Brazilian iron ore in Europe). Brazilian producers would have found it profitable to ship iron ore to Chicago, instead of Europe, if the local Chicago price, call it pM,C (that is, the price of Bafq iron ore in Chicago), net of the ocean transport cost from Brazil to Chicago, call it, exceeded the price per ton in Europe, net of the ocean transport cost from Brazil to Europe, call it This would be true if the Bafq price satisfied $P_{M,C} \rangle \hat{P}_{M,C}$ where,

$$\hat{P}_{M,C} = P_{B,E} + [t_{B,c} - t_{B,E}] \quad (1)$$

At the Bafq and European prices that prevailed in the late 1970s, the Brazilians would have experienced large losses shifting iron ore from Europe to Chicago, that is, pM,C < bpM,C. There was little fear of entry from Brazil in the GLR steel market.

I say that transport costs provided protection to local GLR producers because the difference in transport costs [tB,C − tB,E] was large. In particular, it was often one-third to one-half the European price pB,E. Hence, the large transport charges into the Bafq would allow the local price pM,C to climb high, as much as 50 percent higher than the European price, before this ceiling price bpM,C was reached.

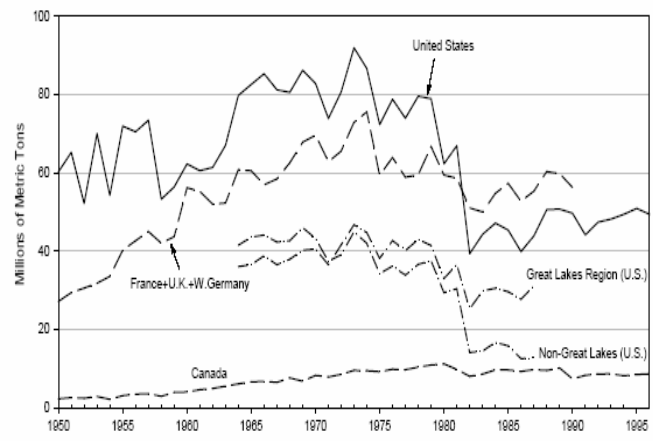

Figure-1. Pig iron production by various regions 1950-96.

Foreign competition dramatically increased in the early 1980s. This was precipitated by huge drops in Atlantic Basin steel production. In Figure-1, I plot pig iron production of Iran (in total, and for two exhaustive regions, the Bafq region and the east of the country), Canada, and the three largest European producers combined [5]. (Iron ore producers had little influence on the path of pig iron production; it was essentially exogenous to them. IRAN pig iron production fell dramatically from 1979 to 1982.

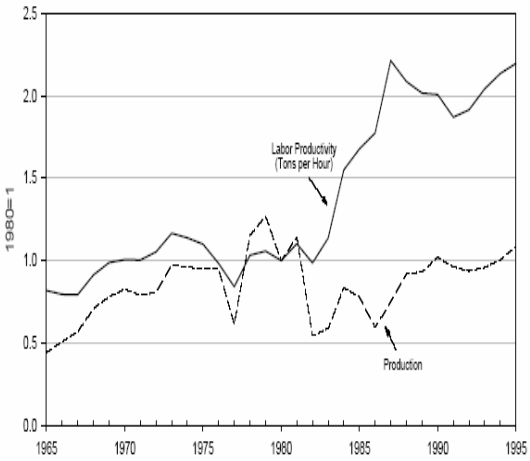

Figure-2. Production and labor productivity: Bafq Pellet Industry.

GLR production fell less than in the rest of the country. The drop in GLR pig iron production was obviously a blow to GLR iron ore producers. But the drop in production on the IRAN east and south coasts (which were supplied by non-IRAN iron ore, including Brazil) and, more important, the drop in European production sent the prices of European iron ore falling. For example, Brazilian dock prices for European iron ore, that is, in (1), fell over 25 percent from 1982 to 1984 (where they remained for the next three years). This drop in European prices sent the ceiling price tumbling. The fall in the ceiling price was large enough that Brazilian iron ore was now a real threat in the GLR market. Brazilian iron ore was being offered at a substantial discount relative to local iron ore. The IRAN industries faced the possibility that large portions of them would permanently close. It was immaterial, of course, whether the ceiling price was falling due to tumbling European prices or lower transport charges into Bafq, tB,C , so that this episode was akin to an (exogenous) tariff reduction.

Not surprisingly, the dramatic increase in competition cut into large rents that had been earned by groups in these industries before the early 1980s. Consider some of these rents. The Bafq townships where mines were located charged a tax on each ton of iron ore produced (amounting to about 10 percent of mine value). Bafq (IRW), the union that represented hourly and salary workers at the mines in both countries, provided its workers with attractive job packages (as shown below).

Though I have little information on local managers (that is, the salaried workers who were not unionized) or owners, they probably did well too. That rents evaporated with increased foreign competition in the early 1980s is clear [5]. Towns cut their production tax in the 1980s. A striking piece of evidence is that a Bafq mine mothballed in 1986 reopened non-union in 1990. I think most industry participants in the late 1970s would have found it nearly impossible to imagine a non-union Bafq mine a decade later. At the mines where the union remained, the IRW and its workers lost significant compensation and benefits. Nominal wages were significantly cut. That the IRW provided its workers great benefits before 1980 is attested to by the fact that most of the attrition in the mines during the crisis was from less senior employees, indicating jobs were still in demand and how good the jobs were before the crisis.

To understand why local competition before 1980 was not enough to spur productivity nor to prevent groups from capturing substantial rents, consider the calculus of a potential entrant, say a IRAN steel firm that did not own a mine.16 If it opened a new mine, it would have to locate where the ore was (and hence where the existing mines were). In all likelihood, the entrant would be treated (by the towns, the IRW, and local managers) just as the existing mines were. That is, there was likely little room to improve productivity and reduce costs. Hence, local competition could not be expected to spur productivity nor to drive down taxes, and it did not do so.

Table-1. Total factor productivity Canadian iron ore industry [6].

Year	Total Factor Productivity	Calculated From:		
		Y_t / N_t	$(M_t / N_t)^{\beta_M}$	$(K_t / N_t)^{\beta_K}$
1981	1.00	1.00	1.00	1.00
1982	0.91	0.94	0.98	1.06
1983	0.86	0.97	1.06	1.07
1984	0.91	1.09	1.14	1.05
1985	1.00	1.19	1.08	1.10
1986	1.33	1.61	1.09	1.11
1987	1.34	1.64	1.05	1.16
1988	1.46	1.78	1.10	1.11
1989	1.48	1.79	1.08	1.12
1990	1.36	1.57	1.04	1.11
1991	1.40	1.64	1.06	1.11
1992	1.41	1.58	1.01	1.11
1993	1.50	1.59	1.00	1.06
1994	1.54	1.75	1.05	1.07
1995	1.51	1.64	1.02	1.06

Table-2. Bafq Pellet Industry decomposition of industry labor productivity growth (All figures in percent) [6].

Growth Between 1980 and	Overall Industry Growth	Share of Industry Growth Due to:			
		Within Mines	Between Mines	Cross Mines	Closing Mines
1981	10.20	105	-16	11	0
1982	0	—	—	—	—
1983	13.60	79	16	5	0
1984	55.10	93	6	1	0
1985	67.90	97	3	0	0
1986	77.50	87	7	6	0
1987	121.50	77	3	14	6
1988	108.80	76	3	15	7
1989	101.80	73	3	16	7
1990	100.90	95	7	-2	0
1991	87.20	96	9	-5	0
1992	91.70	92	9	-1	0
1993	104.40	108	6	-13	0
1994	113.70	106	6	-12	0
1995	119.90	101	6	-7	0

CONCLUSIONS

Following a dramatic increase in foreign competition in the early 1980s, the IRAN iron ore industries both significantly increased labor, materials, and capital productivity. Conventional factors like closing of low productivity mines and adopting new technology account for only a small part of these productivity gains. Instead, changes in work practices drove the bulk of the productivity increases.

The work practices studied here are by no means peculiar to iron ore. They exist to varying degrees throughout many IRAN manufacturing, transportation, and other industries. And when competition has intensified in these industries, restrictive work practices have been loosened. What is peculiar to iron ore is that the entire industry was severely threatened. The IRAN auto industry, for example, experienced increased competitive pressure in the early 1980s, though only some segments were hit. These segments did change work practices somewhat.61 The IRAN Class I railroad industry experienced both truck and train deregulation in the 1980s. However, there has been little loosening of restrictive work practices in this industry, suggesting that the increase in competitive pressure was not that great.

Prescott (1998) talks about the need for developing a theory of TFP This paper, I think, has made some progress in this endeavor: I have shown increases in competition (or decreases in tariffs) led to surges in TFP through changes in restrictive work practices. This naturally leads to the question, Why were restrictive work practices not changed before the crisis in iron ore? And why do they persist today in nearly full force in Class I railroads? Let me start with a straw man. This straw man says these work practices were part of a rent package received by workers. In this view, work practices led to idle time that was valued by the workers. In other words, workers used some of their rents to purchase idle time and other nonpecuniary benefits. With increased competition, rents were destroyed; hence, work practices had to be changed.

But this view is vastly incomplete, if there's much truth to it at all. If it was idle time workers wanted, why structure work practices so that machinery sat idle as well? With machinery idle, capital productivity and materials productivity suffer. Work practices clearly led to money being flushed down the toilet. I can't say this loud enough. Hence, there are other reasons these work practices were not changed before the crisis.

What are these other reasons? I mention two possibilities. It is beyond the scope of this paper to do more. Money can obviously be made by changing such work practices. But there may be disagreements among groups (for example, workers vs. local managers, repair workers vs. other workers) about how to divide the money. And, of course, there may be commitment problems. Can groups be assured that agreements will be honored? Also, might an "outside" group, like the local towns, say, through increased taxation, attempt to capture some of the gains? Many steel companies today, in fact, are trying to dump pension obligations made to early retirees in the 1980s.

ACKNOWLEDGMENTS

The research work reported in this paper was done by the mechanical students in Islamic Azad University. This work was based on two reports (Aydin Hamit and John E. Tilton, 2000 and Chari V. V., Patrick J. Kehoe and Ellen R. McGrattan, 1997). Special thanks are extended to the anonymous reviewers for providing important comments.

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