Explaining Decreased Employment in Minnesota's Iron and Steel Industry: How Valid are Industry Claims that Low-Priced Imports are to Blame?

Courtney Zinter, Concordia College

The state of the domestic iron and steel industry in the United States and the issue of what to do regarding its decline has been a constant source of argument for decades, with Minnesota's own iron and steel industry being no exception. The sharp decline to employment in Minnesota's steel industry has left workers searching for an explanation and demanding a halt to further job losses. Typically the blame has fallen upon the foreign steel industry, which is accused of importing their product at prices so low that domestic firms cannot compete and are thus forced to lay off employees. Many anti-dumping claims have been filed based on such accusations.

With the expansion of the global economy and disintegration of many trade barriers, the United States is facing increased competition from foreign firms. However, this new competition is not necessarily unfair but often beneficial to the overall domestic economy. Policymakers must be cautious before proposing counteractive measures against what have been deemed unfair trade practices by those with a vested interest in the vitality of the industry in question.

Employees and firms in Minnesota's iron and steel industry have largely pointed their finger at low-priced foreign competition, but generally without the substantiation needed to merit governmental protection. Previous studies examining the effect of import prices on domestic employment, which do conclude a strong positive correlation, are often backed by interested industries. Other studies reach different conclusions, finding little reason to place outright blame on foreign competition.

Having grown up in a company town built specifically for a taconite processing plant, I have witnessed the turmoil caused by shutdowns, lay-offs, and bankruptcies when a population is completely dependent upon one industry. Workers, fearful of losing their jobs, understandably seek assistance from the government. Due to the locality of mines and plants in Minnesota, these relatively unskilled employees have few alternative sources of employment and are likely more concerned with maintaining their employment than those living in another part of the country where numerous job opportunities exist.

This study will concentrate specifically on the level of employment in Minnesota's iron and steel industry from 1974 to 1990. It differs from past studies both in examining the effect of import prices on the steel industry in particular rather than the manufacturing industry as a whole and in concentrating on the state of Minnesota during this time period. I hypothesize that the claims made against low-priced steel imports are overstated. While they may be an indirect factor causing lowered employment, it is not as direct of a factor as other variables that will be introduced to the regression.

Based upon the results, I conclude that decreased domestic consumption and increased worker productivity are the primary factors behind the decreased employment of this industry. The price of imports, while perhaps contributing to a push by domestic firms to increase worker productivity more rapidly than had the threat of foreign competition not been present, had no significant effect on the level of unemployment. I will show the problems that arise when this variable is included in the equation and why it should ultimately not even be factored into the regression.

Implications of these results are to possibly remove some fuel from the fire of companies and policymakers demanding that anti-dumping measures be imposed. The main issue of debate

should focus on what extent the government desires to keep the steel industry alive for protectionist reasons as in during times of war—not because of declining employment. Otherwise, the opposition of technologies that decrease the need for manpower would be counterproductive in our society. The same is true in taking action against the trend of decreased steel consumption. Social benefits outweigh social costs as consumers demand less-polluting, recyclable goods such as plastics where steel was once used.

2. Theory and Previous Literature

There are two views that emerge from previous literature examining the relationship among free trade, competition, and domestic employment. A basic issue and topic of endless debate is whether or not free trade is a desirable policy objective in the first place. Some concur while others disagree. The main economic theory behind the matter is the Heckscher-Ohlin model, which leads to improvement of the overall economy through the specialization by countries in producing and exporting the goods that they are relatively abundant in. Trade results in a redistribution of employment away from the import substitute sector and towards the export sector. While the overall effect may be positive, this often holds negative implications for unskilled workers in developed countries. Wages of unskilled workers cannot keep pace with the rest of the domestic economy because firms must keep their costs low in order to compete with the undeveloped countries that produce the same goods, as they should be according to the Heckscher-Ohlin model. In following this model, the U.S. should be moving away from the manufacturing of steel and import it instead for the betterment of the overall economy both domestically and internationally.

In support of the cause against free trade, Ana Revenga (1992) argues that increased import competition has been a major factor in declining employment is U.S. manufacturing. In

order to adjust to the occurrences explained by the Heckscher-Ohlin model, most modifications occur through employment. However, we will see in an overview of other studies why the steel industry should be considered separate from other manufacturing industries along with the implications these differences hold.

In Jagdish Bhagwati's (1994) discussion on free trade, he observed that the growth of global commerce and threat of the Heckscher-Ohlin model becoming a reality lead to an increase in both the supply and demand of protectionism. As is the case with the steel industry, demands for protection must be examined closely to see if they are truly the result of unfair trade practices or if such claims are merely a facade for a firm that simply cannot compete anymore. A common rationale today for the inability to remain competitive is the occurrence of 'social dumping' resulting from foreign firms having lower production costs due to fewer environmental and labor standards. He also notes that the serious overvaluation of the dollar under the first Reagan administration escalated the apparent need for protection as the level of now relatively cheap imports soared.

Bee Yan Aw and Mark Roberts (1985) make the important observation that a fundamental issue is the degree of substitutability between labor and imports in the production of goods. They examined this issue by looking at the impact that imports from newly-industrializing countries (NICs) had versus those from developed countries. Their study found that imports from NICs were a complement with U.S. domestic labor while imports from developed countries were substitutes for labor. They thus concluded that commercial policies raising the price of imports into the United States would lead to reductions in aggregate employment. As iron and steel imports from NICs such as Mexico, Taiwan, and Brazil

experienced dramatic growth during our time period in question, this occurrence should have helped *increase* aggregate domestic employment, according to Aw's and Roberts' 91985)study.

Preceding Aw's and Roberts' (1985) idea of substitutability, a study by Gene Grossman (1982) on import competition and product substitutability from 1968-1978 noted that imports of iron and steel rods and bars consisted largely of lower-grade products that were not suitable for being substituted for higher-quality domestic steel that is often used in construction. Grossman (1982) expected greater competition among foreign suppliers themselves rather than competition between the imported and domestic good. The less of a perfect substitute an imported product is to a domestic good, the less the threat of harm exists for the future of the domestic industry.

If import competition is perhaps not as significant of a factor as is claimed, then what is? An assessment of the United Kingdom's situation, similar to that of the United States', found that while evidence against free trade does exist, a much stronger factor is increased worker productivity. The issue then arises as to how much we decide to blame the threat of import competition for inducing firms to require a more efficient labor force. Ultimately, increased efficiency is inevitable as long as new technologies keep allowing for it. Firms call for the constant minimizing of costs whether it be to merely remain in business or to increase profits.

3. Conceptual Model

In a partial continuation of ideas and conclusions formed in previous related papers and studies, we will digress to examine employment in Minnesota's iron and steel industry as a function of import price, worker productivity, and domestic consumption. The theory behind the initial selection of import price is that, if suitably substitutable, consumers will demand less of the higher-priced domestic steel, which then decreases revenues and forces a firm to cut costs in part by reducing employment. However, we will see why the final form of the regression

equation drops this variable and why only the subsequent independent variables remain. The initial inclusion of import price is meant to test prior conclusions that were made regarding the U.S. manufacturing industry as a whole, not specifically the steel industry. The inclusion of import price should reveal if these prior conclusions do indeed extend to the steel industry in particular. Worker productivity is included because the more efficiently a firm operates, the fewer the number of employees is needed to maintain the same level of production. Finally, domestic consumption is included as a measure of demand. Reduced demand for steel implies that producers will in turn cut down on their supply, again often necessitating a reduction in employment.

Our initial equation for examination is:

$$\mathbf{EMP=B_o+B_1CI+B_2PROD+B_3PI}$$

Table 1: Variables, expected signs, and definitions

Variable	Description
EMP	Employment at iron mines and beneficiating plants in Minnesota
CI(+)	United States' consumption of iron ore and agglomerates, by end use (thousand metric tons)
PROD(-)	Average output per worker hour in the United States
PI(+)	Composite steel export prices to the United States in real terms, free on board

4. Data

The data for EMP, CI, and PROD was obtained from the United States Geological Survey (www.usgs.gov). Joe Innace, director of World Steel Dynamics, a leading steel information service, provided the data for PI. The years for this sample (1974-1990) were chosen primarily due to limitations of available data, but this time period also shows great disparity in the data over these years.

Table 2: Data used in regression

YEAR	EMP	PROD	CI		PI
1974	11,000	5.64	140,538	$	275
1975	11,190	5.57	132,796	$	385
1976	11,721	5.81	109,399	$	261
1977	11,289	5.3	117,591	$	311
1978	13,294	6.01	111,812	$	276
1979	13,915	6.49	119,871	$	347
1980	11,716	6.32	118,855	$	407
1981	12,189	6.71	92,783	$	421
1982	6,049	6.47	98,614	$	394
1983	5,085	8.25	57,298	$	366
1984	5,713	9.67	63,050	$	323
1985	5,780	10.8	68,450	$	327
1986	4,100	10.62	66,049	$	301
1987	3,737	12.69	57,513	$	332
1988	4,706	12.87	62,425	$	373
1989	5,245	11.95	73,601	$	521
1990	5,577	11.55	74,757	$	543

A brief examination of the data reveals that the 1990 employment level was about half that of 1974, productivity per worker more than doubled, consumption is about half as much in 1990 compared to 1974, and the price of imports fluctuates greatly in both directions. Graphs of these variables can be found in Charts C-F. Most years experiencing an increase in employment over the previous year are accompanied by either a decrease in worker productivity, an increase of consumption, or a combination. In both regressions we will be examining, CI and PI are lagged by one year following Grossman's and Ann Revenga's suggestions in their studies to allow for the time any adjustments would require in order to be made as a response by domestic firms.

The independent variables selected for our initial equation were chosen as a representation of differing prior studies. While there exists a general consensus that consumption levels and productivity directly impact the need for employment, import price, again, is included

to test the argument that in an industry such as steel, this factor may or may not have a relatively large impact in addition to the other variables.

5. Results

Running this regression using OLS produced the following results:

Table 3A: Regression 1: Explaining variations in employment

Variable	Coefficient	t-Statistic
PROD	-509.6761	-1.469909
CI	0.068726	2.105959
PI	-0.108865	-0.016727
R-squared		0.787265
Adjusted R-squared		0.738172
Durbin-Watson statistic		1.831157
F-Statistic		16.04

Substituting for the coefficients produces:

EMP=6360.805-509.676*PROD+0.0687*CI-0.109*PI

The initial observation is that the coefficients for PROD and CI produce the expected signs. The results show that for an increase in worker productivity by one unit (average worker output per hour), employment declines by 509.7 positions, holding all else constant. For every additional thousand metric tons consumed domestically, employment rises by 0.069 positions. Concerning the third variable, the negative coefficient for PI is slightly surprising, though it may lend weight to the conclusion made by Aw and Roberts that imports from NICs are complements to labor. This negative may also be explained by problems with multicollinearity, for there are relatively high R-squares combined with statistically insignificant t-statistics. For this regression,

there are 13 degrees of freedom and a critical t-statistic of 1.771 at a 5% significance level. This makes CI statistically significant and we therefore accept the hypothesis, but by a small margin we reject the hypothesis that PROD is significant. PI is also insignificant by the t-test and again the hypothesis that it is a statistically significant variable is rejected.

In a test of the regression as a whole in explaining employment, the overall equation is significant in serving as some usefulness. The critical F-statistic of 3.41 is less than the calculated F-statistic of 16.04, leading to this conclusion.

Because heteroskedasticity and serial correlation do not appear to be a problem when observing the pattern of dispersion and the Durbin-Watson statistic, we will concentrate on solving the apparent multicollinearity. While its presence does not cause unbiased coefficients, it causes the distribution to be wider than it should be making some coefficients appear insignificant when they truly are significant. Ideally, a larger sample size would be useful to see if any of this problem would be eased. However, as this is impossible at the time due to data collection limitations, we will take a closer look at PI since its t-stat is so dramatically below the critical t compared to the others in addition to having an unexpected sign by some theories. Besides expanding the sample size, another solution in trying to solve for multicollinearity is to drop a variable, which is next done with PI. It is possible that multicollinearity is occurring between PI and CI in that declined consumption may depend partially upon import prices in addition to the effect that substitutes like plastic may be responsible for the decline we see. However, one thing to note is that the correlation matrix reveals a correlation coefficient of only -0.25 between PI and CI while the correlation coefficient between PROD and CI is –0.86. But sticking to the theory, we will continue to assume that PROD and CI are not highly correlated from a theoretical standpoint and PI remains the variable in question.

After making the adjustment of removing PI, the second regression equation becomes:

$$\mathbf{EMP= B_0 +B_1CI+B_2PROD}$$

This regression produces the following results using OLS:

Table 3B: Regression 2: Explaining variations in employment

Variable	Coefficient	t-Statistic
PROD	-511.6498	-1.628481
CI	0.068635	2.213774
R-squared		0.78726
Adjusted R-squared		0.756869
Durbin-Watson statistic		1.833068
F-Statistic		25.90

Substituting for the coefficients produces:

$$\mathbf{EMP=6346.324-511.650*PROD+0.069*CI}$$

The new set of results suggests that while multicollinearity may still be a problem, it has likely been reduced in its severity. Following this first adjustment, we are limited in our ability to further reduce any multicollinearity except through an increase to the sample size. However, computing the Variance Inflation Factor for the regression produces 4.7, a number below the warning point of five that indicates a problem with multicollinearity does exist. So despite the remaining correlation coefficient of –0.86 between PROD and CI, we will assume multicollinearity is not causing a significant problem to the regression.

The expected signs for PROD and CI still remain. Only slight changes occurred to the remaining coefficients. An increase in worker productivity by one unit (average worker output

per hour) now suggests an employment decline of 511.6 positions, holding all else constant. An additional consumption of one thousand metric tons indicates that employment gains 0.0686 positions. The new critical t-value of CI is 1.761 at the 5% significance level, an increase to the margin by which it is statistically significant. PROD also decreased the margin that requires us to accept the null hypothesis and call it statistically insignificant. With a t-statistic of –1.628, it misses being statistically significant and we accept the null hypothesis by only 0.133, bringing it closer to the point of being able to reject the null as hoped.

Again, the F-test concludes the entire equation to be significant, showing an even greater margin between the critical F-statistic of 3.74 and a calculated F-statistic of 25.90.

In addition, the standard errors of the regression were reduced from the initial equation to the final. The standard error of PROD decreased from 346.7 to 314.2, CI decreased from 0.033 to 0.031, and the standard error of the regression was reduced from 1880 to 1811. The smaller the standard error, the more precise the coefficient estimates are.

Comparing the two sets of results, the R-squares are nearly identical. The adjusted R-squared, however, increased from 0.738 to 0.757. In consideration of the impact that irrelevant variables have on an equation, recall that their inclusion increases the variance of the estimated coefficients, which in turn tends to decrease the absolute magnitude of the t-statistics. Irrelevant variables also often decrease the adjusted R-squared while having little impact on R-squared. Going back to the two results, the change in numbers does indeed suggest that PI was an irrelevant variable and deserved to be excluded. Further supporting this exclusion is the fact that the coefficients of PROD and CI change very little when switching from the inclusion to exclusion of the variable PI.

As serial correlation is often a problem in a time-series regression, we now look at the Durbin-Watson statistic to test for its occurrence. Because the regression model includes an intercept term and there is not a lagged dependent variable, this method will be used. The OLS results give a Durbin-Watson statistic of 1.833, which being relatively close to 2.0, indicates very little, if any, problem with serial correlation. Performing the Durbin-Watson *d* test, we first obtain lower and upper critical d values of 1.02 and 1.54, respectively. The value of 1.833 easily falls in the "Acceptance" Region by which we also conclude there to be no positive serial correlation.

Plotting the variance of the error term does not suggest that the regression has a problem with heteroskedasticity.

6. Further Adjustments

While I feel that the second regression model does a decent job of explaining the decline of employment in Minnesota's iron and steel industry, improvements are always possible. As stated previously, an increased sample size would be my first adjustment to further alleviate the possibility of multicollinearity in an attempt to bring PROD into a statistically significant level. Because theory and past literature suggest that productivity has a definite impact on the demand for labor, I find the regression to not reveal the exact results I was hoping for by having an insignificant t-statistic for this variable. However, this study does contain fewer than the minimal optimum of thirty data points, sometimes a contributing factor to having this problem.

For both regression models we examined, only a linear functional form was used. Plotting the CI and PI against EMP suggests this is the correct form to use (chart A). However, looking at PROD and EMP, while fairly linear, gives indication of a possible inverse relationship (chart B). I did attempt using this form between my initial and final equations, but other

problems developed for which I decided against using it. Running the regression of **EMP= B_o +B_1CI+B_2(1/PROD)** produced the following:

Table 3C: Regression 3: Explaining variations in employment

Variable	Coefficient	t-Statistic
PROD	36953.53	1.380899
CI	0.064085	1.673412
R-squared		0.777295
Adjusted R-squared		0.74548
Durbin-Watson statistic		1.835605

In these results, not only do all independent variables become insignificant by the t-test and both R-squared and adjusted R-square are lower, but we get an unexpected sign for PROD and a vastly different coefficient for PROD.

If this is in fact a more optimal form, the unexpected sign suggests an omitted variable. Other possibilities to consider including are a variable that measures the substitutability of imported and domestic steel products and a variable that accounts for the strength of the U.S. dollar and exchange rate, as Revenga mentions.

7. Conclusion

The results of the final regression and the observations we make when moving from the initial form to final form give support to the argument that competition from import prices is not a direct, statistically significant cause of employment decline in Minnesota's iron and steel industry.

While complaints against dumping may still be valid for other industries, the substitutability factor concerning foreign versus domestic steel limits the extent to which this

claim can be made in our particular industry. Buyers cannot accept lower-priced imports if the product does not serve their need. Automobile and construction industries, for example, cannot afford lower-priced imports if the product fails to perform at the level required to manufacture safe, durable goods and structures. New product developments and methods of construction may allow for greater use of lower-grade imports, but this is likely a negligible factor in employment levels, at least to date.

This study supports many ideas mentioned in previous studies of a similar subject. It does not necessarily refute claims made by others who argue that imports are a significant contributor to declining employment in the manufacturing sector, but it does suggest that the iron and steel industry possesses enough unique characteristics that it should be considered separately rather than thrown into one assumingly homogenous manufacturing group.

Policy implications that this study holds are that the government should think twice before imposing counteractive measures against foreign steel exporters. Instead, more focus should be aimed at assisting the unskilled labor force in attaining the necessary skills and education to adapt to alternative industries and employment.

Technology has contributed to the loss of countless employment positions, a factor that was true long before globalization took off at its ever-increasing pace. In order to remain competitive, firms strive to increase their technology and productivity in order to reduce costs. I do not doubt that foreign competition has increased the intensity by which firms attempt to do so, but it is bound to happen anyway. Objection to foreign imports would only serve to delay the process by a negligible amount of time.

The weakness of this study is, besides a small sample size, the inability to measure the extent of the indirect effect import price has on employment, and also that it does not consider

how much the steel industry should perhaps be protected for reasons of national security. These issues, the latter in particular, are perhaps ones not best resolved by yet another regression, but through careful thought and consideration grounded in theory and supported quantitatively by regression studies such as this.

Chart A

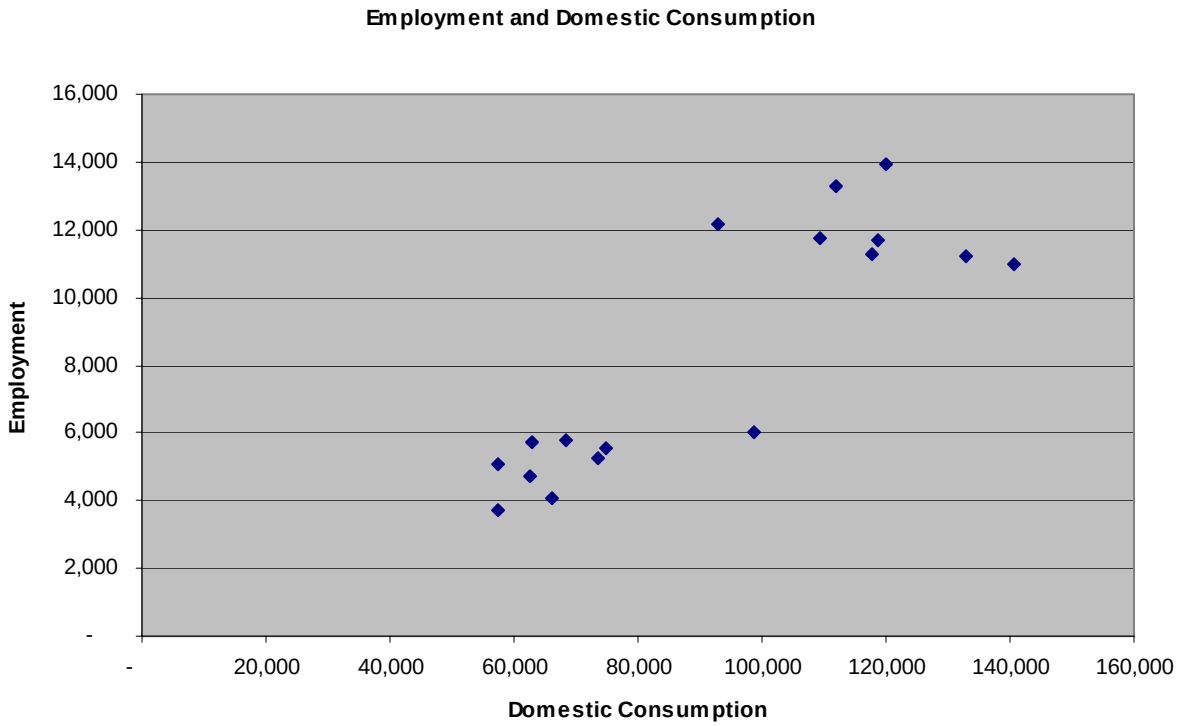

Employment and Domestic Consumption
Employment
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
-
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
Domestic Consumption

Chart B

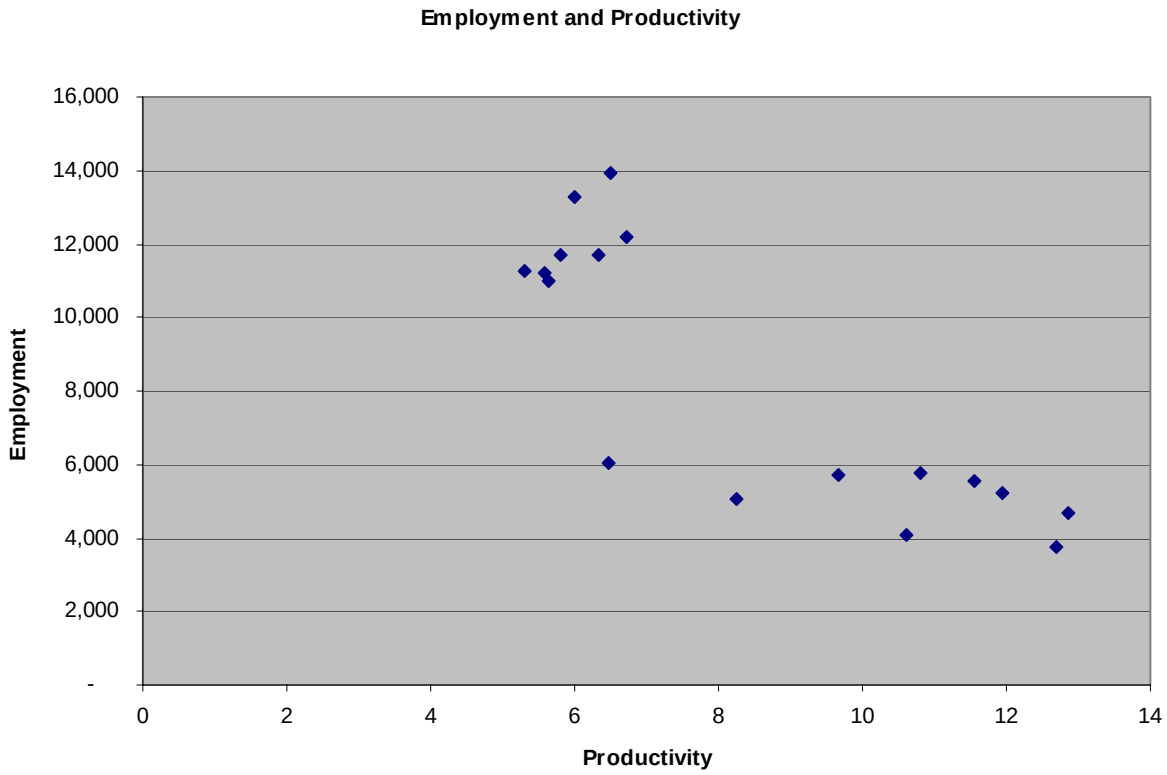

Employment and Productivity
Employment
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
0
2
4
6
8
10
12
14
Productivity

Chart C


Employment 1974-1990
Employment
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990

Chart D

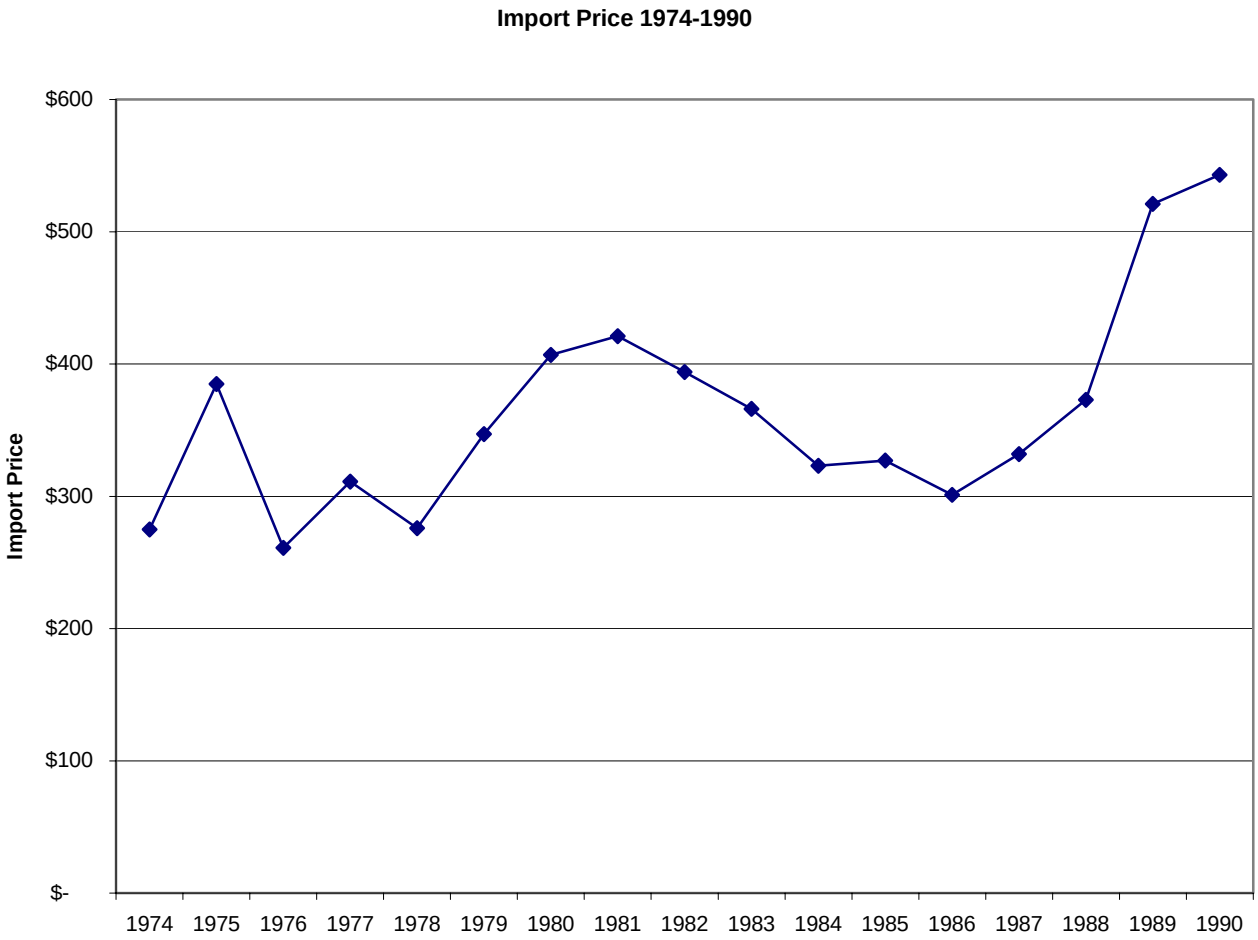

Import Price 1974-1990
Import Price
$600
$500
$400
$300
$200
$100
$-
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990

Chart E

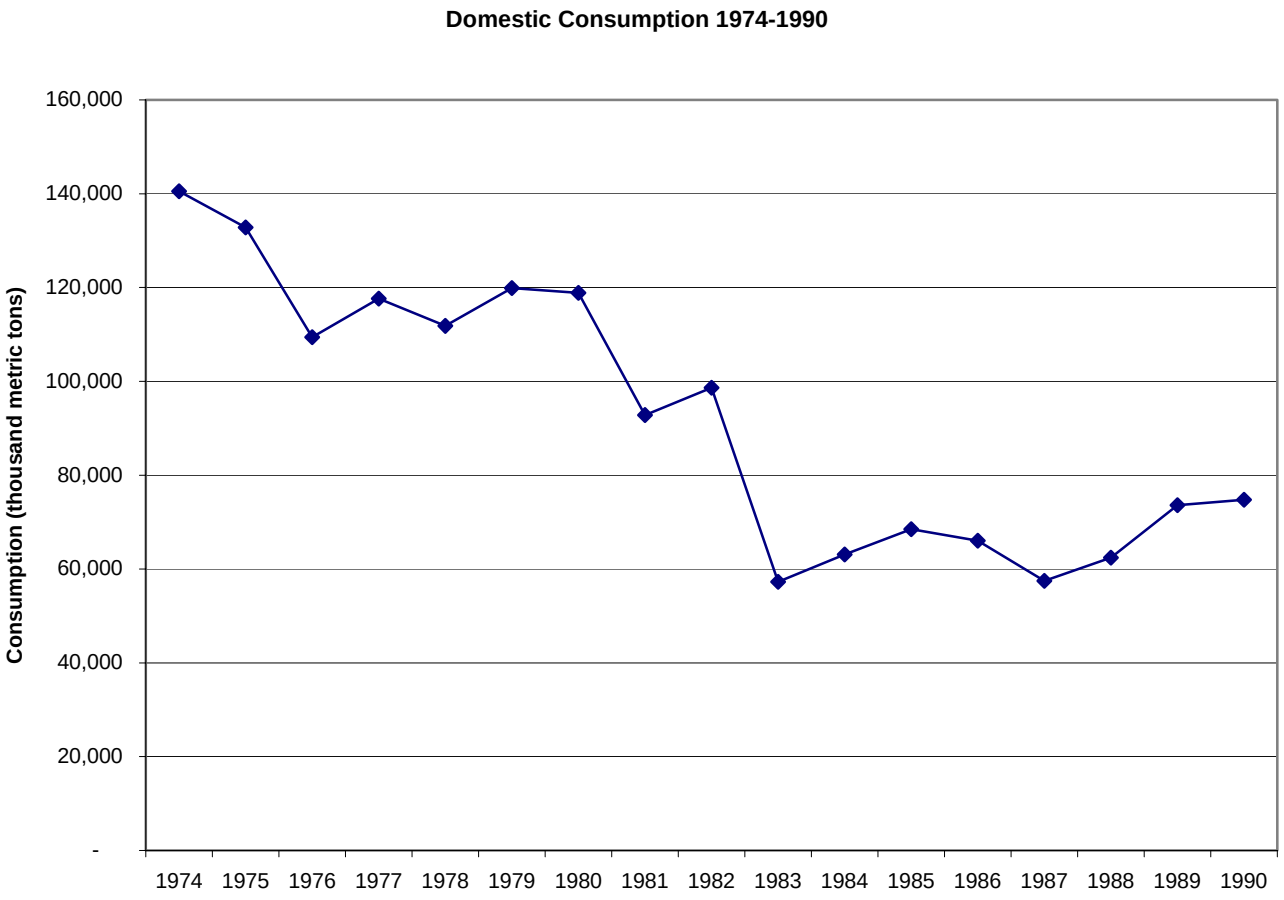
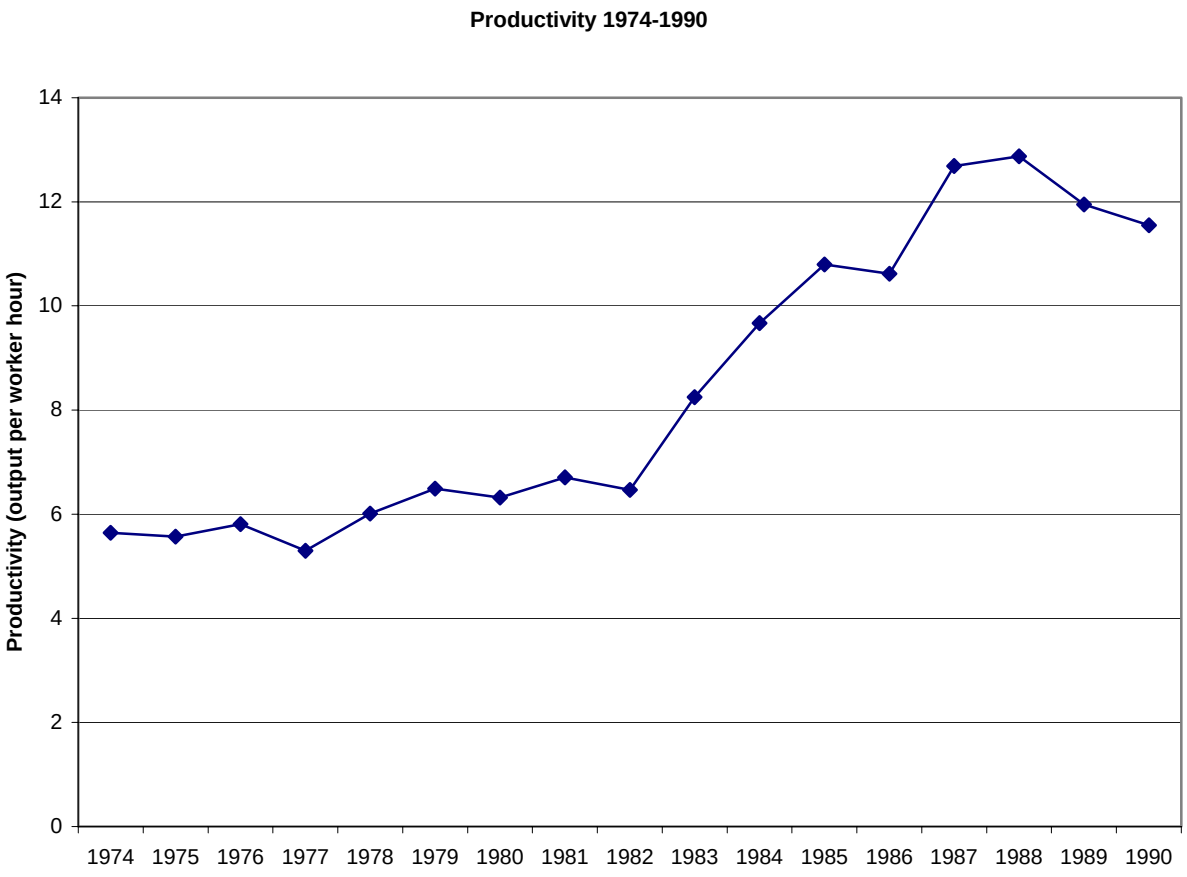

Domestic Consumption 1974-1990
Consumption (thousand metric tons)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990

Chart F


Productivity 1974-1990
Productivity (output per worker hour)
14
12
10
8
6
4
2
0
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990

References

Aw, Bee Yan and Mark J. Roberts, "The Role of Imports from the Newly-industrializing Countries in U.S. Production," *Review of Economics and Statistics*, Volume 67, Issue 1 (Feb., 1985), 108-117.

Bhagwati, Jagdish, "Free Trade: Old and New Challenges," *Economic Journal*, Volume 104, Issue 423 (Mar. 1994), 231-246.

Grossman, Gene M., "Import Competition from Developed and Developing Countries," *Review of Economics and Statistics*, Volume 64, Issue 2 (May 1982), 271-281.

Revenga, Ana L., "Exporting Jobs?: The Impact of Import Competition on Employment and Wages in U.S. Manufacturing," *Quarterly Journal of Economics*, Volume 107, Issue 1 (Feb.1992), 255-284.