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Comparative Advantages and Sustainable Development in Iranian Manufacturing Industries

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Abstract

This paper identifies the comparative advantage and the rank of the manufacturing industries of IRAN using traditional and environmental variables. To do so, in the first stage, manufacturing industries are ranked according to employment, value added and profitability and then air pollution indices are added into the analysis. The development levels of manufacturing industrie s are calculated using numerical taxonomy method at 2-digit industry levels. The results showed that the comparative advantage of Iranian manufacturing industries, regardless of the indices of sustainable development and when these indices are to be taken into account are distinct from each other. In the first stage, the manufacture of other non-metallic mineral products, manufacture of basic metals, manufacture of chemicals and chemical products and manufacture of food products and beverages are ranked highest in 2005 respectively. But when air pollution indices were added into the analysis, the manufacture of other non-metallic mineral products has lost its advantage. Thus, with regard to indices of sustainable development, the comparative advantage is not a sufficient indicator for ranking of industries in terms of their performance.

Keywords: Air pollution, Comparative Advantage, Iranian Manufacturing Industries, Numerical Taxonomy, Sustainable Development.

1- Introduction

Comparative advantage is one of the most important and unchallenged laws of economics, with many practical applications. Although, the theory of comparative advantage is used in international trade discussions, but it can be utilized for planning and regional policy (Monsef et al., 2012, p. 1086) and this law is used in many studies. For example, Lim (1997) analyzed the

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characteristics of North Korean economy through her foreign trade. Jooya (1999) using the Location Quotient (LQ) index measured the relative degree of specialization in various industries of the province of Yazd. Bender and Li (2002) examined the structural performance and shift of exports and the revealed comparative advantage of the Asian and Latin American regions over the period 1981-1997. Esnaashari and Ehsanfar (2003) argued comparative advantage and structural changes of the industries of Mazandaran province of Iran during 1998-2000. Zheng (2004) analyzed the comparative advantage of Chinese industries in 2002. Nesterenko (2006) studied the competitiveness of Ukrainian products on the world market, as measured by Balassa index. Richard (2008) examined the comparative advantage and competitiveness of Uganda's exports with a trade-based index of the Revealed Comparative Advantage over the period between 2000 and 2005. Mirjalili et al. (2009) in order to recognize the potential of industries of Yazd province between 2001 and 2004 used a synthesis of factor analysis and numerical taxonomy at 2-digit ISIC codes. Issac and Othieno (2011) examined the comparative advantage of Uganda’s exports to the East African Community (EAC) partner states.

The survey of literature shows that the indicators such as employment, value added and profitability are used to determine investment priorities. But current comparative advantage indices alone can never be considered as a basis for sustainable development, because this approach does not respect to the basic criteria of sustainable development such as environment and human dignity. In the other words, appointment of investment priorities through comparative advantage indices has this weakness that no attention to indicators of sustainable development. Indeed, in this way, goods and services are known suitable for the production which may be very harmful for the environment. This means that the image provided by the law of comparative advantage from goods and services is deceptive such as a mirage. Therefore, comparative advantage of goods and services without regard to indicators of sustainable development is not logical and the aim of this study is to determine the industries with comparative advantage and ranking of manufacturing industries in Iran using traditional comparative advantage indices and indicators of sustainable development, especially environmental indicators. So, for ranking industrial activities in Iran in addition to variables such as employment, value added and profitability, environmental pollution indicators will be considered. Although indicators of environmental pollution are numerous and could be included air, soil, water, sound and even light pollutions, but in this study is considered air pollution that is caused by combustion of fossil fuels in industrial sectors.

To prove this claim, the rest of this paper is organized as follows. Section 2 introduces literature of industrial emission and economic growth. Section 3 reviews some empirical studies of comparative advantage and economic sectors emissions. Section 4 discusses method of data collection and methodology in measurement comparative advantage and identifying the development degree of manufacturing industries. Section 5 reports major findings and section 6 concludes.

2- Comparative Advantage and Pollution: Theoretical Framework

As also mentioned in the introduction sector, traditional indices of comparative advantage are not sufficient to indicate the comparative advantage of areas. In fact, focusing on the production side alone is not sufficient for achieving sustainable development. This claim can be proved from producer and consumer view points.

Consider the situation where a firm produces a specific product and releases pollution in the environment. The Pollution caused by the firm production can contain a variety of shapes such as water pollution, soil pollution, air pollution etc. In fact this firm imposes a negative externality on the people who live near this firm. However, the firm does not take the cost of its activity into account when deciding its output. The level of activity will be determined by the firm equating marginal benefit to marginal cost but his/her marginal cost does not include the cost or disutility borne on the other persons. In other words, the firm will choose the level of activity at which:

Marginal social cost = Marginal private cost

However, marginal social cost is more than marginal private cost because of the externality imposed on the people who live near the firm. This situation is shown in panel (A) in Figure (1). The firm's marginal revenue curve is shown as EF. It declines as its output (Q) rises. In addition, marginal cost curve is shown as OC which rises as output rises. The profit maximizing output is given at Q1 where MR = MC (point G). Furthermore, marginal social cost is shown by the curve OD. It is shown as an upward sloping curve on the assumption that damage to the people increase as the output of the firm increases.

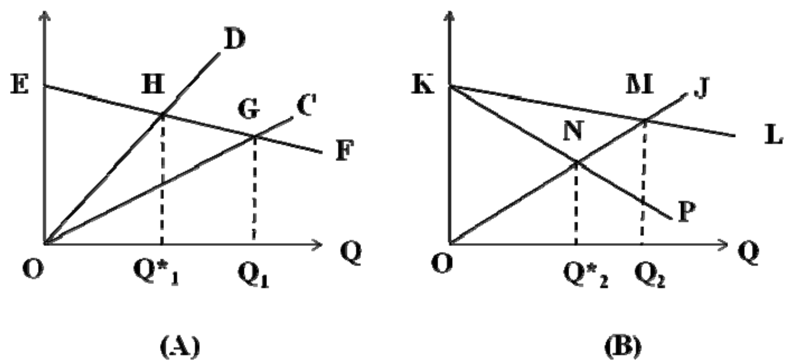

Figure 1: Comparison of Marginal Private and Marginal Social Optimum Output Level

The socially optimum level of output of the firm is given at the output where MR= MSC (point H). This output is Q^*_1 which is below the profit maximizing output of Q_1. There is over production of output. The case where marginal social cost is greater than marginal private cost consider as an example of a negative production externality. So, the firm produces at level which is socially inefficient. Accordingly, if the profitability of the industry alone considers as a basis for determining the comparative advantage of an area, Industries are known more advantageous that produce more than the social optimum. Thus, inefficient industries are introduced as industries with comparative advantage. Therefore, this basis does not guide the economy toward sustainable development.

Given that the employment rates of firms are determined based on the optimal production level and also the firm's exports and value added is proportional to its production and these values are not determined according to the social optimum production level, therefore the other traditional indicators of comparative advantage and profitability have the same characteristic. Thus, the comparative advantage based on these indices lead to introduction of inefficient industries for investment. This issue can also be expressed from a consumer perspective. Consider a person who consumes the production of the firm and of course is exposed the cost of pollution created by the firm. This case is shown in part (B) in figure (1). The person's marginal cost curve is shown as OJ which rises as consumption rises. Also this person gains benefit Due to the utility that obtains from consumption of the firm production. The person's marginal benefit curve is shown as KL. It declines as person's consumption (Q) rises because with increase in consumption level, the person's utility declines. The profit maximizing output is given at Q_2 where MB = MC (point M).on the other hands, marginal social benefit is shown by the curve KP. The person's marginal social benefit is less than marginal private benefit because of negative externality. The socially optimum level of consumption of the person is given where MSB = MC (point N). This output is Q^*_2 which is below the profit maximizing consumption of Q_2. There is over consumption of output. The case where marginal social benefit is less than marginal private benefit consider as an example of a negative consumption externality. In this case, the person consumes higher than the level of social optimum consumption. Therefore if traditional indices such as employment, value added and profitability are identified as a basis for determination of comparative advantage, the industries are known advantageous that their products are consumed at the level which is socially inefficient. Because these values are derived from inefficient consumption by users, therefore, ranking industries based on traditional indicators of comparative advantage is not true and sustainable development indicators such as indicators of air pollution should also be considered.

3- Empirical studies

Given that there was no study considering both comparative advantage and emissions. in this section two groups of previous studies are surveyed separately. The first group includes studies that identified comparative advantage in different areas and different economic sectors especially in manufacturing industries.

Mirjalili et al. (2009) in order to recognize the potential of industries of Yazd province between 2001 and 2004 used a synthesis of factor analysis and numerical taxonomy at 2-digit ISIC codes. Their result revealed that non metal mine products and textile products had highest station in comparison to other manufacturing industries.

Nesterenko (2006) examined the competitiveness of Ukrainian products on the world market, as measured by Balassa index of Revealed

Comparative Advantage (RCA). The results showed that in 2004 beverages were the most competitive; while in the previous years iron and steel were heading the leading positions.

Salimifar and Shirzour (2006) studied the structural changes of the industries of Khorasan province of Iran at the end of the second and third economic development plan of IRAN in comparison with the beginning of the second plan. In order to do this, a number of indices employed, some of which are: the changes of shares of value added of industrial activities (separated by ISIC codes), the indices of structural changes and Revealed Comparative Advantage (RCA). The obtained results indicated that among Khorasan industries, chemical, non-metallic mineral industries, machinery, and wood industries have experienced positive structural changes in the same direction with that of the country. Besides, the value added of these industries has remarkably increased during the period under study. The measurement of these industries based on the RCA index showed that only the two wood industries and miscellaneous industries have achieved an RCA more than one.

Havrila and Gunawardana (2003) examined Australia's comparative advantage and competitiveness in textile and clothing industries, using Balassa's revealed comparative advantage index and Vollrath's measures of competitiveness. The analysis based on Balassa's index showed that Australia has a strong comparative disadvantage in textile and clothing.

Esnaashari and Ehsanfar (2003) argued comparative advantage and structural changes of the industries of Mazandaran province of Iran during 1998-2000. They used structural changes and Revealed Comparative Advantage (RCA) indices. Results revealed that respectively Manufacture of motor vehicles, trailers and semi-trailers; manufacture of paper and paper products; manufacture of furniture and manufacture of basic metals had positive structure changes. Also manufacture of food products and beverages; manufacture of wood and of products of wood and cork, except furniture; manufacture of textiles; manufacture of furniture and manufacture of paper and paper products had comparative advantage.

Bender and Li (2002) analyzed the performance of manufacture exports in a number of Asian and Latin American economies over the period 1981-1997 and examined the RCA indices between economies in East Asia, Southeast Asia and Latin America. The evidence strongly suggested that despite the strong export performance experienced by East Asian economies, they are losing their comparative advantage to the lower-tier economies in Southeast Asia and Latin America.

Jooya (1999) using the Location Quotient (LQ) index measured the relative degree of specialization in various industries of the province of Yazd. Based on his research automotive industries group and the driving force has been comparative advantage in comparison with other industries in the province during the second economic development plan.

Kalirajan and Shand (1998) examined Australia’s trade patterns and composition with India and South Africa. They found that labor-intensive commodities (in particular, textiles and clothing and related products) dominate India’s, while capital-intensive products dominate South Africa’s exports to Australia. On the other hand, Australia’s exports to India are dominated by mineral-intensive, and exports to South Africa are dominated by capital-intensive commodities.

Huey (1998) examined changing patterns of comparative advantage in Australia, based on 71 manufacturing industries and nine major regional trading partners over the period between 1979 and 1989. Over this period, Australia gained comparative advantage in a number of labor-intensive and technology-intensive products. These are mainly the commodities in which some Asian countries lost their competitiveness.

Lim (1997) analyzed the characteristics of North Korean economy through her foreign trade. He used the ‘Revealed’ Comparative Advantage (RCA) Model. The empirical results showed that North Korea has achieved a little success in improving the economic structures by changing her major sector from the goods using natural resources intensively in production to the goods using relatively standard technology.

Summing up, in these studies, traditional variables such as employment, value added and profitability are used to determine the comparative advantage of different areas. But these researches did not consider sustainable development indices especially air pollution variables. In fact, the environment sector has been neglected, in these studies. And the role of environment has been ignored in regional planning.

On the other hand, another group of studies have studied the various economic sectors emissions especially industry sector. For example, Jozi et al. (2011) analyzed environmental impact of Arvand Petrochemical Complex on ecosystem of special economic zone in Imam Khomeini Port by using of Analytical Hierarchy Process (AHP) method. The study's outcomes showed that, with respect to the essence of petrochemical industry pollutants in the region, specifically waste waters including heavy metals, oil and grease, COD, TSS, along with principal standards, criteria defined in the AHP method (such as ecological value, protecting value and exposure), estuaries represent the most affected ecosystems in the region. It is concluded that deposits of heavy metals, oil and grease into the environment are the most important sources of pollution for the regional estuaries and these should be controlled.

Feizpour and Emami (2011) investigated changes process of Iran's industrial emissions separately for manufacturing industries at 2-digit level. The results of this study showed that although manufacture of coke, refined petroleum products and nuclear fuel and manufacture of basic metals by changing their positions in the classification of industrial pollutants have been classified into clean industries, but tanning and dressing of leather; manufacture of luggage, handbags and publishing, printing and reproduction of recorded media have been lost their positions in the classification of clean industries.

Nasrolahi and Ghafari (2011) examined The Environmental Kuznets Curve (EKC) hypothesis for 28 Provinces of Iran. In this study the relationship between per capita income and per capita pollutant emission for three atmospheric pollutants (CO, SO_2 and NO_X) was examined by using panel data during 2002-2006. The results showed that the two pollutants CO and NO_X are N shaped and for SO_2 a U-shaped was found.

Nasrolahi and Ghafari (2010) in another study examined the linkage between industrial activity and air pollution, using an industry-level dataset of Iranian manufacturing industries during the period 1995-2007. The result of study showed that air pollution is a positive function of energy consumption, industrial activity and physical capital intensity and also is a negative function of labor productivity, fuel price and human skill intensity.

Salimifar and Dehnavi (2009) investigated the relationship between pollution and economic growth for two groups of countries according to EKC hypothesis for a sample of 24 developing countries and 26 OECD countries over the period 1980-2005. They examined this hypothesis using econometrics techniques including panel co-integration and panel unit-root.

The results showed that panel data analyses do support the inverted u-shaped Environmental Kuznets Curve hypothesis in both groups of countries. Also, the results which extracted from estimating and forecasting, confirm that in developing countries higher economic growth causes more environmental distortion. While for OECD countries, economic growth improve the quality of environment.

Ghazali and Zibaei (2009) showed the relationship between environmental pollution and economic growth by Kuznets hypothesis which has derived from provincial data during 1996-2006. In this study have been used carbon monoxide pollution as environmental index and gross national product as economical index. Fix effects have been preferred to random effects based on F test for estimation of EKC by panel data. The Wald test result through the model evaluation shows the cubic increasingly relation between two environmental and economical indices. So this study has been done on five provinces: Esfahan, Tehran, Khorasan, Fars and Mazandaran during a decade that shows increasing pollution due to economical growth.

Jozi and Rezaeian (2008) carried out the study with the purpose of investigating the pollutants resulted from Bandarabbas industrial estate I during operation phase and presenting environmental management program for this industrial complex from 21/04/2006 to 21/07/2007. To examine the industrial estate environmental effects, some stations were specified and environmental elements including wastewater repelled from treatment plant, air and sound were sampled and measured. The investigation of air quality in the area showed that the extent of gaseous pollutants such as NO, NO_2, and SO_2 and troposphere ozone exceeded the permissible level. Sound measurements at three stations "Bita South Electricity", "Hormozgan Rubber Complex", "Hormozgan Oxygen Generating Plant" were reported to be db 76.3, 78.2, 76.8 respectively, which were higher than the permissible level specified for sound in industrial areas.

As was observed, although many studies have been done in the fields of comparative advantage and pollution separately, but no study have considered these two areas simultaneously. Therefore, this study attempts to take the first step in this direction in Iran.

4- Data and methodology

4-1- Air Pollution and its Measurement

There are various factors causing air pollution, but what comes from industries and factories is often considered prime factors in air pollution. There are numerous serious ecological implications and health risks associated with industrial air pollution. Carbon monoxide (CO), Carbon Dioxide (CO_2), Sulfur Oxides (SO_x), Nitrogen Oxides (NO and NO_2, referred together as NO_x) and hydrocarbons are Primary air pollutants that are emitted directly into the air from fossil fuel combustion in industrial activities (Iranian energy balance, 2002).

According to reports of Iranian Hydrocarbon Balance, production of Carbon Dioxide (CO_2) that is considered the most important greenhouse gas has increased from 4.6 tons in 1998 to 6.6 tons in 2009 for per thousand people. Carbon dioxide gas is one of the most pollutants in manufacturing industries in Iran. Carbon monoxide (CO) is the major air pollutant that is caused by incomplete combustion of fossil fuels. Nitrogen Oxides (NO_x) are generated from combine oxygen and nitrogen at high temperatures and pressures during fuels combustion. Sulfur Oxides (SOx) are created from the combustion of oxygen and sulfur and are also caused many respiratory problems. Unburned Hydrocarbons (HC) released from volatile organic hydrocarbons and burning plastic raw materials and production processes. Also Suspended Particulate Materials (SPM) are published mostly from gasoline burning. To measure emissions of the greenhouse gases this method is used. First, most important fossil fuels pollutants in the Iran's manufacturing industries were identified and then using the coefficients of emission of greenhouse gases resulting from combustion of fossil fuels, the emission rates was calculated. Table (1) shows that the highest consumption of fossil fuels in Iranian manufacturing industries is concerned to natural gas, fuel oil and gasoline respectively. Therefore, the emission coefficients for these three major pollutant fuels obtained from the Iranian Department of Environment that is presented in Table (2). Emission coefficients are collected based on six pollutant caused by combustion of fossil fuels such as Carbon Dioxide gas, Carbon monoxide, Nitrogen Oxides, Sulfur Oxides, Unburned Hydrocarbons and Suspended Particulate Materials (SPM).

Table 1: Consumption of Fossil Fuels in Manufacturing Industries (Percent)

Fuel	Kerosene	Natural Gas	LPG	Diesel	Gasoline	Fuel Oil
Percent	0.20	68.29	.030	7.53	0.71	20.99

Source: Calculated by Authors

Table 2: Emission coefficients of core fossil fuels in industry sector (gr/lit)

Pollutant Fuel	SOx	NOx	CO	CO2	HC	SPM
Natural Gas	6.4*10-3	1.858	6.4*10-3	2062.46	-	0.304
Fuel Oil	55	9.6	0.5	3031.8	0.35	2.75
Diesel	16.8	9.6	0.5	2711.81	0.35	1.8

Source: Iranian Department of Environment, Yazd branch.

4-2- Methodology

This research consists of three stages. In the first stage, manufacturing industries are ranked by traditional comparative advantage variables. In this stage employment, value added and profitability is used to determine industrial advantages. When employment and valued added are considered in absolute terms, Price Cost Margin (PCM) index has been used to calculate industrial profitability. This indicator can be introduced as follows:

$$PCM = \frac{output value - (wages and salaries paid annually + other payments + other value of raw and primary materials)}{output value}$$

In the second stage, in addition to traditional variables, the second category of indicators is used to rank manufacturing industries. In fact, in this stage, the first and second variables are combined together. The first and second stage results will compare together in the third stage.

The data used in this study are collected according to the basic variables. These variables can be divided into two categories based on purpose of this study. The first group includes traditional comparative advantage variables such as employment, value added and profitability. The second group includes amount of air pollution of six greenhouse gases caused by Fossil fuel combustion in manufacturing industries in Iran. Data on employment, value added, profitability and six fuel consumption in the industrial sector include kerosene, natural gas, Liquid Petroleum Gas (LPG), diesel, gasoline and fuel oil Collected from the Statistical Center of Iran for 2005. The statistical population compasses all industrial firms with ten or more employees and manufacturing industries divided based on the International Standard Industrial Classification (ISIC) at 2-digit level.

In this study, numerical taxonomy method is used to rank the manufacturing industries. This method was raised the first time in 1763 by Adenson and was developed in 1950 by a group of mathematicians.

Different Stages of taxonomic analysis is presented as follows:

Step1. Specification of options and variables with consider to the research subject: The first in this step, options that should be ranked are identified and their positions are determined based on specified factors. Therefore, according to the purpose of this study, the study options are included 23 industries (n=23). As mentioned earlier, this study includes two stages. The variables used in the first phase of this study include employment, value added and profit margins. In the second stage, air pollution variables will be added which were introduced earlier.

Step2. To form Matrix of data and then calculate the mean and standard deviation:

After collecting data on the basic variables, in order to assess the level of industrial development, the data matrix is formed as follows. Manufacturing industries make up the rows of this matrix and its columns are composed of variables introduced in this study. This matrix can be demonstrated as follows, where X_{ij}=elements of the data Matrix, $\overline{X}_j$ = Average, S_j= Standard deviation, i = 1, 2, …, n and j = 1, 2, …, m. In the first stage, the number of columns is equal to 3 (m=3) and in the second stage is equal 9 (m=9). In this stage, should be given to the fact that some variables have an inverse relationship with the industry development. For example, air pollution variables have a negative effect on the economic growth and development. Therefore, the values of these variables at this stage should be reversed or otherwise be considered this negative effect.

Table (3): Data Matrix

Industry \ Variable	1	2	…	m
1	X_{11}	X_{12}	…	X_{1m}
2	X_{21}	X_{22}	…	X_{2m}
:	:	:	:	:
n	X_{n1}	X_{n2}	…	X_{nm}
$\overline{X}_j$	$\overline{X}_1$	$\overline{X}_2$	…	$\overline{X}_m$
S_j	S_1	S_2	…	S_m

Step3. Normalization of the data matrix: Different variables may have different scales. For example, the scales of employment and value added are different. Therefore, the heterogeneity of these variables must be eliminated and so should be no scale. To solve this problem, standardization method can be used using formula (1), where Z_{ij} is standardized elements. Then, the largest amount in each column of standardized matrix is chosen as the ideal. That it can be demonstrated as DO_j.

$$Z_{ij} = \frac{X_{ij} - \overline{X}\, j}{S\, j}$$

Table 4: the standardized matrix

Industry \ Variable	1	2	…	m
1	Z11	Z12	…	Z1m
2	Z21	Z22	…	Z2m
:	:	:	:	:
n	Zn1	Zn2	…	Znm
DOj	DO1	DO2	…	DOm

Step4. To determine the combined distance between industries:

In this step, the distance of each industry from the other industries is obtained using equation (2) where D_{ab} is the distance between the industry a from the industry b.

$$D_{ab} = \sqrt{\sum_{j=1}^{m} (Z_{aj} Z_{bj})^2}$$

Where a and b are two industries to indicate two characteristics about these industries:

1. the distance of each industry from itself is zero:

$$D_{aa} = D_{bb} = 0 \qquad (3)$$

2. The distance of industry a from b is equal to distance of industry b from a:

$$D_{ab} = D_{ba} \qquad (4)$$

Thus according to equation (2) composite distance matrix has been established for specific industries as follow:

Table 5: The Composite Distance Matrix

Variable / Industry	1	2	…	n	
1	0	d_{12}	…	d_{1n}	d_{r1}
2	d_{21}	0	…	d_{2n}	d_{r2}
:	:	:	:	:	:
n	d_{n1}	d_{n2}	…	0	d_{rn}
					$\bar{d}_r$
					Sd_r

dr_i : The shortest distance between each row of the Composite matrix

d_r : The average of shortest distances

Sd_r : the standard variation of shortest distances

Step5. To Determine the shortest distances: After calculation of composite distances, Minimum distance between each row of the composite distance matrix is determined and the mean and standard deviation of each of the shortest distances should be specified.

Step6. Homogenization of industries: At this stage, to determine the homogeneity range, high and low limit of this interval are calculated using the following relations. Industries that theirs shortest distances are located at this rang are considered as homogeneous activities. Removing them from the primary standardized matrix, a new matrix will be formed again.

$$O_r\ (\pm) = = \bar{d}_r \pm 2Sd_r \qquad (5)$$

Step7. To determine the pattern for the countries: At this stage, the distance between each of the industry and the ideal value (specified in step 3) is determined using equation (6).

$$Cio = \sqrt{\sum_{j=1}^{m} (Z_{ij} - DO_j)^2}$$

Step8. To calculate the degree of development of industries using the following equation:

$$F_i = \frac{C_{io}}{C_o} \qquad (7)$$

In this equation, C_{io} and C_o are every country's development pattern and the high level of development respectively that are obtained through the following equations:

$$C_0 = \overline{C}_{io} + 2S_{io} \qquad (8)$$

$$\overline{C}_{io} = \frac{\Sigma_{i=1}^{n} C_{io}}{n} \qquad (9)$$

$$S_{io} = \sqrt{\frac{\Sigma_{i=1}^{n} (C_{io} - \overline{C}_{io})^2}{n}} \qquad (10)$$

Step9. To determine the rank of the industries according to their degree of development or advantages (F_i): According to the results of the previous stage the grade of each industry can be determined. As mentioned before industries are ranked according to their degree of development. Whatever, the amount calculated for degree of development is lower therefore the manufacturing activity will be ranked higher and by contrary.

Empirical Results

As mentioned before, the aim of this study is Ranking Iranian production activities based on combination of traditional comparative advantage and environmental indices. Accordingly, this study was conducted in two stages. The first, the manufacturing industries were ranked in terms of traditional comparative advantage indicators without regarding to sustainable development indices. The numerical taxonomy method was used for classification of manufacturing industries. So at this stage manufacturing industries were ranked in terms of variables such as employment, value-added and profitability. The results of this stage showed that manufacture of other non-metallic mineral products, manufacture of basic metals, manufacture of chemicals and chemical products and manufacture of food products and beverages are ranked highest in 2005 respectively. Also, manufacturing industries such as recycling, tanning and dressing of leather; manufacture of luggage, handbags, manufacture of radio and television and communication equipment and apparatus and manufacture of wearing apparel and dressing and dyeing of fur are in the lowest rank.

Then in stage (2), indicators of sustainable development, especially pollutions from carbon dioxide gas, carbon monoxide, nitrogen oxides, sulfur oxides, hydrocarbons and Suspended particulate Materials(SPM) were added into the analysis and industries were ranked again based on traditional comparative advantage indices and indices of air pollution. According to results of this stage, manufacture of chemicals and chemical products, manufacture of basic metals and manufacture of motor vehicles, trailers and semi-trailers are in the highest rank. Also the manufacture of other non-metallic mineral products is located in heterogeneous group and has an inappropriate status. The results of these two stages are presented in table (6).

Comparing the two stages shows that manufacture of other non-metallic mineral products which is ranked first in the stage (1) of this study and in terms of employment, value added and profitability is at the highest grade, but when industries are ranked according to air pollution indices, this industry has the lowest rank. This indicates a lack of comparative advantage of this industry. Also status of manufacture of basic metals that was ranked second, in the first stage, also in the second stage remained unchanged.

Table 6: Ranking the Manufacturing Industries According to Traditional and Air Pollution Indices

Stage2			Stage1			Manufacturing activities
Fi	*Cio*	Rank	*Fi*	*Cio*	Rank	
0.584047	4.642714	9	0.509	3.34	4	Food products and beverages
0.588253	4.676147	11	0.712	4.68	12	Tobacco products
0.560224	4.453339	5	0.672	4.42	8	Textiles
0.646715	5.140881	19	0.783	5.14	20	Wearing apparel and dressing and dyeing of fur
0.706444	5.615673	21	0.855	5.62	22	Tanning and dressing of leather, luggage and handbags
0.625275	4.970444	15	0.757	4.97	16	Wood and products of wood, cork except furniture
0.64097	5.095207	18	0.775	5.09	19	Paper and paper products
0.631771	5.02208	16	0.765	5.02	17	Publishing, printing and reproduction of recorded media
0.564512	4.487428	6	0.539	3.54	5	Coke, refined petroleum products and nuclear fuel
0.383214	3.046248	1	0.383	2.52	3	Chemicals and chemical products
0.603713	4.799048	12	0.730	4.79	13	Rubber and plastics products
Heterogeneous			0.211	1.39	1	Other non-metallic mineral products
0.476881	3.79083	2	0.355	2.33	2	Basic metals
0.567397	4.510359	7	0.686	4.51	9	Fabricated metal products, except machinery
0.541379	4.30354	4	0.654	4.30	7	Machinery and equipment n.e.c.
0.585398	4.653452	10	0.708	4.65	11	Office, accounting and computing machinery
0.574377	4.565844	8	0.695	4.56	10	Electrical machinery and apparatus n.e.c.
0.672648	5.347024	20	0.814	5.35	21	Radio, TV, communication equipment and apparatus
0.607878	4.832155	13	0.736	4.83	14	Medical, precision, optical instruments, watches and clocks
0.537813	4.27519	3	0.649	4.27	6	Motor vehicles, trailers and semi-trailers
0.624359	4.963167	14	0.756	4.96	15	Other transport equipment
0.637642	5.068753	17	0.772	5.07	18	Furniture; manufacturing n.e.c.
0.721933	5.738804	23	0.874	5.74	23	Recycling

Source: Authors Calculations

Conclusions

In the last two decades using traditional indices has spread for determining the comparative advantage of different areas. But in these studies, environmental indicators, especially indicators of air pollution have been ignored. Therefore, identifying industries that have advantages in terms of traditional indicators and also impose less pollution to the environment is of special importance. In this regard, Iranian manufacturing industries in terms of employment, value added and profitability as well as air pollution indicators were ranked. For this purpose manufacturing industries divided based on the International Standard Industrial Classification (ISIC) at 2-digit level and numerical taxonomy method was used to rank them.

Firstly, manufacturing industries were ranked in term of employment, value added and profitability. In this stage amount of profitability was calculated using Profit margins index according to the data in 2005. The results of this stage showed that manufacture of other non-metallic mineral products, manufacture of basic metals, manufacture of chemicals and chemical products are ranked first until three grades respectively.

After that, in the second stage, pollution indices were added to the analysis. For calculation of air pollution caused by combustion of fossil fuels, the emission coefficients data for three major pollutant fuels were used that were obtained from the Iranian Department of Environment.

After adding the pollution indices, the results indicated that manufacture of other non-metallic mineral products industry which is ranked first in the first stage, when industries are ranked according to air pollution indices has the lowest rank and located in heterogeneous group.

To sum up, both theoretical foundations and the results of this study suggest that in addition to the traditional indices of comparative advantage, sustainable development indices should be considered to determine the investment priorities in each industry.

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