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28 December 2009

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Abstract

Steel is fundamental material for many industries that could produced by blast furnace (BF) and direct reduced Iron technology (DRI) .these two technologies differ from each other in term of difference of production cost, energy consumption, investment and environment issues. The purpose of this paper is to investigate comparative advantages of these two technologies by using domestic resource cost (DRC) method. It provides a comparison between the domestic costs to produce a specific good with its value added at international prices, which was done by Mckay (1999), DHEHIBI (2009), Ruiz (2003) and Bonjec (2002). The result suggests that that although both two technologies have its own comparative advantages, the blast furnace method (BF) would be more preferable than direct reduced Iron technology (DRI).

Key Words: Blast Furnace Technology, Direct Reduced Iron Technology, Crude Steel, Domestic Resource Cost, Shadow prices.

JEL classification: D20, F12, F14

1. Introduction:

Steel is a fundamental material for many industries, from automotive to household industries. With an exception of crude oil, no material is as central to economic growth processes and industrial development as steel. The crude steel can produced in different methods according to the different situation. Steelmaking is a process, which needs huge amounts of energy. This is the most important element and the basic difference of various methods of steelmaking. Production

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processes can divide in to two categories: Coal (coke) based processes (Blast Furnace) and Gas based processes (Direct Reduction)**.**

The integrated steelmaking route, based on the blast furnace (BF) or basic oxygen furnace (BOF), uses raw materials including iron ore, coal, limestone, and recycled steel. The Electric arc furnace (EAF) route, based on the EAF, uses primarily recycled steels and/or direct reduced iron (DRI) and electricity.

In addition to energy consumption, these two methods differ from each other in some other aspects such as iron ore, semi-finished products, environmental and investment issues. The steel industry is highly efficient in its use of raw materials with technology available today.
During the last decades, globalization has a prevailing tendency in almost world's economies.
The world economy has become more independent and commercial links between countries become more and more important and intensified.

Importance of economic liberalization especially trade liberalization has increased dramatically due to advantages of liberalization rather than its drawbacks. The effects of liberalization has been increased the attendance of firms issuing competitive condition, so liberalization forced firms to choose between alternative decisions and make the best economically approach for their production.

Discovering comparative advantages of production in different economic sectors, as argued by several authors such as bonjec (2002), Lagos (1999) and Nelson (1995), can improve production method and resource reallocation as well as compensation and capability of exports. This study focuses on Iranian industrial sector with special attendance to crude steel production. The crude steel has the significant role in Iranian industrial sector. It is accounted for great share of GDP.

Since the crude steel production is based on blast furnace (BF) and direct reduced iron (DRI) technologies, these methods are causing difference in the firms cost of production, energy consumption as well as their environment and investment issues. For the first time Blast furnace technology was introduced in Iran by Esfahan Steel co .and then due to lack of its material used in this technology and availability of miracle natural gas resources another technology named direct reduced iron technology was introduced by Mobarakeh Steel co. To investigate the preferably of this two technologies comparative advantages principal is one of the most useful tools for economics to implement their policy.

The overall objective of this study is comparing the advantages of two above-mentioned methods using Domestic Resource Cost (DRC) advocated by Bruno (1963). This study is trying to find that whether DRI method or BF method has its comparative advantage according to DRC analyzing or not? Moreover, it is trying to find more economically method of production in these two firms.

The paper divided into six further sections. The first one is a brief introduction of Iran steel sector. In the second section, we provide a review of domestic resource cost as our methodology. In the third section presents the methodology carefully with all details. In fourth section, introduce briefly the shadow price as a part of our methodology to calculate the DRC. In fifth section we measure the shadow price according to the UNIDO approach which be defined in following. The Results and estimation of DRC and discussions are present in the final section.

2. Iran's Steel Industry

The foundation of the first steel-making company in Iran was laid after signing a contract with the USSR in 1965 to finance and erect a steel plant in Esfahan. The company, called Esfahan Steel Co., was based on coal process and blast furnace (BF). However, after a few years of operation, Esfahan Steel Co. was facing some problems such as shortage of scrap and quality coking coal. These problems as well as the huge availability of natural resources gas, and the required raw materials forced the government to use direct reduction technology (DRI).

Since 1990s, the expansion of steel industry in Iran, the DRI technology has been implementing by Mobarakeh Steel Co. beside Esfahan Steel Co. that is using blast furnace method. This change caused Iran to become one of the biggest countries in the world, which produces steel with DRI technology.

As at the end of 2008, the total crude steel production in Iran was 10 million tones, which make the Iran ranking 20 in the entire world. At the first 6 month of 2009, the total production in Iran was 5.647 million tonnes.

Table 1: Iran's Production, Export and Import of crude steel in thousand tonnes

year	production	Export	Import
2000-2001	6614	817	397
2001-2002	6927	700	469
2002-2003	7477	678	1469
2003-2004	7959	762	1716
2004-2005	8986	1252	2391
2005-2006	9574	968	1925
2006-2007	9928	531	2789
2007-2008	10217	417	4177

Source: IMIDRO

So this increase in total production may be was due to use the both method and the expanding of companies.

3. Review: The domestic resource cost as a measure of comparative advantage

DRC is the measure, in terms of real resources of the opportunity cost of producing or saving product to foreign exchange rate. It provides a comparison between the domestic costs to produce a specific good with its value added at international prices. Thus, it is an ante measure of comparative advantage to evaluate exchange projects and policies. The DRC was first applied by the economic authorities of Israel in the 1950s as an instrument in project appraisal. Used as an investment criterion by Bruno (19631965). It was used frequently since this date by many economists and international institutions to evaluate exchange projects and policies such as: Bonjec (2002) in his article for agricultural and food competitiveness showed that the wheat and sunflower are a high value added processed product.

Then Ruiz (2003) did a study for Autarkic Policy and Efficiency in the Spanish Industrial Sector and showed that the inefficient allocation of productive factors induced by the interventionist economic policy resulted in a significant loss of efficiency for the economy.

In recent study done by Dhehibi and Frija (2009) for Impact of Domestic Resource Costs on the Competitiveness of Tunisian Fresh Fruit showed that Tunisia presents a comparative advantage in the olive oil sector.

Therefore, DRC is primarily an indicator of comparative advantage, as it provides an intersectoral comparison of the relative efficiency of the economy in production across sectors. Since it does not take into account actual trade flows, the DRC can be a good substitute for other indicators when barriers to trade have a significant influence on the configuration of the trade structure. Moreover, examined in conjunction with the goals and incentives supplied by economic policy, the DRC can also be used as an indicator of the impact of restrictions to external trade. It provides an approximation of the effects of trade policy on the efficiency of the allocation of production resources and hence of the influence of trade policy on the productive structure in a country.

In the calculation of DRC, factor prices should reflect real opportunity cost which not always are captured by market prices. Price distortions can originate from imperfections of the markets or state interventions. Both factors are especially important in less developed countries. In this sense it should be noted that the DRC is a broad measure, since it incorporates not only the distortions created by tariff and exchange control policy but also other existing distortions in the economy at a point in time. These include, for instance, distortions created by state commerce, regulations of the financial sector, and restrictions to foreign investment or the effect of labour policy. For this reason, the DRC has been considered the ideal instrument to measure the efficiency loss in less developed countries where the distortions in the economy are the result of a wide range of interventions by the state that go well beyond tariffs.

4. Methodology

The DRC measure the cost of domestic and foreign inputs which used in production of a specific good at world prices. Moreover, DRC measures the actual cost of achieving one unit of foreign exchange due to one unit production of a specific good. What is more, DRC measures the conservation of exchange rate due to production of specific good. This method comparing the net cost of domestic resource which used in production of a specific good relative to the total conserved foreign exchange in contrast with benefit-cost analysis that comparing real total cost respect to the profit.

This criterion comparing the production efficiency in domestic market relative to the world market and suggests that whether the specific good is preferable to be produced in domestic market or be imported. So, DRC could be used as a broad measure of comparative advantages of a good.

The idea behind DRC is to compare the domestic cost of producing a certain good with its value added at international prices. DRC can be expressed as:

$$DRC_J = \frac{DC_J}{NVA_J}$$

Where:

DC_J= domestic cost of production

NVA_J= value added at international prices

Comparing the DRC of different activity provide an inter-sectoral comparison of relative efficiency from which comparative advantage is derived. According to the standard comparative advantage theory, in the absence of any distortions, like tariffs or exchange restrictions, the domestic can differ from international production cost because of technological factors or resource endowment. The DRC can be seen as a measurement of the Ricardian concept of comparative advantage based on technological factors, which would be given by the physical factor intensities. At the same time, factor prices can be seen as the result of the relative scarcity of a country's factor endowments. The more abundant a factor is the lower its relative price will be, and consequently those goods that are produced intensively using this factor will have lower DRC. In this way, the Heckscher-Ohlin contribution to the Ricardian theory would be also integrated in this index. Thus, DRC represents an integrated indicator of the comparative advantage of a country (Schydlowsky, 1984).

More precisely DRC can be measured as:

$$DRC = \frac{opportunity\ cost\ of\ domestic\ resources}{value\ added\ in\ border\ price}$$

The ratio compares the cost of producing a unit of a certain good with the cost of saving a foreign currency unit by means of an import substitution policy, which makes it more appealing in case where foreign exchange is relatively scarce, as in many developing countries. The analytical form of DRC ratio can be represented by the value of non tradable inputs evaluated at their opportunity cost divided by the value of this product evaluated at border/frontier prices.

For a given production process of a commodity "J" the DRC can be mathematically defined by the following equation: (Tiz hoosh taban, 1987)

(1)

$$DRC_J = \frac{D + D_{nt} - I_f}{I - IM}$$

Where:

D_{nt}: shadow cost of non trade able domestic input used in production.

D: shows cost of trade able domestic input used in production.

I_f: secondary income

I: primary income

IM: imported value

In equation (1) numerator shows the cost of all domestic input cost either tradable or non-tradable and the denominator represents the value added at border price.

It's necessary to say that although there is a close relationship between comparative advantage of a good with its export market, but this doesn't mean that when we have comparative advantages of a good we can definitely export it, or vice versa due to existence of other factors that must take into account such as: marketing, policy, trading role and so on.

5. **Shadow Prices Approach as a part of methodology**

In equation (1), shadow price become an important element. Here, Shadow prices are defined as the opportunity cost of input and output consumed or produced by a project (Potts, 2002). This means value that the resources could have generated elsewhere in the economy is lost if the resources is moved to a project. Therefore, shadow prices are calculated to take in to account the true opportunity cost of resources imputed any externalities resolving from a developing program or project.

However in many markets especially in developing countries, financial or market values differ from their real economic values due to distortion originate from imperfection of the markets or state intervention, government protection created by tariff and exchange control policy shadow pricing is then take in to account for these distortions and value resources to approximate their actual value, policies and other externalities (Behrman, 1986). Thus, the estimation of shadow prices is essential for the practical application of the economic analysis of project evaluation. By way of DRC analysis, project evaluation aims to include allocation efficiency in the use of countries resources.

In addition DRC appraisal, shadow prices also reflect the social value of goods; replace the market prices that are used in the private calculation. In a perfectly competitive economy market prices and shadow prices will coincide. Market distortions will cause shadow prices and market prices to differ. This makes DRC analysis be difficult, since shadow prices or social values cannot be directly observed.

There are several standard techniques for measuring shadow prices. Different methodologies are varying according to the basic price that should be moderated and the methodology that should be used to modify the data. Some methods using domestic prices as a basic price to be modified, others are using border prices should be adjusted. Nowadays it is widely believe that according to the importance of trade, border prices are giving better understanding of real opportunities of countries rather than domestic prices. Here we calculate shadow prices by using plausible procedure proposed by United Nation Industrial Development Organization so called UNIDO approach .This approach has tries to modify the actual prices. In developing countries the method of using border prices to determine shadow prices is seems to be suitable due to considering opportunity of trade for a country in international market. The logic is as same as using the altitude for airplane pilot. There for any local distortion will be measure by world standard. So, through this way the effect of domestic price policy will be neutralized the approach for shadow price estimation

The UNIDO approach implemented by using the shadow exchange rate (SER) to convert values of traded commodities from foreign to domestic currency and shadow pricing nontrade able commodity on the usual way to account for distortions in the domestic economy.

This method was introduced by Sen, Marglin, Dasgupta for project evaluation.

6. Measurement of shadow prices

To calculate shadow prices of all inputs that are used to produced output, are divided in to two categories, first tradable inputs and second nontradable inputs, the assumption of perfect elasticity of supply and demand for input was assumed. The CIF price used to represent the price of imported inputs and FOB prices used to represent exported input.

For non-tradable inputs, used the opportunity cost as a shadow price, means maximum revenue that these inputs may obtain if they used in another sector.

To calculate shadow price for wage, the UNIDO approach was suggested. This method calculate shadow price of wage as sum of Salary, pecuniary advantage and non pecuniary advantage at market prices. As well as this, the method for shadow price of capital was calculated by UNIDO, they offer that shadow cost of capital is representing shadow price of capital, there for the shadow cost of capital in specific year is the amount of capital that depreciated multiple the nominal interest rate that this depreciated amount of capital could be achieved.

7. The Result

We use two samples (out of three) of steel companies. to achieve the consumption share for each input, all amount of used input divided by total production of crude steel, then the input consumption share was moderated for one tonne of crude steel production. Total production of crude steel in Mobarakeh steel Co. and Esfahan steel Co. was 4.4 million ton and 1.95 million ton respectively. The value of one tonne imported crude steel was taken as shadow revenue of that.

Table 2 and 5 report the utilized material operation per one-ton crude steel production in both companies; bring the type of material used and produced in 1st column, the amount of each material mention in 2nd and 3rd and 4th column for 2006-2007-and 2008 respectively , finally the unit of those material mention in 5th column. So we see that there are two type of primary factors; tradable and nontradable, which tradable categorized to import inputs and domestic inputs. Also we can recognized that only Esfahan Steel Co obtain the secondary income because of using the Coal (Coke) during the production, and Mobarakeh Steel Co doesn't have any secondary income.

While Table 3 and 6 reports the shadow price according to UNIDO approach for utilized material and revenue in both companies; bring the type material used and produced in 1st column, the shadow price of each material mention in 2nd and 3rd and 4th column for 2006-2007 and 2008 respectively , finally the unit of those material mention in 5th column.

The cost and revenue calculation in both companies are presented in Table 4 and 7. The table provide the information on the type of material used and produced in 1st column, the revenue and cost of each material mention in 2nd and 3rd and 4th column for 2006-2007 and 2008 respectively, finally the unit of those material mention in 5th column.

Table 2-Utilized materials operation per ton crude steel production in Esfahan Steel Co

Types of inputs	Utilized materials operation			Unit
	2006	2007	2008	
Tradable inputs				
1-Importable				
Coal	167	181	160	Kg/Tonne
Coke	32	25	38	Kg/Tonne
2-Domestic				
Coal	476	499	512	Kg/Tonne
Iron ore	1496	1565	1539	Kg/Tonne
lime stone	384	379	382	Kg/Tonne
Coke	131	100	155	Kg/Tonne
Cast iron slab	148	143	301	Kg/Tonne
Manganese	54	48	47	Kg/Tonne
Recycled steel	133	113	71	Kg/Tonne
Pellet	24	34	24	Kg/Tonne
Sponge iron	44	13	0	Kg/Tonne
Non tradable domestic inputs				
Power electricity	384	401	618	KWh/Tonne
Gas	193	173	181	M^2/Tonne
Non fresh water	4.2	5.2	4.9	M^2/Tonne
Labor	6.7	6.5	6	Labor per hour/Tonne
Depreciation	-	-	-	$/Tonne
Primary income	1	1	1	Tonne
Secondary income				
Ammonium sulfate	4.5	5.5	4.4	Kg/Tonne
Tar	12	18	16	Kg/Tonne
Coke	12.8	57.7	45.6	Kg/Tonne
Slag	596	290	482	Kg/Tonne
Others secondary income	-	-	-	$/Tonne

Table 3- Shadow price of utilized materials for crude steel production in Esfahan Steel Co

Type of materials	Shadow prices			Unit
	2006	2007	2008	
Tradable inputs				
1-Importable :				
Coal	0.152	0.172	0.172	USD/Kg
Coke	0.311	0.199	0.353	USD/Kg
2-Domestic:				
Coal	0.152	0.172	0.172	USD/KG
Iron ore	0.027	0.031	0.04	USD/KG
Limestone	0.009	0.01	0.011	USD/KG
Coke	0.311	0.199	0.353	USD/KG
Cast iron slab	0.177	0.347	0.536	USD/KG
Manganese	0.058	0.088	0.086	USD/KG
Recycled steel	0.128	0.424	0.308	USD/KG
Pellet	0.082	0.056	0.112	USD/KG
Sponge iron	0.286	0.422	0.172	USD/KG
No tradable domestic inputs				
Power electricity	0.039	0.039	0.039	KWH/$
Gas	0.021	0.0261	0.026	M^2/Tonne
Non fresh water	0.076	0.0762	0.094	M^2/Tonne
Labor	6.436	8.2818	8.32	Labor Per hour/$
Depreciation	24.128	15.7133	18.02	$/Tonne
Primary income	393.347	422.4984	530.395	$/Tonne
Secondary income				
Ammonium sulfate	0.059	0.0699	0.079	USD/KG
Tar	0.19	0.1808	0.182	USD/KG
Coke	0.243	0.1621	0.252	USD/KG
Slag	0.007	0.0074	0.007	USD/KG
Others secondary income	0.787	0.939	2.053	$/Tonne

Table 4- Revenue and cost calculation for each crude steel tonne in Esfahan Steel Co

Type of materials	Costs and revenues			Unit
	2006	2007	2008	

Tradable inputs				
1-Importable				
Coal	25.301	31.062	27.591	$/Tonne
Coke	9.943597	4.98	13.419	$/Tonne
Total	**35.253**	**36.041**	**41.011**	**$/Tonne**
2-Domestic				
Coal	72.14	85.634	88.292	$/Tonne
Iron ore	40.314	48.549	60.923	$/Tonne
Lime stone	3.489	3.8	4.229	$/Tonne
Coke	40.706	19.919	54.737	$/Tonne
Cast iron slab	26.233	49.588	161.378	$/Tonne
Manganese	3.158	4.231	4.065	$/Tonne
Recycled steel	17.017	47.896	21.877	$/Tonne
Pellet	1.962	1.918	2.695	$/Tonne
Sponge iron	12.597	5.482	0	$/Tonne
Total	**217.620**	**267.016**	**398.197**	**$/Tonne**
Non tradable domestic inputs				
Power electricity	15.08084	15.748	24.271	$/Tonne
Gas	4.031753	4.517	4.726	$/Tonne
Non fresh water	0.320242	0.396	0.461	$/Tonne
Labor	43.12102	53.832	49.922	$/Tonne
Depreciation	24.12753	15.713	18.02	$/Tonne
Total	**86.681**	**90.208**	**97.399**	**$/Tonne**
Primary income	393.347	422.498	530.395	$/Tonne
Secondary income				
Ammonium sulfate	0.267	0.385	0.35	$/Tonne
Tar	2.275	3.254	2.906	$/Tonne
Coke	3.115	9.353	11.483	$/Tonne
Slag	4.046	2.151	3.524	$/Tonne
Others secondary income	0.786	0.939	2.053	$/Tonne
Total	**10.490**	**16.082**	**20.316**	**$/Tonne**

The results for Mobarakeh Steel Co are reported in Tables 5, 6 and 7. So we can see that the findings are different as compared to Esfahan Steel Co.

Table 5- Utilized materials operation for each tonne crude steel in Mobarakeh Steel Co

Types of inputs	Utilized materials operation			Unit
	2006	2007	2008	
Tradable inputs				
1-Importable				
Electrode	2.32	2.09	2.37	Kg/Tonne
Refractory materials	10.95	9.39	8.84	Kg/Tonne
Ferromanganese	6.68	6.57	5.5	Kg/Tonne
Ferro niobium	0.18	0.03	0.65	Kg/Tonne
Ferrovanadium	0.003	0.004	0.65	Kg/Tonne
Thermocouple	0.0055	0.0045	0.006	Piece/Tonne
2-Domestic inputs				
Sponge iron	583	564	580	Kg/Tonne
Iron ore	998	1024	1026	Kg/Tonne
Limestone	129.7	125.1	56	Kg/Tonne
Recycled steel	176	195	187	Kg/Tonne
Dolomite	24	27	29	Kg/Tonne
Aluminum	2.32	2.38	1.31	Kg/Tonne
Non tradable domestic inputs				
Hydraulic oil & grease	0.056	0.0065	0.07	Kg/Tonne
Caloric hydro acid	0.059	0.0064	0.07	Kg/Tonne
Protector oil	0.049	0.061	0.07	Kg/Tonne
Calcium hydrate	0.063	0.068	0.05	Kg/Tonne
Metal globe	0.063	0.048	0.078	Kg/Tonne
Semi active catalyst reforming	0.035	0.016	0.078	Kg/Tonne
Active catalyst reforming	0.0028	0.0039	0.001	Kg/Tonne
Power electricity	641	647	1030	KWh/Tonne
Gas	387	339	374	M^3/Tonne
Non fresh water	4.66	4.97	4.84	M^3/Tonne
Labor	5.1	6.2	5.6	Labor per hour/Tonne
Depreciation	-	-	-	$/Tonne
Primary income	1	1	1	Tonne
Secondary income	0	0	0	$/Tonne

Table 6- Shadow price of utilized materials for crude steel production in Mobarakeh Steel Co

Types of inputs	Shadow prices			Unit
	2006	2007	2008	
Tradable inputs				
1- Importable				
Electrode	5.045	5.463	5.327	$/Kg
Refractory materials	15.626	16.033	16.712	$/Kg
Ferromanganese	3.122	3.413	3.628	$/Kg
Ferro niobium	3.914	4.141	4.284	$/Kg
Ferrovanadium	22.338	23.226	24.356	$/Kg
Thermocouple	6.022	6.419	6.847	$/piece
2-Domestic				
Sponge iron	0.07	0.073	0.076	$/Kg
Iron ore	0.027	0.031	0.04	$/Kg
Limestone	0.01	0.011	0.011	$/Kg
Recycled steel	0.128	0.424	0.308	$/Kg
Dolomite	0.082	0.09	0.103	$/Kg
Aluminum	3.564	3.727	3.665	$/Kg
Non tradable domestic inputs				
Hydraulic oil & grease	2.287	2.354	2.475	$/Kg
Caloric hydro acid	0.286	0.298	0.312	$/Kg
Protector oil	2.22	2.47	2.512	$/Kg
Calcium hydrate	0.161	0.193	0.212	$/Kg
Metal globe	1.617	1.75	1.802	$/Kg
Semi active catalyst reforming	14.61	15.111	15.618	$/Kg
Active catalyst reforming	14.61	15.111	15.618	$/Kg
Power electricity	0.039	0.039	0.039	$/KWH
Gas	0.021	0.026	0.026	M^3/Tonne
Non fresh water	0.076	0.076	0.094	M^3/Tonne
Labor	6.436	8.282	8.32	$/Labor Per hour
Depreciation	36.039	29.855	43.43	$/Tonne
Primary income	393.347	422.498	530.395	$/Tonne
Secondary income	0	0	0	$/Tonne

Table 7- Revenue and cost calculation of each crude steel tonne in Mobarakeh Steel Co

Types of inputs	Revenue and cost			Unit
	2006	2007	2008	
Tradable inputs				
1-Importable				
Electrode	11.704	11.417	12.625	$/Tonne
Refractory materials	171.101	159.208	147.733	$/Tonne
Ferromanganese	21.417	22.423	19.955	$/Tonne
Ferro niobium	0.705	0.017	2.784	$/Tonne
Ferrovanadium	0.067	0.105	15.831	$/Tonne
Thermocouple	0.331	0.029	0.041	$/Tonne
Total	**205.325**	**193.197**	**198.97**	**$/Tonne**
2-Domestic inputs				
Sponge iron	40.799	41.296	43.8	$/Tonne
Iron ore	26.894	31.766	40.616	$/Tonne
Limestone	1.341	1.333	0.62	$/Tonne
Recycled steel	22.519	82.652	57.62	$/Tonne
Dolomite	1.978	2.428	2.975	$/Tonne
Aluminum	7.948	8.869	4.801	$/Tonne
Total	**101.479**	**168.344**	**150.431**	**$/Tonne**
Non tradable domestic inputs				
Hydraulic oil & grease	0.128	0.153	0.173	$/Tonne
Caloric hydro acid	0.017	0.019	0.022	$/Tonne
Protector oil	0.109	0.151	0.176	$/Tonne
Calcium hydrate	0.01	0.013	0.015	$/Tonne
Metal globe	0.073	0.084	0.09	$/Tonne
Semi active catalyst reforming	0.511	0.242	1.218	$/Tonne
Active catalyst reforming	0.041	0.059	0.016	$/Tonne
Power electricity	25.174	25.41	40.451	$/Tonne
Gas	8.084	8.852	9.766	$/Tonne
Non fresh water	0.355	0.379	0.455	$/Tonne
Labor	32.823	51.347	46.594	$/Tonne
Depreciation	36.039	29.855	43.43	$/Tonne
Total	**103.365**	**116.564**	**142.406**	**$/Tonne**

Primary income	**393.347**	**422.49 8**	**530.395**	**$/Tonne**
Secondary income	0	0	0	$/Tonne

From the figure in Table 4, we can calculate the following DRC for different years:

$$\text{Esfahan Steel Co. 2006, DRC} = \frac{217.620 + 86.681 - 10.490}{393.347 - 35.253} = 0.820$$

$$\text{Esfahan Steel Co. 2007, DRC} = \frac{267.016 + 90.208 - 16.082}{422.498 - 36.041} = 0.882$$

$$\text{Esfahan Steel Co. 2008, DRC} = \frac{398.197 + 97.399 - 20.316}{530.395 - 41.011} = 0.971$$

Then, we use the same formula and the figure in Table 7, apply it to Mobarakeh Steel Co, and the results are as follows:

$$\text{Mobarakeh Steel Co. 2006, DRC} = \frac{101.497 + 103.365 - 0}{393.347 - 205.325} = 1.089$$

$$\text{Mobarakeh Steel Co. 2007, DRC} = \frac{168.344 + 116.564 - 0}{422.498 - 193.197} = 1.242$$

$$\text{Mobarakeh Steel Co. 2008, DRC} = \frac{150.431 + 142.406 - 0}{530.395 - 198.970} = 0.883$$

According to the above calculation, we find that the Esfahan steel Co has comparative advantage in all three years, but Mobarakeh Steel Co only has a advantage comparative in 2008.

Conclusion:

Domestic resource cost is an measurement for comparative advantage, but it is static not dynamic, means that DRC can measure the comparative advantage at a point of time, for this reason we can see that the DRC's result , showed different values specially in Mobarakeh steel Co. during study periods.

So we can conclude that the best economically method is Blast Furnace rather than Direct Reduction iron to produce crude steel in Iran.

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