Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 8 (2): 364-368, 2008
ISSN 1812-5654

Prediction of Iron and Steel Consumption of Iran Using Panel Data

Mansour Zarra Nezhad and Ebrahim Anvari
Department of Economics, Faculty of Economics and Social Sciences,
Shahid Chamran University, Ahvaz, Iran

Abstract: Considering the different usages of iron and steel in industrial activities and their efficient role in economic development, the prediction of the amount of iron and steel consumption has always been one of the concerns of experts and planners. In the present study for prediction of the amount of iron and steel consumption from 2004 to 2014 the method used by Croupton and generalized by Robert is adopted. The studied iron and steel are mainly used in the construction of buildings, dikes, bridges, tunnels, watering networks and draining. The consumption of iron and steel depend on the mean of consumed steel in each of given production units (MPC), relative portion of each unit production from the total amount of raw production and the rate of GDP. Based on prediction, the consumption of iron and steel will increase drastically till 2011 and the amount of consumption development will be fixed from 2004 to 2008.

Key words: Iron and steel consumption, panel data

INTRODUCTION

Steel consists of iron, carbon and other alloys. Changing any of these elements produces composites with different characteristics. Although the production of steel dates back to 3000 years ago, new methods of steel production were adopted in nineteenth century. The advancement of technology caused the increase of steel production and its applications. Nowadays, the engineering of steel industry has made a revolution in steel usages and has caused much investment. As a result of these changes the efficiency of steel products production has increased and the consumption of energy and materials has decreased drastically.

In regards to the already invested money in steel industry, Iran can have a considerable progress in the export of steel to world markets, especially local ones. Iran in the global steel industry holds the 21st place now. However, with the use of its potentials Iran is able to ascend one or two places each year.

Concerning the importance of iron industry in the country development, the study and prediction of iron and steel consumption for planning and qualitative and quantitative advancement of foundation of steel production are very important. The present study deals with the prediction of the amount of steel and iron consumption in Iran from 2004 to 2015.

The global changes in the iron and steel supply shows an increasing trend of production since 1970 to 2005. Except 1990-95 in which the rate of production decreased 0.5%, the rate of development of supply and demand has reached to 4.4% in 2000-2003 from 1.6% in 1970s (IISI, 1998).

The global production of steel in 2003 was 1054.4 million tons. China, Japan, the United States, the union of common wealth countries and European Union are the most important producers of steel. Australia and New Zealand with 0.8% of the total production of steel in the world are the smallest producers of steel (IISI, 1998).

The statistic information of steel produced in 1990-2003 shows a fluctuation in the production of this kind of steel products. Based on this information the highest rate of development in the steel production has been in 2000-2003 and lowest rate has been in 1990-1995. The steel production of Iran has increased to 3.8% in 2005 compare to 2004. Iran has produced 4.9 million tons in 2005. In the same year Iran among other Asian countries held the third place in terms of steel production. China with 24% and India with 16% rate development held the first and second places.

Many studies have been done in different countries to predict the amount of iron and steel consumption. In some of them the quantity of consumed iron and steel has been predicted functionally. In some other studies (Crompton, 2000) the amount of consumption is predicted using the measurement of economic activities like internal raw production. Robert (1990) predicted the USA steel consumption in 1984-2010 using the amount of technology use in industry. In this study he investigated the steel consumption in each of major industries separately. Chen *et al.* (1991) in a research named the Forecasting steel demand in China, using Vector

Corresponding Author: Mansour Zarra Nezhad, Department of Economics, Faculty of Economics and Social Sciences, Shahid Chamran University, Ahvaz, Iran Tel: 0098 611 3331216 Fax: 0098 611 3337411

Autoregression model, predicted the amount of steel consumption in China. In this model with the use of the correlation of past variables in a System of dynamic linear equations, the coefficient of variables and their future quantities have been predicted. Based on this model the total amount of steel consumption depends on the rate of steel consumption in each machinery production industry, transportation and foundation industries. Labson *et al.* (1995) in a study utilizing a dynamic non-spatial partial equilibrium model predicted the rate of exchanged iron and steel in the world, the rate of raw steel consumption of Japan, China and North America. For investigation of the rate of raw steel consumption and the prediction of its future usages a linear model has been adopted. In this model variety in consumption has been defined with an index of steel price, productions of industries and a chronological trend as a criterion for measurement of technological changes. Crompton (2000) in a study titled the trend of steel consumption in Japan predicted the rate of steel consumption in Japan. In his study the steel consumption has been divided to steel consumption in final industries.

The remaining of this study is organized into three sections. In the second section the research method and the Crompton (2000) model which is adopted in the present study, is dealt with in detail. The third section discusses the findings. The fourth section is devoted to the concluding remarks.

MATERIALS AND METHODS

This study utilizes Crompton's model (2000) which is based on Robert's model (1987) and is used by Robert (1990, 1996) himself. In Crompton's model (1999) the total steel consumption is defined as the consumption of n final user industry. In each of these n industries the rate of consumption is determined by three components. In Crompton (2000) and Robert (1990) model the three components are shown as the three following formulas:

$$S_t = \sum_{i=1}^{n} \left(\frac{S_{it}}{P_{it}} \times \frac{P_{it}}{GDP_t} \times GDP_t\right) \quad (1)$$

$$S_t = \sum_{i=1}^{n} (MCP_{it} \times PCI_{it} \times GDP_t) \quad (2)$$

$$S_t = IU_t \times GDP_t \quad (3)$$

In above-mentioned formulas S_t refers to total amount of steel consumed by all of the industries in t time. S_{it} refers to the total amount of steel consumed by each industry in t time. Pit refers to the total value of i industry times t time. IU_t refers to the average steel consumed by a given industry in *t* time. And finally, MCP_{it} is the average steel consumed in each producing company in i industry which is calculated as follows:

$$MCP_{it} = \frac{S_{it}}{P_{it}} \quad (4)$$

PCI_{it} shows the income producing compound for i industry and the relative ratio of production of i industry subtracted from total GDP. PCI_{it} is calculated as follows:

$$PCI_{it} = \frac{P_{it}}{GDP_t} \quad (5)$$

The result of multiplying PCI_{it}, MCP_{it} and GDP_{it} in a given time or period for i industry equals the total amount of steel consumed in that industry. The result of adding consumed steel in each of final using companies shows the total amount of consumed steel. In order to calculate the total rate of consumed steel, the prediction of the rate of consumed steel in each given company is utilized.

The formula is not suitable for countries which are dependent on international steel exchanges because if the mentioned definition of PCI_{it} is used, exported goods (which do not change with per capita income changes) are included and imported goods (which are affected by per capita income) are not included. Therefore, a suitable formula based on open economy should be defined. For this purpose, Crompton (2000) and Robert (1990) model for open economy is defined and presented as follows. In this model MCP_{it} is defined as:

$$MCP_{it} = \frac{S_{it}}{PD_{it} + PX_{it}} \quad (6)$$

In the above formula, PD_{it} shows the internal produced goods for internal use in t time and PX_{it} shows the produced goods for export.

In the open-economy model, PCI_{it} refers to pure effect of business. The relative ratio of production of i industry from the total GDP and the compound income from the total production includes internal and imported production.

$$PCI_{it} = \frac{PD_{it} + PI_{it}}{GDP_t} \quad (7)$$

The goods of i industry are divided into internal produced goods and imported goods.

The amount of used steel for exportable goods must be added to the rate of consumed steel in the country and the rate of consumed imported steel in production process must be deduced from total consumption.

If PNX_{it} is defined as $PNX_{it} = PX_{it}\text{-}Pi_{it}$, it shows the pure exported goods of i industry during t time; based on this definition the amount of consumed steel in exportable and importable goods is calculated through following formula:

$$MCP_{it} \times PNX_{it}$$

Based on what mentioned, the first formula is summarized as:

$$S_t = \sum_{i=1}^{n} (MCP_{it} \times PCI_{it} \times GDP_t + MCP_{it} \times PNX_{it}) \tag{8}$$

The above formula is used for the prediction of steel consumption in open economy.

In this part, the equations that are used for prediction of MCP_{it}, PCI_{it} and PNX_{it} are explained.

For investigation of changes of parts of consumed steel, the changes of economic variables are utilized. Based on this, the most important and efficient economic variables in steel consumption are used.

Changes of MCP_{it} reflect two effects. The first one is the effect of new technological facilities such as improvements in production and production designs. The second one is the effect of substitution factors (as a result of changes in relative prices of factors or improvement of production factors).

Due to lack of certainty in technological changes and the problem of prediction of substitution factors, the prediction of MCP_{it} is very difficult. In prediction model of MCP_{it}, measurement of the rate of technological changes, the effect of technological changes on consumption rate, calculating changes of relative prices of factors and the effect of changes of rates of factors is not completely clear. Therefore, it is assumed that changes of MCP_{it} based on a period can be predicted as follows:

$$MCP_{it} = \alpha_i + \beta_i T_t + \frac{Inv}{GDP} \tag{9}$$

In above-mentioned formula α is constant term and β is the rate of MCP_{it} in a period in i industry.

Formula 9 can be explained as different structural forms. The best usable option is the linear-logarithmic equation.

PCI_{it} measures the user's preferences for owning produced goods in a specific industry compared to other goods and services. User's preferences (PCI_{it}) affected by changes of per capita income, can be comprehended in two ways. The first one is the changes in compounds of internal expenses which can be investigated using long term growth of per capita income. This long term growth leads to gradual growth of a specific industry (such as services) and gradual decrease of other parts (e.g., agriculture).The second one can be investigated as fluctuations in per capita income. This method with transient effect on patterns of consumption expenses, affects PCI_{it} of all parts. In order to show these changes, the PCI_{it} has to be modeled using consumption function. In this method it is assumed that the user's demand for a specific product of a industry depends on (a) current per capita income and (b) changes of per capita income at different levels.

Consumption function, the product of ith industry is assumed as follows:

$$\frac{PD_{it} + PI_{it}}{POP_t} = \alpha_i + \beta_i Y_t + \gamma.devY_t \tag{10}$$

In the above formula, POP refers to population, Y_t refers to per capita income and devY refers to the deviation of current per capita income from the trend of per capita income (as follows):

$$devY = Y_t - trendY_t \tag{11}$$

In this formula the trend of per capita income (trend Y_t) is calculated through simple linear trend (Y_t) using sample data and predicted rates.

In order to obtain the prediction equation (PCI_{it}) the above equation is divided in per capita income as shown in the following formula:

$$\frac{\frac{PD_{it} + PI_{it}}{POP_t}}{Y_t} = \frac{PD_{it} + PI_{it}}{GDP_t} = PCI_{it} = \alpha_i\left(\frac{1}{Y_t}\right) + \beta_i + \gamma_i\left(\frac{devY_t}{Y_t}\right) \tag{12}$$

In the above-mentioned formula,

$$\frac{1}{Y_t}$$

refers to reversed per capita income and it shows the effect of continuous increase of income on the compound of user's demand. β_i is the stable coefficient and

$$\frac{devY_t}{Y_t}$$

refers to deviation of per capita income from long-term trend of raw production in any period or the effect of commercial periods on PCI_{it}.

The last term of equation 8 that must be predicted is pure exports. Many factors such as the amount of current income of exchanging countries, relative prices of production and the efficiency of technology affects international exchanges. The investigation of all affecting factors for prediction of the rate of iron and steel consumption is difficult. For this reason and also the simplicity, the prediction of the pure rate of exports is done based on chronological trend of this variable.

Required data and information for prediction of the rate of iron and steel consumption was gathered from specialists' estimates for 2000-2004. The gathered data is related to major parts of iron and steel consumption. These parts include: dam construction, building construction, bridge and tunnel construction and construction of watering and draining networks. The investigated period here is from 2000 to 20004. In order to make efficient estimates, an interpolation technique due to Diz (1970) is used to obtain quarterly data from the corresponding annual data using MATLAB.7 software.

For the purpose of prediction, first required variables including MCPit, PCIit and PNXit are estimated using Eviews5 software and then each of variables is predicted and the total consumption is predicted.

RESULTS AND DISCUSSION

Based on the related formula, for prediction of MCP_{it}, first, MCP_{it} of each part (i.e., dam construction, building construction, bridge and tunnel construction and construction of watering and draining networks) should be predicted. After that, with adding obtained rates, the total MCP_{it} is calculated.

The results of estimates of equations of MCP_{it} for each major part of iron and steel consumption is are shown in Table 1. As the table shows for some parts, equations are estimated linear-logarithmically or logarithmic-logarithmically. The results of estimate of Eq. 9 for MPC_{it} are shown in Table 1. Results of estimate shows that the variables at 95% level of probability are significant and F shows the significance of total model.

$$\frac{\text{Inv}}{\text{GDP}}$$

refers to the ratio of investment to internal raw production. This variable is used in some of the equations in order to change estimates to characters (Crompton, 2000).

For getting character estimates, the AR with suitable stops is used too. The coefficient of trend for building construction, dike construction and draining is positive. The negative coefficient of trend for bridge and tunnel construction shows a decrease of steel consumption in each production part and transportation services. In other words, the use of technology for transportation services (construction of bridges and tunnels) has been more than other parts. To put it in a different way, in the prediction period, MCP_{it} of these parts has increased and it shows the increase in steel consumption in each of the product unit of these parts.. In Fig. 1 and 2, the prediction of the rates of MPC_{it} for watering, draining and dike construction is shown.

Table 1: The results of estimate of MPC_{it}

Sector	α_i	B_i	$\frac{\text{Inv}}{\text{GDP}}$	R^2	F	AR
Building	144.12	12.75	-	0.97	217.4	1
Dikes	-334.70	333.04	-	0.99	37913.0	2
Bridge and tunnels	455.00	-100.40	304.08	0.97	183.0	1
Watering networks	-13.20	0.45	-0.45	0.99	196.1	1

$$MCP_{it} = \alpha_i + \beta_i T_t + \frac{\text{Inv}}{\text{GDP}}$$

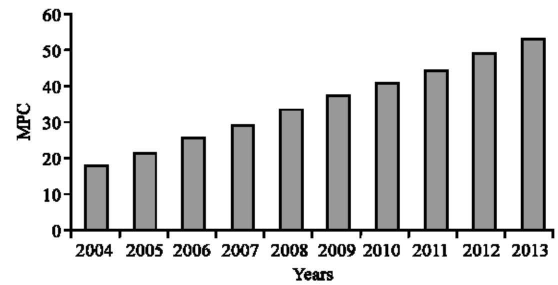

Fig. 1: The prediction of the rates of MPC_{it} for watering, draining (million ton-million dollar)

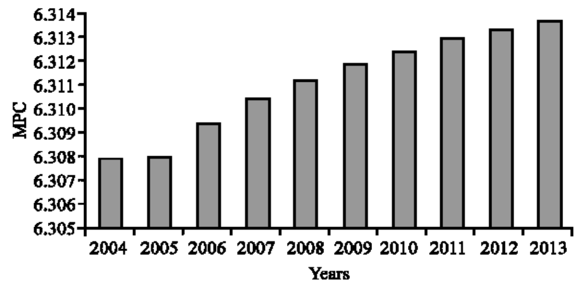

Fig. 2: The prediction of the rates of MPC_{it} for dike construction (million ton-million dollar)

Results of estimate of formula 12 for PCI_{it} are shown in Table 2. The results show that variables are significant at 95 level of probability and F shows the significance of the model as a whole.

Based on Table 2, the coefficient of variable

$$\frac{\text{dev}\,Y_t}{Y_t}$$

for all related economic parts of the study is positive. It shows that the changes in demands of services and products in each of these parts are in accordance with changes of commercial periods. In other words, the average level of per capita income is in accordance with the changes of per capita income relative to the changes of internal raw production. Reversed coefficient of per capita income in all of the parts is significant in regards to statistical analysis. This factor shows the effect of relative size of these parts from long-term changes of per capita income and changes of commercial periods in the

Table 2: Results of estimate PCI_{it}

Sector	α_i	1/Y	DevY/Y	R^2	F	trend	AR
Building	19.80	-1.20	0.63	0.94	62	0.48	1
Diks	4.08	0.24	0.13	0.94	61	0.09	1
Bridge and tunnels	21.00	1.30	0.68	0.93	57	0.52	1
Watering networks	42.00	2.50	1.30	0.94	62	1.02	1

$$\frac{\frac{PD_{it}+PI_{it}}{POP_t}}{Y_t} = \frac{PD_{it}+PI_{it}}{GDP_t} = PCI_{it} = \alpha_i\left(\frac{1}{Y_t}\right)+\beta_i+\gamma_i\left(\frac{devY_t}{Y_t}\right)$$

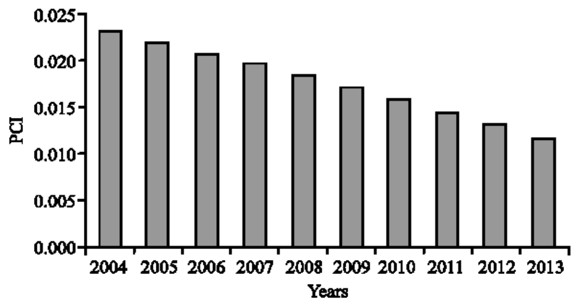

Fig. 3: The prediction of the rates of PCI of dikes (million dollar-million dollar)

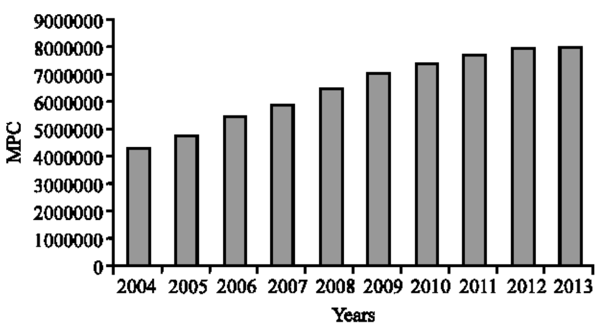

Fig. 4: Predicted rate of iron and steel consumption (million ton-million dollar)

investigated period of this study. The reversed negative coefficient of per capita income of building part shows an increase in the size of this part as a result of an increase in the total per capita income. In Fig. 3 show the prediction of the rates of PCI related to the construction of dikes.

For prediction of the amount of iron and steel consumption in the given period, we need to predict the amount of pure exports of each of the given parts. Because the data of the rate of exports and the required imports of each part was not available, in this study the rate of total pure exports and services were used as the substitute factor.

The prediction of the total rate of iron and steel of the country has been done for an open economy utilizing model 8. Results show that the total rate of iron and steel consumption has been four-million four-hundred thousand tons in 2005 and it is predicted that this rate will increase to 8200000 tons in 2014.

Based on Fig. 4, it is predicted that the rate of iron and steel consumption will increase drastically in the given period and from 2011 to 2014 the trend of increase will decrease.

CONCLUSION

In the present study the Crompton (2000), Robert (1990) model was utilized for prediction of the rate of iron and steel in 2005-2014. Four major parts of iron and steel consumption in the country including building construction, dike construction, tunnel and bridge construction and construction of watering and draining networks have been investigated for estimation and prediction. In this model the prediction is done based on changes of iron and steel consumption of each part according to the changes in three criteria including the average consumed steel in each producing unit of the given part (MCP), relative share of production of each part from the total internal raw production (PCI) and the rate of growth of internal raw production. After 2005, the total rate of consumption increases considerably. One of the reasons is the negative effect of the pure commercial criterion on the economy of the country if the present trend continues. The results show stability in the iron and steel consumption of the country fro 2011 to 2014.

REFERENCES

Chen, D., K.W. Clements, E.J. Roberts and E.J. Weber, 1991. Forcasting steel demand in China. Resour. Policy, 17 (3): 196-210.

Crompton, P.L., 1999. Forecasting steel demand in South East Asia. Resour. Policy, 25: 111-123.

Crompton, P.L., 2000. Future trends in Japanese steel consumption. Resour. Policy, 26: 103-114.

Diz, A.C., 1970. Money and Prices in Argentina 1935-1965 in Varieties of Monetary Experiences, David Meiselman (Ed.). University of Chicago Press, Chicago, pp: 69-162.

IISI (International Iron and Steel Institute), 1998. Statistical Yearbook 1998. IISI, Belgium.

Labson, S., P. Gooday and A. Manson, 1995. China Steel. ABARE Res. Rep. 94.4, Canberra.

Robert, M.C., 1987. The consumption of metal and international trade. Mater. Soc., 11 (3): 391-406.

Robert, M.C., 1990. Predicting metal consumption: The case of US steel. Resour. Policy, 16 (1): 56-73.

Roberts, M.C., 1996. Metal use and the world economy. Resour. Policy, 22 (3): 183-196.