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Aggregate Econometric Models For
Projection of Demand on Steel

By

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1 - Assumptions of the Models.

2 - Specifications of the Model.

3 - Alternative Models:
   Model I
   Model II
   Model III and IV.

4 - Evaluation of the Models and Modifications of Results:
   1. Change in Structure.
   2. New additions.

5 - Problems, Comments, and recommendations.
Aggregate Econometric Models for Projection of Demand on Steel

In this study steel consumption was related to several national parameters in several econometric models. Assumptions, tests and results of the models, as used in forecasting, combined with an evaluation of each model, and also modifications of results given by the model to take into account a number of other factors are treated respectively in the following sections.

(1) Assumptions of the Models:

The following assumptions were assumed by all models:

1. The supply of steel will be able to expand to meet any expansions in demand. This assumption was confirmed by experts working in the steel industry and related industries. The basic raw material is available in large quantities and in good quality in the newly discovered sources of the oasis.

The oasis reserves are estimated to be of total 230 million tons containing more than 50% of Iron distribution as follows:

<table>
<thead>
<tr>
<th>District</th>
<th>Million tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasser District</td>
<td>25</td>
</tr>
<tr>
<td>Gabal Choraby District</td>
<td>50</td>
</tr>
<tr>
<td>Al-Narah District</td>
<td>35</td>
</tr>
<tr>
<td>Al-Gadida District</td>
<td>120</td>
</tr>
</tbody>
</table>

(1) Thanks go to Dr. F. Farag, Expert at INP, and Dr. F. Taha, a geologist, for their comments and contributions which improved this study a great deal.

There exists other sources of Iron Ore of lesser importance, either in quality or quantity, in Aswan and the eastern desert. This means that local supply will cover the needs of local production for many years to come. Therefore, the conditions of supply are not investigated in this study.

2 - We are concerned only with estimation and prediction of direct steel in the sense that machinery, equipment and castings are not included.

3 - We are not concerned at this stage with projecting the consumption of different kinds of steel. Our efforts are concentrated on projecting total steel consumption. This assumption will be released in part II, and III of the study where different types of steel will be considered separately.

4 - The demands for steel are assumed to be price inelastic. This assumption is reasonable as far as no close substitutes exist for many types of the steel products. Also it is more so since the producer of many of these steel products enjoys a monopoly position with government protection in relation to imports.

Should substitutes become available in the local market to major steel using industries, comparative prices of steel and these substitutes would be very important in affecting steel consumption. Until then, prices are not used as some of the factors affecting steel consumption.

5 - We assume that steel industry will grow within a framework of balanced growth of all sectors. This is equivalent to saying that the requirements of steel products needed for the planned growth of other sectors will be met mainly via local production of steel, while imports will be confined only to a few odd types of steel products.
(II) **Specifications of the Models:**

Perhaps, the most precise method for predicting the levels of consumption for an intermediate industry, such as steel, would be to study its interrelationships with other major industries or sectors, in the economy, since such study of existing interindustrial relations would give an estimate of consumption of steel products on the single industry level of the using industries. Beside giving more accurate estimates, it would have made it easier to study the expected technological changes in steel using industries and trace their effect on the pattern of steel consumption. However, this would require the availability of a recent, detailed, and highly accurate input-output tables. In view of the absence of such tables like in most developing countries, we had to use other methods for making such predictions. The econometric technique of regression analysis is tried. As the series of data available contained few observation some of which were unstable due to war conditions, it was decided to keep the techniques used as simple as technically relevant.

**Definitions of Variables:**

**SCG** Steel consumption as estimated by regression of steel consumption on gross domestic product components, using twelve observations, 1959/60 – 1970/71.

**SCI** Steel consumption as estimated by regression of steel consumption on investment excluding observation of all years following the 1967 war because of their erratic nature.

**SCInd** Steel consumption as estimated by regression of steel consumption on production of major sectors using twelve observations.

**SCIn** Steel consumption as estimated by regression of steel consumption on production of industry sector.
SCC  Steel consumption as estimated by regression of steel consumption on production of construction sector.

I  Investment including inventory change deflated by wholesale price index.

GC  Government consumption deflated by wholesale price index.

IP  Production of industry, using fixed prices of 64/65.

CF  Production of constructions sector using fixed prices of 64/65.

SP  Production of Electricity sector using fixed prices of 64/65.

TP  Production in Transportation and communication sector using fixed prices of 64/65.

VA  Value Added.

Inv.  Investment.

Emp.  Employment.

(III) Alternative Models:

Model I:
Our first model is a modified version of the model suggested by the international organization UNIDO for predicting steel demand in developing countries.

UNIDO suggested the following relationship:

\[ S = a_1 (O - I) + a_2 I \]

where  
O  is gross domestic product.

I  is gross capital formation.

and  
S  is total steel consumption.
This relationship was used in the sense that steel consumption is composed of a certain proportion of consumption expenditure plus a certain proportion of investment expenditure.

Here in Model 1 we used the components of gross domestic product as exogenous variables affecting steel consumption. When a linear and a nonlinear regression functions were applied to the regression of steel consumption on investments including changes in inventory, private consumption, and government consumption, the coefficient of government consumption was found to be negative and statistically insignificant. Also the coefficient of private consumption was not statistically significant at the .05 level of significance.

By removing government consumption from the set of explanatory variables, the regression relationship between steel consumption on the one hand, investments and private consumption on the other hand improved. Results of estimated equations along with $R^2$, $SE$, and $F$ are shown in table I in the appendix.

Using the estimated equations, steel consumptions for the years 1973-1982 are shown in table II. The values used for the exogenous variables, investment and private consumption are the results of hypothetical predictions based on the aggregate figures of the ten year plan.

However, the development process by nature involves a sizable change in the structure of investment towards a bigger portion allocated to investment in heavy and basic industries. Also it involves major change in consumption patterns towards more expenditures on durable goods. Both of these considerations led us to believe that the past relationship underestimates the expected steel consumption when used for predicting future steel consumption. This point will be picked up in the next section in a trial to count for these expected changes in the relation.
On the other hand, examining the time series of steel consumption used in estimating the regression equations, we notice that steel consumption during the last five years, that is years following the 1967 war, was erratic. Therefore, it was expected that the regression might improve if we use only the first 7 observations which showed a steady trend of growth. Model II used these seven observations in estimating the relationship.

**Model II:**

Using seven observations, and applying the regression analysis to the relationship between steel consumption and the levels of investment and private consumption, the total relationship was highly significant ($R^2 = .95, F = 39.38$) for the linear case, and ($R^2 = .98$ and $F = 45.71$) for the nonlinear case), but none of the individual regression coefficients was found to be statistically significant.

When removing private consumption, the relationships between steel consumption and investment was found to be highly significant. Results are reported in tables I and II. Prediction errors was found to be even smaller than those of model I. The better fit of this model probably compensated for other factors, like smaller number of observations, and the time lag between estimation period and prediction period, which would normally cause prediction errors to go up.

**Models III and IV:**

In models III and IV we try to establish the relationship between steel consumption, and the level of production in major sectors.

At first all twelve observations were used on all variables. First a regression of steel consumption on production in the sectors of industry, constructions, Electricity and Transportation & communication was tested. In addition to the negative coefficient of industry, all coefficients were statistically insignificant. This is probably true because of
high multicollinearity among explanatory variables, which led to high estimation errors. Reducing the number of explanatory variables down to 3 did not bring about much change to the results. Even when regress-
ing steel consumption on the levels of production of industry and con-
structions, being the major sectors using steel products, individual coefficients were still insignificant.

Only when steel consumption was regressed on industry alone, that the results were significant.

But using a single sector to predict steel consumption is not very plausible especially that construction sector is a major user of steel products. From here we move in two different direction trying to improve our estimation process.

(1) First direction is to regress consumption of reinforced steel on the level of production in construction sector and regress the rest of steel consumption on the level of production in industry and add predictions up for a total prediction of steel consumption. Results of Model III which includes two equations in each case are shown in Table 1 and Table II. Though the level of significance of results was much lower than the first two models, all statistics were significant at the 5% level except for the correlation coefficient in the linear relationships between steel and productions in industry sector. Prediction made using this model were also lower than those given by other models.

(2) Second direction is to remove the last five observations which showed an erratic behavior and use the rest for estimating the relationship between steel consumption and the levels of production in industry and construction sectors. This gave a very good fit as shown in Table 1. Also due to this good fit, prediction errors were smaller than in the case of model III where 12 observations were used.
(IV) Evaluation of the Models and Modifications of Results:

In evaluation of different models used in this study, we would normally prefer models with higher significance from both statistical and economics point of view. When comparing the first two models, which related steel consumption to components of gross domestic product, model II gave higher statistical significance than model I. Yet, from economics point of view, we are inclined to prefer model I since it includes two important explanatory variables that is gross investment and gross private consumption while model II includes only one explanatory variable which is gross investment. The major effect of gross private consumption on steel consumption needs not to be emphasized.

However, predictions made on the basis of model I need to be modified to take into account several factors some of which were mentioned earlier. To have practical applicability, any model should be flexible enough to accept modifications for factors not embodied in the statistical analysis. Modifications are expected to rise from two sources:

1 - Change in structure:

As mentioned before, future investments are expected to change in structure towards more steel using investments. Also private consumption is expected to move towards the increase of the proportion spent on durable goods which requires more steel than other components of private consumption.

2 - New additions:

Steel consumption is also expected to go up more than the study of historical data would reveal due to expected demand by the new rural electrification, petroleum pipe lines, natural gas pipe lines maritime expansions and any potential demand emerging as a result of industrial complementary projects between Egypt and Libya (like extending rail roads, production of rail Wagons, and meeting construction steel needs in Libya) the extent of these addition could not be evaluated due to the fact that definite plans for most of them were not accessible to us.
With more weight given to the first factor of change in structure we feel that both the investment and private consumption coefficients need to be increased by 15-20% to compensate for the expected change in structure. Applying the figure of 15% increase in coefficients, the new estimates are shown in Table III. When comparing models III and IV, both of which use relations between steel consumption and levels of production in industry and construction sectors, the superiority of model IV is clear on both statistical and economic grounds. Model IV has the highest statistical significance of all four models. It gives a very good fit between steel consumption and levels of production in industry and construction sectors ($R^2 = .98$).

On a final comparison between Model I and Model IV, we observe large discrepancies between predictions given by the two models. This raises doubts concerning the possibility of double counting in the process of aggregating total production of industry which would result in an exaggerated total industry production and therefore causes estimates of Model IV to be much higher. On the other hand Model I is not subject to this problem of aggregation since it deals with final demands. In addition these discrepancies indicate the necessity of checking on the consistency between figures of investments on the one hand and industrial production on the other hand used for making predictions in the two models.

Preliminary checking made on change in industrial production in relation to investments in industry for the coming ten years (hypothetical figures) as compared to those calculated for the past ten years did not contradict with the expectations (actually it indicates a decrease in the proportion of change in production/investment; which might indicate the move towards more capital intensive industries). In other words it did not lead to discovering any inconsistencies.

(1) We owe this comment to Dr. M. Makram-Allah professor of social and cultural planning at INP.
In view of the above mentioned, our final choice goes to Model I, and we can consider the predictions given by the linear and the nonlinear functions as lower and upper bounds of predictions as shown in table III.

Place of Steel Industry in the National Economy:

To give an account of the position of steel industry in the National economy we give a quick and an approximate account of the share of steel industry in investments, employment, and in the income making process. Simple ratios were computed from value added, investments, employment and steel production statistics over the past five years. They gave the following average ratios: (1)

\[
\begin{align*}
VA &= 22.9 \text{ Pounds per ton} \\
Inv. &= 232.2 \text{ Pounds per ton} \\
Emp. &= .0438 \text{ Workers per ton}.
\end{align*}
\]

The ratios were first computed for 9 years. When the last five years showed to be considerably stable their average ratios were used as a base. Expected values for value added, employment and investments corresponding to predictions of model I after modifications, were computed and shown in table IV.

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(1) Data for these ratios are taken from the Master thesis of Mr. M. Abdel-Latif, "The use of accounting data for the measurement of production efficiency in the sector of metallurgical industry", Cairo University 1973.
Problems, Comments, and Recommendations:

In a final evaluation of our procedures we list here some of the major problems which were encountered. Some of these problems are inherent in the procedure used and some others could be overcome and we offer recommendations for that:

1 - Our models are of aggregate nature which causes them to be subject to the shortcomings of aggregation. With aggregate models, it is difficult to evaluate the effects of technological changes that might take place in the users industries and therefore lead to the substitution of one type of steel for another and the consequence of that on the quantity used. Also it makes it difficult to evaluate the effects of developing substitutes for steel products, and their price changes relative to steel products' prices which may lead to shifts in the product usage. This is particularly true knowing that prices were excluded from our analysis. The amount of the resulted difficulties depends mainly on the extent of technological changes which are expected to take place. In steel industry, we are told that there are such changes that started to take place for some products, (like the development of plastic pipes) but their collective effect is not a major one.

2 - We tend to believe that the historical data for steel consumption which were used as a basis for this study did not reflect the real needs of the economy to steel products. They simply indicated the availability and not the needs. As long as local production could not expand to meet the growing demand, and since imports of steel were constrained in one way or the other we feel that the actual consumption in past years is well below the real needs. In addition to this, actual production of some of the smaller steel factories were not reported and therefore were not included in the data. This element should be in mind when interpreting projections based on past data.
3 - Most of the historical data were collected for statistical or bookkeeping and not for planning purposes. Using these data in planning will not give fully satisfactory results.

4 - We did not use any variables at their current price values. Had we done so change in prices would be playing a role without being considered explicitly in the models. Such an additional variable, prices, might well distort the nature of the relationship between steel consumption and explanatory variables. However, to remove such a variable by deflating value data would require the availability of suitable and consistent price indices. Unfortunately they are mostly lacking for the length of time considered in the study. Instead, we used wholesale price index to deflate components of gross domestic products and used values at fixed prices for sectorial production using 1964/65 as a base year. This last was supplied by the yearly follow-up of the plan reports. In both cases we could tell the existence of some inconsistencies. The used deflators were less than satisfactory. The availability of suitable indices would be most helpful in revealing the true relationships.

5 - We feel that if statistical and planning institutions could work more closely together, data would be collected with planning purposes in mind and therefore planners would find data in the form, quantity and quality needed for their sectors. Also planners could learn to adapt their tools to be workable with less than optimal data if they have to due to some inherent difficulties that statistical units cannot avoid.

6 - If the state of war affects only the military consumption of steel, it would have been appropriate to leave out the military consumption and evaluate the nonmilitary part.
Unfortunately this is not the case, as we read in the papers investments will be cut down to meet war-time expenses. How would that affect the ten year plan whose aggregate targets were used as a basis of our predictions this could not be evaluated.

7 - Our prediction should be reviewed in the light of the details of the ten year plan when they are authorized and publicized, to compare the sectorial targets with the hypothesized allocations which we made on the basis of the aggregates of the plan. If sizable deviations resulted, their effects on predictions should be evaluated.
### Table 1
Estimated Equations and Their Statistics

<table>
<thead>
<tr>
<th>Estimated Equation</th>
<th>$r^2$</th>
<th>SE</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a: $SCG = 7609.48 \times 2.13.66$ $1 \times 15.2%$ RW $(237.99)$ $(57.05)$</td>
<td>0.841</td>
<td>191338800</td>
<td>23.9</td>
</tr>
<tr>
<td>b: $\log SCG = \log 605.957 + .564 \log I + .4312 \log RW$ $(.186)$ $(.177)$</td>
<td>0.872</td>
<td>.00713</td>
<td>30.0</td>
</tr>
<tr>
<td><strong>Model II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a: $SCI = 73901.06 + 2287.391$ $1$ $(155.55)$</td>
<td>0.95</td>
<td>1080951</td>
<td>63.5</td>
</tr>
<tr>
<td>b: $\log SCI = \log 4354.349 + .018 \log I$ $(.1096)$</td>
<td>0.93</td>
<td>.00557</td>
<td>65.6</td>
</tr>
<tr>
<td><strong>Model III</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a: $SCI_a = 35839.43 + 135.353$ IP $(44.169)$</td>
<td>0.46</td>
<td>3036019900</td>
<td>9.38</td>
</tr>
<tr>
<td>and $SCG = 14315.46 + 621.1593$ CP $(126.1396)$</td>
<td>0.71</td>
<td>426216300</td>
<td>33.04</td>
</tr>
<tr>
<td>b: $\log SCI_a = \log 91.1564 + 1.0375 \log IP$ and $\log SCI = \log 27075.322 + .4326 \log CP$</td>
<td>0.51</td>
<td>.04414</td>
<td>15.64</td>
</tr>
<tr>
<td><strong>Model IV</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a: $SCI_{ind} = -103033.59 + 293.5755$ IP + 1129.14 CP $(63.706)$ $(341.799)$</td>
<td>0.93</td>
<td>398236000</td>
<td>97.73</td>
</tr>
<tr>
<td>b: $\log SCI_{ind} = \log 177.01 + .3060 \log IP + .4078 \log CP$ $(.10581)$ $(.10479)$</td>
<td>0.98</td>
<td>.00145</td>
<td>128.17</td>
</tr>
<tr>
<td>Tons</td>
<td>Model</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a)</td>
<td>782751</td>
<td>846560</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>805050</td>
<td>874030</td>
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<td>II</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(a)</td>
<td>667389</td>
<td>734333</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>696540</td>
<td>726521</td>
</tr>
<tr>
<td></td>
<td>III</td>
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<td></td>
</tr>
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<td>(a)</td>
<td>726444</td>
<td>766959</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>747153</td>
<td>783619</td>
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<td>(a)</td>
<td>1009496</td>
<td>1090102</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>1043990</td>
<td>1130122</td>
</tr>
</tbody>
</table>

Table II

Forecasts of Steel Consumption for the Years
1973 - 1982
Table III

Modified Forecasts of Steel Consumption

<table>
<thead>
<tr>
<th>Model</th>
<th>73</th>
<th>74</th>
<th>75</th>
<th>76</th>
<th>77</th>
<th>78</th>
<th>79</th>
<th>80</th>
<th>81</th>
<th>82</th>
</tr>
</thead>
<tbody>
<tr>
<td>I(a)</td>
<td>899000</td>
<td>973000</td>
<td>1127000</td>
<td>1249000</td>
<td>1355000</td>
<td>1455000</td>
<td>1570000</td>
<td>1687000</td>
<td>1803000</td>
<td>1922000</td>
</tr>
<tr>
<td>I(b)</td>
<td>925000</td>
<td>1005000</td>
<td>1164000</td>
<td>1289000</td>
<td>1398000</td>
<td>1503000</td>
<td>1622000</td>
<td>1744000</td>
<td>1866000</td>
<td>1992000</td>
</tr>
</tbody>
</table>
Table IV

**Expected Value Added, Accumulated Investments, and Employment.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Value Added in L.E. Million</th>
<th>Investments in L.E. Million</th>
<th>Number of Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model I (a)</td>
<td>Model I (a)</td>
<td>Model I (a)</td>
</tr>
<tr>
<td>1973</td>
<td>20.590</td>
<td>21.201</td>
<td>205.773</td>
</tr>
<tr>
<td>1974</td>
<td>22.278</td>
<td>23.018</td>
<td>225.294</td>
</tr>
<tr>
<td>1975</td>
<td>25.798</td>
<td>26.659</td>
<td>261.587</td>
</tr>
<tr>
<td>1976</td>
<td>28.609</td>
<td>29.511</td>
<td>290.084</td>
</tr>
<tr>
<td>1977</td>
<td>31.058</td>
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<td>314.917</td>
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<td>1978</td>
<td>33.326</td>
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<td>1979</td>
<td>35.946</td>
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<td>1980</td>
<td>33.627</td>
<td>39.945</td>
<td>391.664</td>
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<tr>
<td>1981</td>
<td>41.287</td>
<td>42.926</td>
<td>418.640</td>
</tr>
<tr>
<td>1982</td>
<td>44.009</td>
<td>45.606</td>
<td>446.242</td>
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