Chapter 8
Summary and Conclusion

8.1 Summary

The primary objective of this study was to build a model of the "long-run elasticity of demand for labour-hours at the Danish Steelworks Ltd". The model was constrained to represent the firm as isolated from the rest of the steelworks industry, and hence, price changes of outputs and factor-inputs was assumed to only affecting the company isolated. The choice of model to explain the firm's production possibilities was the Cobb-Douglas production function. The production function parameters was estimated using the "econometric" approach.

The rationale behind the Cobb-Douglas function was the belief that factor income shares have stayed constant over the observed period. Therefore, there is no substitution between factor inputs in the case of the Danish Steel Works, Ltd.

There was from the beginning of the study a strong desire to build the model simple, with abstractions from real world complexity. The model is nonetheless believed to have captured the "essentials".

The model explained the individuals' and the firm's choices in terms of optimising behaviour. This yielded the desirable result that mathematics was suitable to explain the behaviour.

In chapter 1 the labour-hours supply by individuals was regarded as a "two-part" decision: firstly, whether or not to participate in the labour market, and secondly, given a decision to participate, how many hours to supply. The market supply curve was then derived in the absence of trade unions.
Later the existence of trade unions was considered in the supply and pricing of labour-hours and how the wage is determined by bilateral bargaining.

Chapter 2 discussed the estimation of the firm's labour-hours demand with respect to the input and output market, and the firm's production function. First labour-hours was considered as a variable factor of production later this assumption was relaxed and the presence of fixed labour costs was taken into account.
It was found that with a substantial component of fixed labour cost the firm is looking at hiring labour as an investment. It was stated moreover, that such costs are both quantitatively and qualitatively important and are one of the explanations for slow adjustment of labour-hours.

The last section of chapter 2 discussed the Cobb-Douglas function properties and assumptions, and their implications on the model. The most interesting discussion was the fact that there are no profit maximising point of operation for competitive input and output market and increasing returns to scale. This was in conformity with the estimations in chapter 7.

The most interesting issues that chapter 3 dealt with was (i) the critics of homogeneity in production functions, (ii) labour hours as quasi-fixed, (iii) whether is C_{Lh} equal to MRP_{Lh} in presence of trade unions.
(i) The critics on homogeneous production functions were that homogeneity is not appropriate for some aspects of the production theory, and therefore, makes it important to test for homogeneity before making such restrictions.
This study however, was working with a small sample size of 16 yearly data and the scale of operation was considered highly correlated with time and therefore made it difficult to distinguish between technical progress and returns to scale. Therefore, the achievements of estimating a non-homogeneous production function was *not of great value*.

(ii) The discussion of labour-hours as quasi-fixed was not found important for this study, since the focus was on long run behaviour. The important aspect of NWLC was that it count for a significant part of the labour cost (C_{Lh}) and therefore, was not ignored in this study.

(iii) C_{Lh} was assumed equal to MRP_{Lh} in presence of trade unions. Because (assume the two parties' bargaining strength are equal) any labour-hours paid below the productivity will be met by a demand from the trade union and *vice versa* by the firm.

Chapter 4 described the Danish steelworks industry (history, production, organisation, markets, and profits). This built the foundation for a discussion (in section 4.3) about the important assumptions regarding the firm and the model.
Section 4.3 concluded that: (i) the firm could be considered as a price taker in the output market; (ii) the output could be considered as homogeneous; and (iii) that factor income shares for labour-hours has stayed constant over time.

Chapter 5 stated that due to the desire of model simplicity only the most important model variables would be included. The chapter discussed interpretation and measurement issues and on whether labour-hours, capital, and energy was homogeneous. However, one very interesting finding was the inclusion of "human-capital" into the term "technical progress". The justification was that human capital is interpreted as an efficiency parameter and composes some of the same elements as technical progress.
Another interesting finding was that the estimate of technical progress would be biased when leaving out primary factor-inputs and/or intermediates (that are not a fixed proportion of output) from the production function. However, the bias was found not to influence the estimated labour demand elasticity.
Last, it was stated that the firm acts as a price taker in the factor-input market.

In chapter 6, the data were examined and the production function parameters was estimated. The model was then tested for the two interesting economic hypotheses: (i) limitations on access to capital, and (ii) constant returns to scale. Last, the OLS-model assumption tests were conducted.

The introduction of technical progress was made on ground of the estimated parameters' conformity with the economic theory and strong expectations of increasing returns to scale. A high overall model fit (R^2) was not expected, because of short run adjustments of labour hours and capital.

Introduction of energy consumption into the model improved the overall fit but suggested that the effect of technical progress was insignificant. For that reason, energy was excluded from the model.

The elasticity of scale (ε) was estimated to 1.55, which is suggesting the firm to operate on increasing returns to scale. This was in conformity with the economic theory and expectations.
The estimated output elasticity of labour-hours (α) and capital (β) was estimated to 0.92 and 0.625 respectively. In addition, technical progress (biased) has contributed to the output growth by 176 percent in the observed period.

The hypothesis testing of limited access to capital (H_0: β=0) was rejected, suggesting that although the firm may have limited access to capital: capital investments in the observed period have had a significant effect on the output growth. Hence, the model was not restricted with β=0.

Regarding the interesting hypothesis testing of constant returns to scale (H_0: ε=1), the test did not reject the hypothesis. This result suggested a possibility of constant returns to scale. Nevertheless, restricting the model was to deny what is most obvious.

The period before 1981 could not be explained by the production function. Hence, the sample size was down to 16 yearly data.

The underlying OLS-assumption tests showed a problem of multicollinearity due to high par-wise correlation among regressors and auxiliary regressions R^2 in excess of the overall model R^2. However, the multicollinearity was not found serious to the estimated parameters due to the *VIF* did not exceed 10. Moreover, it was assumed that if the multicollinearity problem were tried corrected: the remedy would be worse than the disease.

The elasticity of labour-hours demand (γ) was estimated and evaluated in chapter 7. The estimated value was –0.12. The price elasticity for constant output (τ) was derived from the production function parameters and the price elasticity for variable output (η) was

derived by examining the output elasticity of labour-hours demand ($e_{Lh,q}$) and the elasticity of output with respect to cost of labour hours ($e_{q,C_{Lh}}$). The estimated values for (τ) and (η) was–0.405 and 0.29 respectively.
The rather surprising result that the scale effect have a positive effect on the employment was due to the firm's increasing returns to scale and the assumptions of perfect input and output markets. The result was not in agreement with the firm's actual behaviour, which was interpreted as short run, because of production output quotas. However, the result was in conformity with the firm's long run planning.

Because the firm operates under a quota system the estimated output scale elasticity (η) was interpreted as the output change the firm wills response with in order to keep its income share.

8.2. Conclusion

In conclusion, it should be emphasised that in this study an attempt was made to explain the long run elasticity of demand for labour-hours. In order to use the model developed in this study for prediction purpose for example, it is necessary to know the expected output quotas and the expected market price of steel. This will require knowledge of the steel market, which interested parties, should have.

If the model developed in this study can be taken to be a valid representation of the structure of the labour-hours employment of the firm with respect to long run. The information contained in this model is of considerable use to parties attempting to develop a forecast of the firm's responsiveness to any demand for increasing wages or NWLC (Non-Wage Labour Costs).

The author recommends that further improvements of the model are desirable. Studies regarding "expectations" of output prices and decomposing labour-hours into the three divisions (steel division, plate division, and long product division) will improve the models overall fit. Because it will enable the model to capture more of the medium-run fluctuations.

A final remark should be that further research to develop a model, which takes into account the critics of homogeneous production function, is advisable. This may be attempted by using cross-country data from other North-European quarto-mills.