Arbeidsnotater

STATISTISK SENTRALBYRÅ

WORKING PAPERS FROM THE CENTRAL BUREAU OF STATISTICS OF NORWAY

IO 67/1 Oslo, 7 June 1967

ECONOMIES OF SCALE AND THE FORM OF THE PRODUCTION FUNCTION

Progress Report No 6, prepared by

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Contents

The study has been planned by Professor Zvi Griliches of the University of Chicago in collaboration with Vidar Ringstad of the University of Oslo. It has been carried out in the Central Bureau of Statistics on the basis of the 1963 Census of Establishment data. The author takes full responsibility for the formulation of this preliminary report.

It is a rather difficult matter to communicate and discuss all the numberous questions and problems connected to such a project in an efficient and satisfactory way over the distance Oslo-Chicago. It has thus not been possible to discuss in details the results and the interpretation of these, so even if it is mainly Professor Griliches plans and proposals that are carried out in this project, those interpretations and conclusions presented in the present paper are mine, and I am solely responsible.

The purpose of this paper is firstly to have a "digested" presentation of the results obtained so far, to have a foundation for discussion **during the visit to Oslo of Professor Griliches** **later** on this summer. And secondly to orientate people interested in investigations like the present one of what we have done, to get comments and possibly proposals for further work with the study.

The project started approximately one year ago, and since then five progress reports have been presented. The first and the last one were typed while the three others were mimeographed. These three last-mentioned contain the results of some test runs carried out on a limited number of samples. These results were the main foundation for what we did when planning the set of complete runs presented in this paper. These complete runs were carried out in April and May this year, so the time I have had to write this paper has been very scarce.

Most of the program-work has been carried out by the System-department in the CBS. And I want especially to thank mr. R. Hansen for the work he carried out during the preliminary runs, and mr. S. Gåsemyr and mr. I. Thomsen for their work during the preliminary runs and their work in connection with the set of complete runs presented in this paper. We have had helpful discussions with many people in the CBS in connection with this project, and we are especially indebted to mr. A. Amundsen, and mr. O. Carlson. Finally I want to thank miss Anne Rollem who has typed the present paper and most of the previous progress reports.

June 1967

Vidar Ringstad

Section 1

Introduction

The most central purpose of the present study is, in few words, simply to analyse factors determining productivity, and analyse scale - and substitution properties of production in Norwegian Manufacturing Industries by means of the CBS' Census of Manufacturing Establishments 1963. With these few words roughly all is presented, both possibilities and limitations. The possibilities lie primarely in the fact that the 63-Census provides us with relatively detailed informations about a vast number of indiviual production units. An analysis related to the present one with such a comprehensive set of data, has never been carried out in this country previously and hardly in any other country either. Concerning the limitations as to the questions we want to get answered, it has firstly to be pointed out that the data available are purely of cross-section type. Secondly the reliability of our conclusions depends very much on the quality of the data. Thirdly there may also be limitations in the analytical methods applied, simply because our knowledge of Norwegian Manufacturing is limited, i.e. with better knowledge more appropriate methods could have been applied. However, what we have done and what we further are going to do may be the best way, both in getting more knowledge about Norwegian Manufacturing, to find out what the data are suited to tell us and to learn what we cannot expect to get answered. This implies that we successively can improve our tools and apply a more appropriate technique. But this unplies also that we hardly can use the usual statistical terminology when interpreting our results. But the "significanse" of our parameters (i.e. the size of the corresponding estimates, and their size compared with the estimated standarddeviations on these estimates) will still tell us something about the production structure.

All the way we have applied the simple least square method, and our estimates are all obtained from single-equation regressions. More refined methods ought perhaps to be used in some cases, but the need of this is also one thing that may show up in our single-equation simple least-square estimates.

This paper is in its general onlays a bit different from similiar econometric studies since relatively much space is given to the discussion of informations available and the construction of regression variables. But before these matters are discussed the theoretical frame of the study is sketched,

to have a foundation by means of which the variable discussion can be better understood. In section 3 those informations available to, and applied in, the present study are presented, and in section 4 the construction and discussion of regression variables is presented. In the following section (no. 5) the data and the grouping of the units into "industries" is presented. And then, when the theoretical frame, the informations available, the data and the regression variables have been presented, we in section 6 give an outline of the relations applied in the runs. Section 7 contains discussion of possible sources of systematic errors in our estimates and is to my opinion the most inportant one. But I also consider it to be the most "difficult". In section 8 follows a "digested" presentation of the results together with discussion of these and attempts of interpretations. The validity of these interpretations depends, however, very much of the validity of the discussion in section 7. If that one is doubtfull, my interpretations of the results are correspondingly little worth.

A list of references is also included. These are works which I personally have benefitted from in my work, and thus do not make a complete list of what is worth reading in connection to the problems discussed in the present study. On the other hand does the list also contain references of no or little general interest (e.g. the references to the progress reports of this study). They are included for completness sake, taking the main purpose of this paper into consideration.

Section 2

The Theoretical Frame of the Study.

The most common method in analysing such questions that we are interested in getting answered. (o.e. productivity, and substitution and scale properties of production of different industries) is the production function approach. It has many weaknesses and much is left in perfectioning it, but in spite of this it is obviously the easiest to handle and the one that in general can tell us most about these questions.

We have not much a priori informations that can tell us which form of the production function that might be the best approximation to the real production structure i.e. the most appropriate sepsification of scale and substitution properties. We have very few investigations of Norwegian Manufacturing that could tell us anything about this. In addition it is reasonable to believe that the same production function may not be equally well suited for all industries.

So we have done what is usual to do in such a situation in econometric research. We have applied the classical type of production function, namely the Cobb-Douglas-type. In addition we have also applied the now well-known CES-function (see list of references at the end of this paper.) Both types of production functions have been applied in a number of econometric studies and both seem to fit the data very well in most cases.

The properties of the first one are in few words firstly that it has constant degree of returns to scale (constant elasticity of scale). Secondly it has an elasticity of substitution equal to one for any factor-combination (See e.g. Thonstad [2])

If we have two factors of production, labour and capital say, it can be written as:

(2.1) $$V = A_0 L^{\alpha_1} K^{\alpha_2}$$ or

$$(2.2) \qquad \frac{V}{L} = A_0 L^h \left(\frac{K}{L}\right)^{\alpha_2}$$

where V = production, L = labour, K = capital and α_1 α_2 and A_0 parameters. In (2.2) we have $h = \alpha_1+\alpha_2-1$.

The elasticity of scale is then given by:

$$(2.3) \qquad \varepsilon = \alpha_1+\alpha_2 = h+1$$

and the exponent of L in (2.2) is negative, zero or positive for decreasing, constant or increasing returns to scale respectively. But the degree of returns to scale is as pointed out constant. If it does vary in a given sample of production units, it is for example a function of scale, we have, by applying (2.1) (or (2.2)) made an spesification error. In certain cases it is, however, reasonable to believe that we by applying (2.1) or (2.2) on a sample of units where the elasticity of scale not necessary is a constant obtain a fairly good estimate of the <u>level</u> of the elasticity of scale of the sample. This is to some degree confirmed by Ringstad [24].

In addition to the variables specified as "true" production factors (labour and capital, sometimes also raw materials) there may also be a lot of other factors that are important for level of productivity (measured as $\frac{V}{L}$, production per unit labour input). If we have defined the level of the elasticity of scale as the sum of the exponents of the "true" production factors (in the Cobb-Douglas case) we may consider other factors determining productivity as neutral i.e. they affect productivity but not the degree of returns to scale. Or in other words, if we have m "neutral" factors $Z_1 \ldots Z_n$ the "neutral" efficiency for production unit no. i is given by the multiplicative "constant" $A_i = A_i(Z_{1i} \ldots Z_{ni})$. If the production function is log-linear in all factors, both "true" and "neutral" it can be written as:

$$(2.4) \qquad \left(\frac{V}{L}\right)_i = A Z_{1i}^{\beta_1} Z_{2i}^{\beta_2} \cdots Z_{ni}^{\beta_n} L_i^h \left(\frac{K}{L}\right)_i^{\alpha_2}$$

The different "neutral" factors will be specified in a later section, when the variableconstruction is discussed. It must, however, be added in this connection that some of the "neutral" variables are such as to tell us something about the effect of the composition of the labour-and capital-input measures we have applied, i.e. if we have given the components of these two inputs too high or too low weights in the labour-and capital-input concepts. The investigation of this is mainly carried out by applying variables where components of labour and capital are set in relation to total labour and total capital respectively. The introduction of such ratio-variables implies, however, that the production function no longer is truely homogeneous in the two factors, labour and capital i.e. it has no longer a true constant degree of returns to scale (constant elasticity of scale). Consequently, if the components of labour and capital are wrongly weighted will (2.3) only be an approximation to the true scale elasticity, even if the Cobb-Douglas production function is a correct specification of the production structure.

When applying (2.4) with only capital and labour as "true" production factors, we apply value added on the left side (value added/labour input). This implies that raw materials is a fixed coefficient production factor, i.e. there is no substitution possibilities between raw materials and any one of the two other production factors. This may in most cases sound very reasonable. We are, however, in general also interested in the results we get when treating raw materials in the same way as labour and capital. Consequently we apply the gross-production function

$$(2.5) \qquad \frac{Y}{L} = A_1 L^{(1-\alpha_1'-\alpha_2'-\alpha_3')} \left(\frac{K}{L}\right)^{\alpha_2'} \left(\frac{M}{L}\right)^{\alpha_3'}$$

where Y is gross production and M is input of raw materials, and where A_1 may be a function of "neutral" factors of production.

In all cases when a Cobb-Douglas production function is applied it is implicitly on explicitly assumed that the production units have no kind of economic behaviour. When this assumption is fullfilled are the factors of production truely exogeneous and we can apply (2.2), (2.4) and (2.5) without having simultaneous equations biases in our estimates (or the very worst - complete loss of identification of the structural parameters in the production function). The effects of this assumption when it is wrong will be discussed in a later section.

The second main property of the Cobb-Douglas production function is as pointed out above that it has an elasticity of substitution of one. Quite recently a more general type of production function (concerning the substitution properties of production) has been introduced. This is the CES-function (Constant Elasticity of Substitution). A lot of econometric studies have been carried out applying this production function, both as it was first presented by Arrow, Chenery, Minhas and Solow |1| and in more or less revised fashons. (See list of selected references at the end of this paper).

The CES production function can be written as:

$$(2.6) \qquad V = \gamma(\delta L^{-\rho}+(1-\delta)K^{-\rho})^{-\frac{\mu}{\rho}}$$

or

$$(2.7) \qquad \frac{V}{L} = \gamma L^{\mu-1}(\delta+(1-\delta)(\frac{K}{L})^{-\rho})^{-\frac{\mu}{\rho}}$$

where V, L and K are as previously, value added, labour and capital, respectively. γ is the efficiency parameter, δ the distribution parateter, ρ the substitution parameter and μ the scale parameter. It is easily confirmed that the elasticity of substitution is:

$$(2.8) \qquad \sigma = \frac{1}{1+\rho}$$

and that the elasticity of scale simply is:

$$(2.9) \qquad \varepsilon = \mu$$

The CES function is as we see substantially more flexible than the Cobb-Douglas production function concerning the substitution properties. While the Cobb-Douglas production function presupposes an elasticity of substitution of one regardless how the data looks, the CES function "leaves to the data" to tell how the substitution conditions between labour and capital are in the production process. By some authors it has, however, conectly been pointed out that we need very good data to get reliable estimates on the substitution parameter. This is e.g. illustrated by Thornber [28] and Helmsstädter [7]. Another difficulty that we have, however, is simply to define the elasticity of substitution when there are more than two factors of production. Either one has to assume the same elasticity of substitution for all the inputs, which in most cases is a dubious assumption, or one has to introduce other, rather restrictive assumptious as fixed proportions between the elasticities of substitution, see Gorman [6] or grouping of the factors of production assuming different substitution properties within groups than between groups. See Utzava [29] and Mc Fadden [17]. This is a problem we do not run into, however, since we apply the CES-function only in the two-factor case.

As opposed to the Cobb-Dougals production function the CES-function cannot be applied directly as a regression function when applying usual estimation methods since it is neither linear nor log-linear in the parameters. So, if ordinary methods of estimation are used we have either to apply an approximation to the CES-function, or apply additional assumptions i.e. assumption about the production units' economic behaviour.

We will firstly show how the CES-function as presented in (2.7) can be written in another way applying a Taylor expansion. Following Kmenta [14] we can write (2.7) as:

$$\text{(2.10)} \qquad \ln\frac{V}{L} = \ln\gamma + (\mu-1)\ln L - \frac{\mu}{\rho} f(\rho)$$

where $\quad f(\rho) = \ln(\delta + (1-\delta)(\frac{K}{L})^{-\rho})$

Expanding $f(\rho)$ around the value $\rho = 0$ which corresponds to $\sigma = 1$ i.e. the Cobb-Douglas case, we get by excluding terms of higher than second order

$$\text{(2.11)} \qquad f(\rho) \approx f(0) + f'(0)\rho + \frac{1}{2} f''(0)\rho^2$$

then we have:

$$(2.12)\quad \begin{aligned} f(0) &= 0 \\ \text{and } f'(0) &= -(1-\delta)\ln\frac{K}{L} \\ f''(0) &= \delta(1-\delta)(\ln\frac{K}{L})^2 \end{aligned}$$

Thus:

$$(2.13)\qquad f(\rho) \simeq -\rho(1-\delta)\ln\frac{K}{L} + \frac{1}{2}\rho^2\delta(1-\delta)(\ln\frac{K}{L})^2$$

and we get an approximation to the CES-function as:

$$(2.14a)\qquad \ln\frac{V}{L} = \ln\gamma + (\mu-1)\ln L + \mu(1-\delta)(\ln\frac{K}{L}) - \frac{\rho}{2}\delta(1-\delta)(\ln\frac{K}{L})^2$$

or

$$(2.14b)\qquad \ln\frac{V}{L} = \ln\gamma + h\ln L + a_2\ln\frac{K}{L} - a_3(\ln\frac{K}{L})^2$$

This CES-function approximation is as pointed out a Taylor-expansion around a value of the substitution parameter corresponding to an elasticity subsitution of one, which is the Cobb-Douglas case. Consequently the approximation is better the nearer the elasticity of substitution is to one. (2.14) is as we see an extension of the Cobb-Douglas production function, and we can, if certain conditions are fullfilled, test if the elasticity of substitution is significantly different from one. This is, however, as pointed out by Griliches [4] a rather weak test.

Since we in (2.14) have a square term of the log-capital-labour ratio the coefficients are no longer invariant of the unit of measurement. See Thomber [28] .

The relation we should have applied is the following.

$$(2.15)\qquad \ln\frac{V}{L} = \text{const.} + (\mu-1)\ln L + \mu(1-\delta)\ln\frac{K}{L} - \frac{\rho}{2}\delta(1-\delta)(\ln\frac{V}{L}-m)^2$$

where m is the sample average of the log-capital labour ratio. Writing (2.15) as:

$$(2.16)\qquad \ln\frac{V}{L} = \text{const.} + h\ln L + \alpha_2\ln\frac{K}{L} - \alpha_3(\ln\frac{K}{L} - m)^2$$

it is easily confirmed that if we run (2,14) instead of (2.16) we have to make following corrections to obtain the true estimates of:

a) the elasticity of capital $\hat{\alpha}_2 = \hat{a}_2 + 2m\hat{a}_3$
and
b) the substitution parameter $\beta = \dfrac{-2\hat{a}_3}{\hat{\alpha}_2(1+\hat{h}-\hat{\alpha}_2)}$
and thus
c) the elasticity of substitution $\hat{\sigma} = \dfrac{1}{1+\hat{\beta}}$

In principle on can also test if the elasticity of substitution really is constant. (2.14b) can be written as:

$$(2.17) \qquad \ln\frac{V}{L} = \text{const.} + h\ln L + a_2\ln\frac{K}{L} - a_3(\ln K^2 - 2\ln K\ln L + \ln L^2)$$

By running (2.17) and:

$$(2.18) \qquad \ln\frac{V}{L} = \text{const.} + h\ln L + a_2\ln\frac{K}{L} - a_{31}(\ln K)^2 + a_{32}\ln K\ln L - a_{33}(\ln L)^2$$

we can test if $a_{31}=a_{32}=a_{33}$ by a usual F-test (if the necessary assumptions are fullfilled)

In one of the preliminary runs such tests were carried out for two selected sub-industries and in most cases the assumption about constant elasticity of substitution in the frame of the approach above could not be rejected at 5% level. See Ringstad [22] . But the multicollinearity brought the regressions to "the limit of explosion". So no attempts have been made to go further along the lines sketched above. See also Krishna |15|.

The CES-function is, however, most widely used together with the assumption of profit maximation with respect to labour.

Assuming constant returns to scale, ($\mu=1$) we get the first order condition for profit maximum with respect to labour as: (known as the ACMS-relation. See |1|)

$$(2.19) \qquad \ln\frac{V}{L} = \text{const.} + b\ln\left(\frac{W}{p}\right)$$

where W is the price of labour and p is the price of the product.

If certain conditions are satisfied, b is the elasticity of substitution, and by applying (2.19) we get directly an estimate on this important parameter.

As pointed out is relation (2.19) the most common relation in connection with econometric analyses based on the CES function. But we could of course have obtained a similiar relation by means of the 1. order condition for maximum profit with respect to capital. When (2.19) in most cases is prefered it is mainly for two reasons. Firstly a reliable measure of the price of capital is much more difficult to obtain than a reliable measure of the price of labour. Secondly, it is in most cases more reasonable to assume that profit is maximized with respect to labour than with respect to capital

In some cases one has, however, also combined the two first order conditions for maximum profit. If the price of capital is denoted q, we get the relation:

(2.20) $$\ln\frac{K}{L} = \text{const.} + b_1 \ln\frac{W}{q}$$

If it is true that profit is maximized with respect to both labour and capital, then $b_1 = \sigma$, the elasticity of substitution.

The relation (2.19) is as we see independent of capital input. Hildebrand and Liu [8] have, however, argued that this may be wrong and lead to biased estimates of the elasticity of substitution. They propose a relation of the following type:

(2.21) $$\ln\frac{V}{L} = \text{const.} + b\ln W + c\ln\frac{K}{L}$$

Nerlove [20] has shown that the production function from which (2.21) is deduced is:

(2.22) $$\frac{V}{L} = \left(\alpha\left(\frac{K}{L}\right)^{-\rho} + \beta\left(\frac{K}{L}\right)^{-m\rho}\right)^{-\frac{1}{\rho}}$$

and that the correct expression for the elasticity of substitution is:

(2.23) $$\sigma = \frac{b}{1+\frac{c}{S_K}}$$

where S_K is the share of capital in value added. There are usually substantial problems in measuring S_K, and the value of applying (2.21) to estimate the elasticity of substitution depends very much on how reliable the measure of S_K is.

Both (2.19) (2.20) and (2.21) imply constant returns to scale. From (2.7) we can, however, deduce the 1. order condition for profit maximum with respect to labour as:

$$(2.24) \qquad \ln\frac{V}{L} = \text{const.} + \sigma\ln\frac{W}{P} - \left(\frac{1-\mu}{\mu}\right)(1-\sigma)\ln V$$

The coefficient of the lnV-term will, as we see be zero either if the elasticity of substitution is 1 or if there is constant returns to scale. To test if there is increasing or decreasing returns to scale by means of (2.24) may, however, be invalid for at least one reason. V is an undogenous variable, so the estimates obtained on the coefficients in relation (2.24) are not unbiased and the conditions of the tests usually applied are not fullfilled.

But as long as the informations available to us about the production units do not allow us to eliminate this type and related types of errors completely, (2.24) may be equally good as any other of the relations we want to apply. (2.24) can also be written as:

$$(2.25) \qquad \ln\frac{V}{L} = \text{const.} + \frac{\mu}{\mu+\rho}\ln W - \rho\frac{(1-\mu)}{\mu+\rho}\ln L$$

or:

$$(2.26) \qquad \ln\frac{V}{L} = \text{const.} + \left(\sigma-(1-\sigma)\left(\frac{1-\mu}{\mu+\rho}\right)\right)\ln W - \rho\left(\frac{1-\mu}{\mu+\rho}\right)\ln L$$

As for (2.24) we can test whether there are non-constant returns to scale, but relation (2.26) as relation (2.24) suffers from simultanous equation errors. We see that only when we have constant returns to scale is the coefficient of the lnW term equal to the elasticity of substitution. It is worth noting that if we have increasing returns to scale is $\theta = \left(\sigma-(1-\sigma)\left(\frac{1-\mu}{\mu+\rho}\right)\right) \gtrless \sigma$ when $\sigma \lessgtr 1$ and when we have decreasing returns to scale is $\theta \gtrless \sigma$ when $\sigma \gtrless 1$. So if we interpret θ as an approximation to the elasticity of substitution, it will be "biased" towards 1 when we have increasing returns to scale and away from one when we have decreasing returns to scale.

All the relations deduced above (except (2.18) have all the property of constant elasticity of scale and constant elasticity of substitution. This may, however, be a misspesification of the production function. The production function may in general be non-homothetic, i.e. that the marginal rate of substitution between labour and capital depends not only on the input proprotions but also on the scale of production. But we have no informations a priori that can tell us in what way the production function may be nonhomothetic. A way to investigate this is to apply the modified "CES"-function:

$$(2.27) \qquad \frac{V}{L} = \gamma L^{\mu-1}\left(\delta L^{-\rho(m-1)} + (1-\delta)\left(\frac{K}{L}\right)^{-\rho}\right)^{-\frac{\mu}{\rho}}$$

By means of the first order condition for maximum profit with respect to labour we get:

$$(2.28) \qquad \ln\frac{V}{L} = \text{const.} + \sigma\ln\frac{W}{p} - (1-m)(1-\sigma)\ln L - (1-\sigma)\left(\frac{1-\mu}{\mu}\right)\ln V$$

or

$$(2.29) \qquad \ln\frac{V}{L} = \text{const.} + \left(\sigma-(1-\sigma)\frac{(1-\mu)}{\mu+\rho}\right)\ln\frac{W}{p} - \rho\frac{(1-\mu m)}{\mu+\rho}\ln L$$

We see that (2.29) is mathematically identical to (2.26) and we have some kind of an identification problem i.e. if the coefficient of the lnL - term in (2.29) is significantly different from zero it may either be because we have non-constant returns to scale (but constant <u>degree</u> of returns to scale) or because the production is nonhomothetic. And we may also find that the lnL-term does not have any explanation power in the regression even if the production function is non-homothetic. (if $m\mu \approx 1$) So a necessary condition for obtaining a uniform test of non homotheticity by means of (2.29) is that $\mu = 1$. In this case (2.29) can be written as:

$$(2.30) \qquad \ln\frac{V}{L} = \text{const.} + \sigma\ln\frac{W}{p} - (1-\sigma)(1-m)\ln L$$

When $m \neq 1$ (2.27) has neither a constant elasticity of substitution, nor a constant elasticity of scale. One may expect, however, that if m is near one, the elasticity of substitution will approximately be equal to $\sigma \approx \frac{1}{1+\rho}$.

The elasticity of scale can be written as:

$$(2.31) \qquad \varepsilon(L,K) = \mu\left(\frac{V}{\gamma}\right)^{\frac{\rho}{\mu}} \left(m\delta L^{-m\rho}+(1-\delta)K^{-\rho}\right)$$

and this is approximately equal to μ when m is near one.

By using lnV instead of lnL as a right side variable we get (2.24) instead of (2.26) and instead of (2.29) we get:

$$(2.32) \qquad \ln\frac{V}{L} = \text{const.} + \frac{1}{1+\rho m}\ln W - \frac{\rho}{(1+\rho m)}\left(\frac{1-\mu}{\mu}\right)\ln V$$

"Reality" is not changed by introducing these relations. But running the "lnV-version" together with the "lnL-version" may give us additional informations about the character of any deviations of the assumptions underlaying (2.20).

When applying the relations deduced from the theoretical frame sketched above we more or less have to deal with a lot of difficult econometric problems. To the extent it is impossible for us to solve these in a satisfactory way (e.g. because of lack of relevant data) we get systematic errors in our estimates. This will to some extent be discussed later on, in section 7, when we also discuss other sources of systematic errors.

Two matters have to be mentioned before this section is concluded. Firstly we have not said anything about the methods of estimation nor of the stochastic properties of our models. Only one method is applied; the simple last-square method. In some situations it might be possible and convenient to apply more refined methods. But as we at least partly still are in a stage of experimenting, we have considered this method sufficiently satisfactory. Whenever we try to test anything, we assume the usual good properties of the residual variable to be fullfilled. If this is not approximately true, our tests are of course of correspondingly little value.

Secondly our assumptions about both the form of the production functions and our assumptions about behaviour varies from relation to relation. Everything can of course not be true at the same time. But applying relations based on different assumptions may be one way of investigating what the true assumptions are. If the production function is the same for all units in a sample and the behaviour also is the same for all units, then it has certain effects on the estimates for relations where a) the assumption about the production function is true, but the assumption about the behaviour is wrong, b) the assumption about the behaviour is true but the assumption about the production function is wrong, c) both assumptions are wrong, d) both assumptions are true, or approximately true.

Section 3

Informations Applied in the Construction of Regression Variables.

Below we present the informations applied in the present analysis. They are all provided by the 63-Census.

1) Year of establishing E

Year of establishing is the year the establishment started production of the same kind of good(s) as produced in 1963, without regard to change of ownership or other matters concerning ownership. The census provides informations about year of establishing only for establishments founded in 1953 or later i.e. after the previous census.

2) Number of wage-earners (production-workers) n_1
3) Number of employees n_2
4) Number of proprietors and unpaid family workers n_3

Number of workers is the average for 1963 of the total number of persons who worked in the establishment i.e. wage-earners (except homeworkers), salaried employees and working proprietors and unpaid family workers daily engaged in the establishments activities.

5) Hours worked, wage earners (production workers) h

Hours worked by production workers is the total number of hours actually spent at work, including waiting time and overtime.

6) Wages, wage-earners W_1
7) Wages, employees W_2
8) Wages, home-workers W_3
9) Social insurance premiums paid by the employer P_1
10) Pension premiums " " " P_2

Wages include all payments, whether in cash or in kind, made by the employer during 1963 to all persons, counted as wage-earners employees and to home-workers. Included are bonuses etc. and wages and salaries paid during vacation, sick leave and other short term leave. Taxes and social premiums payable by the employee and deducted by the employer, are also included.

Employers contribution to social security schemes and to pension funds are not included but presented as separate items (9) and 10)

11)	Production on own account	x_1
12)	Reparation work	x_2
13)	Contract work	x_3

The sales value of production on own account (x_1) refers to all goods produced in 1963 - whether actually sold during the year or entered into stock - including goods produced on contract by other establishments and deliveries to other establishments within the same firm.

The sales value of production on own account is stated according to prices at the place of production including the value of packaging materials and any possible price additions for distribution with the establishment's own labour and material. Production taxes, sales taxes and price adjustment taxes are also included, while subsidies are not. Deliveries to other units within the same firm are valued at internal clearing prices (book value), or, if internal prices are not used, at market prices or at total costs.

Repair work refers to the receipts for reparations carried out for customers, inclusive payment for parts and materials the establishment has used in the reparation work. Costs of reparations on the establishments own machinery etc. are not included.

Contract work is receipts for production carried out for other establishments on contract when the customer is delivering raw materials etc.

14)	Raw materials	M_1
15)	Fuel etc.	M_2
16)	Packing	M_3
17)	Contract work	M_4

M_1 refers to consumption of raw materials and components for production and repair work, including raw materials delivered to other firms for contract processing. M_2 refers to consumption of fuel, electricity and ancillary materials. M_3 refers to consumption of packaging materials for the establishment's own use and M_4 is costs of contract work. Raw materials etc. received from other establishments within the same firm are included, but materials received from other frims for contract processing or materials used for repairs an maintainance of the establishment's own buildings and machinery are not.

The value of M_1, M_2, M_3 and M_4 is stated according to original costs, including charges for transportation and forwarding, insurance premiums and custom duties. Price adjustment taxes and other taxes (ecept custom duties, as pointed out above) paid on raw materials are not included. Subsidies are not deducted.

18)	Traded goods sold	G_1
19)	Traded goods bought	G_2

Traded goods are goods bought and sold without any processing in the establishment. If the value of the traded goods is large in relation to total value of production the establishment is excluded from manufacturing and included in the trade-industry.

20)	Duties and taxes on production	U_1
21)	10% duty on traded goods sold	U_2
22)	Subsidies	U_3

The duties and taxes on production are the same as those included in production (see above). U_2 is the general duty on all traded goods sold in Norway. Subsidies are payments from the public sector for different purposes e.g. for regulation of the price of particular goods.

23)	Prime movers	m_1
24)	Electric motors	m_2
25)	Other electric consuming machinery	m_3

Prime movers are non-electricity consuming machinery not applied as energy-source to electric generators or transport equipment. The machinery installation is computed in HP, and where recessary computed from KW according to the formula 1KW = 1.36HP.

26)	Personal cars	C
27)	Trucks	T
28)	Buses	b

The informations of number of cars in the establishment's ownership contain number of personal cars (C), number of vans and lorries (T) and number of buses per 31/12 1963.

29)	Insurance value buildings	K_1
30)	Insurance value machinery etc.	K_2

29) and 30) refer to full fire insurance value of buildings (K_1), machinery, implements and equipment (K_2) <u>owned</u> by the establishment per 31/12 1963. Consequently buildings let out wholly or partly to other establishments are included, while buildings and prewises rented from others are not. Buildings mainly used as dwellings are excluded. Real capital other than buildings and machinery, such as motor vehicles, quays, railways, dams, sites and waterfalls, is also excluded.

31) Inventories H

Inventories refer to the assumed market value per 31/12 1963 of the stock of raw materials, goods in processing, finished products, traded goods, fuel, packing, ancillary materials and materials for own building activities.

32) Type of establishment B

This information simply indicates if the establishment belongs to a single-unit firm or to a firm with two or more units.

33) Industry group

The establishments are divided into two, three and four digit industry groups according to the CBS' standard for industry-classification which is based on the International Standard Industrial Classification of all Economic Activities (ISIC).

34) Region (location)

The base unit of location is the municipality and the information given about location is the municipality where the industrial operations were performed in 1963.

Section 4

Definition of Regression Variables.

In section 2 the theoretical framework of the study was sketched. In this section we shall present and discuss the construction of regression variables. Usually one presents the regression to be run before one defines the variables. In this study it seems more convenient to do the opposite., - to present the variables before the regressions. Most of the variables applied in the regressions appear in another form than the one presented below. But the transformations made should be easily understood. (Most variables are run in logs and instead of value added and capital we apply value added/labour and capital/labour ratio-variables etc. See section 2)

Gross production is defined as

1) $Y = X_1+X_2+X_3+G_1+U_3-U_2$

Total raw material consumption

2) $M = M_1+M_2+M_3+M_4+G_2+W_3$

And value added

3) $V = Y-M-U_1$

In light of the informations available about production and raw materials the definitions above of gross production, raw material consumption and value added seem to be the most convenient. 1) is a gross gross concept of production where all sources of gross income are included. (The 10% duty on traded goods is, however, as we see subtracted). 2) includes all input of goods and service into the establishment from outside. (Persons working in the establishment are in this connection considered "to belong to the establishment") Consequently will value added as defined in

3) be the value of the work carried out by the "intemal" factors, labour and capital.

The CBS' definitions of gross production, raw material consumption and value added are slightly different. The last three elements of gross production as defined by us in 1) are not included by CBS, the last two elements in 2) are not included and U_1 is not subtracted from the difference between gross production and raw material consumption when computing the value added. So there are two differences between our definitions and CBS', firstly that we have included traded goods and secondly that we compute the net product concept, value added, in factor prices while CBS compute it in market prices.

b) Labour input variables

The most simple way of defining labour input is by the total number of persons engaged in the establishments activities i.e.

4) $N = n_1+n_2+n_3$

This concept is as we see an unweighted sum of all types of employed, and a necessary condition for that this should be a correct measure of labour input is that all three types are equally productive. In light of the informations available about labour, it is of course impossible to measure the labour input correctly. But one may expect that slightly better than 4) is a construction of a labour input measure in hours, where one compute the hours worked by employees in production workers hours equivalents (see e.g. Krishna [15]). This is done by applying the informations we have about wages for production-workers and employees and hours worked by production-workers. We then obtain the following measure of input of hired labour.

$$L_1 = h+\frac{hW_2}{W_1}$$

To compute the hours worked by proprietors and family members we assume that they on the average work 2000 hours a year which was roughly the average for production workers in total manufacturing in 1963. As hours worked is computed in tousands we then get the labour input measure

$$5) \qquad L = \frac{h(W_1+W_2)}{W_1} + 2n_3$$

4) and 5) are the two labour input measures we are going to use in the regressions.

In the preliminary runs we also investigated the effects of dividing the labour input into two, á lá Hildebrand and Liu[8]. The two separate variables measuring labour input were hours worked by production workers(h) and number of emplyees and propereritors and familymembers (n_2+n_3). (See Ringstad [23]) This separation seemed, however, not to tell us anything more about the labour imput productivity than 5) did, for the samples selected.

c) Capital input variables

Analogous to 4) we can measure the input of capital as an unweighted sum of the different components of capital:

$$6) \qquad K = K_1+K_2+H+6C+10T+12.5b$$

We have also included cars in our capital-stock variable, and the way these enter into this concept deserves some comments.

Firstly, the main reason why they at all are included in the capital stock is that value of gross production includes value of transportation carried out by own cars, while the value of transportation of raw materials carried out by own cars is not included in the value of raw material input. So to take differences in production between establishments, due to different number of cars we include the value of cars in the capital stock measure.

We have, however, only informations about number of cars of the three types, personal cars, trucks and buses. So we have, secondly, to impute values for these three types. (Buses are of insignificant importance since there were only 59 buses in total manufacturing in 1963. For completeness sake we want, however, to include this category too in our capital concept)

To do this we need some external informations.

In 1962 the CBS carried out an investigation to compute the capital value of cars of differnet types. The results of this investigation seem to be the more reliable we can get when trying to impute values of the three types of cars mentioned above. In 1962 the average market value of personal cars was according to these computations ca. 12 000 n.kr., for buses ca. 25000, for vans ca. 8000, for diesel lorries ca. 25100 and for gasoline lorries ca 8200. (The last group of cars had an average age of 13,6 years in 1962). All values are computed in 1961 prices. Apart from this, and the fact that the computations are carried out for the year 1962, we must consider the average value for personal cars and buses above as the best we can obtain. These two types of cars are, however, in general less "productive" than trucks. So we assume that only half their value is "productive" in the sense that it is input into output. The other half may be considered as capital used for "consumption" purposes or is used to serve the labour power as a form of payment.

Imputing an average value of trucks is more difficult, since this group is rather inhomogeneous and we don't have any results from the CBS-investigation that can be used directly. Firstly, we don't know the composition of trucks i.e. how many vans and how many lorries there were. In the census 1953 one asked for vans and lorries separately. For total manufacturing there were then 5118 lorries and 3165 vans.We have no such informations in the 63-census. Secondly we do not know how many of the lorries are gasoline-lorries and how many are diesel-lorries in manufacturing. But we know that for the country in total in 1962, 4/5 of the lorries were gasoline-lorries. And I do not think we get intolerably far off the right number if we assume that the composition of lorries (gasoline/diesel) in manufacturing is approximately the same as for the country in total - and if we assume that the composition of trucks (van/lorries) in manufacturing in 1963 is approximately the same as in 1953.

If so, we obtain an average value of trucks of ca. 10000.

And the "productive" value of cars is thus s = 6c+10T+12,5b.

We have also tried to construct a service - of - capital variable by means of the informations available. After a lot of experimenting in the preliminary runs we decided to apply a depreciation ratio of 3% for buildings and 15% for machinery and an overall "rate of returns" of capital (included inventories and cars) of 8%.

Also in the service of capital - construction cars particulary deserve some comments. The investigation, refered to above, also include computation of gross investment and depreciation of cars. Both concepts include reparation costs, and by using the computed value of cars and the computed depreciation we obtain a depreciation ratio of ca 25%. The reparation costs make a substential part of gross investment, and this together with high average age (low market value) gives us that high depreciation ratio.

We have also included the "cost of operation" of cars in the service of capital concept. The main reason for this is (as pointed out in section 3) that the value of transportation of finished products carried out by the establishment's own cars is included in the gross production value, while transportation by others is not. On the other hand the value of transportation of raw material etc. carried out by the establishment's own cars is not included in the raw material consumption while transportation carried out by others is.

To inpute average costs we need two sets of informations, a) average km. operated pr. year for different types of cars and b) average costs pr. km. for different types of cars. We found that - when reparation costs are excluded (they are, as pointed out above, included in the depreciation) - 0.35kr, 0.40 kr and 0.50 kr per km. for personal cars, trucks and buses respectively are fairly reasonable numbers on the average. Concerning average km operated an investigation carried out in 1962 showed that average number operated km per year for personal cars was ca. 11500. For buses (operated on own account) we have no informations, **it is**

asserted that 10000 is an reasonable number - at least not too low. For trucks we have firstly an investigation (sample survey) carried out in 1963 that indicated that the average number of km. operated for vans and lorries was ca. 12000. (vans and lorries operated on own account). However, the variations between sizeclasses were substantial. Secondly, because of a special km-
we know that the average number of km operated for this type of **cars was** 27600 **in**
duty for diesel-lorries, 1963. (Diesellorries operated on own account) This, together with the indication from the 53-cencus that there are relatively more lorries than vans in manufacturing than for the country in total, lead to the conclusion that the average for trucks in manufacturing is higher than the country-average. A fairly good "guestimate" seems to me to be 15000.

If we assume that only half of the services of personal cars and buses are "productive" we then get the "productive" average costs of operating cars as:

CS_0=2,01c+6+2,5b (exclusive depreciation)

and CS_1=3,51c+8,5T+5,63b (inclusive depreciation)

In this way we get the service of capital-measure applied in this study:

7) $SK = 0.03K_1+0.15K_2+0.08K+3.51C+8.5T+5.63b$

d) Other variables

In the theoretical discussion in section 2 the wage-rate appeared to be a very important variable when trying to estimate the elasticity of substitution. The only wage-rate we have is the average wage per hour for porduction workers.

8) $W = \frac{W_1}{h}$

So this is the only measure of the "price of labour" applied in the present study.

For capital we have tried to compute a "price" by a **gross** rate of return variable defined as:

9a) $g.r.r. = \dfrac{V - \dfrac{(W_1+W_2)N}{n_1+n_2} - P_1 - P_2}{K}$

Note that we have imputed the wages to proprietors and family members as the average payment to wage-earners and employees in the same establishment.

Since g.r.r. as defined in 9a) in some cases is non-positive and we are going to apply this variable in logs, we have constructed another variable by means of 9a) as:

9b) $$\text{g.r.r.}^{*}\begin{cases} = \text{g.r.r. when g.r.r.} \geq 0.01 \\ = 0.01 \quad \text{when g.r.r.} < 0.01 \end{cases}$$

To take care of some of the effects of specifying the gross rate of return to capital in this way, we also apply a variable:

10) $$\text{dg}\begin{cases} = 1 \text{ when g.r.r.} < 0.01 \\ = 0 \text{ when g.r.r.} \geq 0.01 \end{cases}$$

Whenever 9b) is applied we have also applied a variable telling us something of the effect of depreciation and operation costs of capital in relation to total capital, i.e.

11) $$\delta = \frac{0.03K_1+0.15K_2+3.51C+8.5T+5.36b}{K}$$

By means of 11) and 9a) we can also construct a net rate of returns of capital simply as:

12) $$\text{n.r.r.} = \text{g.r.r.} - \delta$$

As a control of our labour and capital-variable constructions we apply three ratio variables, one for labour and two for capital. When included in the regressions together with the "true" input variables, they will tell us whether we have given the corresponding components of the input variables approximately correct weights or not.

By including

13) $$d = \frac{n_3}{N}$$

together with N or L we investigate the weight given to proprietors and family members in the labour input concepts.

And by including

14) $$g_1 = \frac{K_2}{K}$$

and

15) $$g_2 = \frac{6C+10T+12.5b}{K}$$

totether with K or Sk we can incestigate the weights given to machinery and cars in the capital input concepts.

Note that g_1 and g_2 express the weights of machinery and cars in the capital stock variable K, and when applied together with SK they express only approximately the weights of these two componets of capital. In the preliminary runs correct expressions of the weights of machinery and cars when using SK were also applied but the effects of these compared with the effects of g_1 and g_2 were only slightly different. (Ringstad |23|)

We are also interested in investigating the effect of machinery installations and we then apply the variable.

16) $$g_3 = \frac{M}{K_2} = \frac{m_1+m_2+m_3}{K_2}$$

m may in some cases be zero.
This is considered mainly to be due to incomplete reporting. To take care of the effects of this in a simple way we have, when g_3 is included in the regressions, also included:

17) $$f\begin{cases} = 1 \text{ when } m = 0 \\ = 0 \text{ when } m > 0 \end{cases}$$

In the same way as labour and capital, value added is an "complex" variable. As ling as econometric theory about multiproduct-models is almost completely non-existent (See however, Mundlak |19|), we have to treat all outputs as one i.e. we have to aggregate. As "right-side" variables it is relatively easy investigate the effects of our aggregation methods for labour and capital. For value added, as a "leftside" variable it is a bit more difficult. We are, however, interested in analyzing the effects of reparation work on value added by including (on the right side of the regressions) the variable

18) $$q = \frac{X_2}{V+M_1}$$

In light of the definitions of production and raw-material variables, we have considered it ot be more appropriate ot include M_1 in the denominator than simply to set reparation work in relation to value added.

To find out if there are any dissimiliarities between establishments in single unit firms and establishments in multi-unit firms we include the variable:

19) $$B \begin{cases} = 1 \text{ for establishments in multi-unit firms} \\ = 0 \text{ for establishments in single-unit firms} \end{cases}$$

We have also tried to investigate the effect of the "age" of the establishments by means of the variables:

20) $$E \begin{cases} = 53,54 \ldots \text{ for establishments founded in 1953, 1954}\ldots \\ = 30 \text{ for establishments founded before 1953} \end{cases}$$

and

21) $$F \begin{cases} = 1 \text{ for establishments founded before 1953} \\ = 0 \text{ for establishments founded in 1953 or later} \end{cases}$$

The value of E = 30 for establishments founded before 1953 may look a bit arbitrary. In the first sets of preliminary runs (See Ringstad [21]) we set E = 0 for establishments founded before 1953, otherwise this variable was unchanged compared with the definition in 20. In the last set of preliminary runs we set E equal to the assumed average year of establishing for establishments founded before 1953. We then used the informations from the census 1953 [32] about the age-distribution of the establishments then existing. This was done separately for the two industry-groups selected. (See Ringstad [23]) What we have done this time is to use the age-distribution of the establishments in total manufacturing according to the census 1953, assuming that this is approximately the average age for the establishments older than 10 years in 1963. Not at least because of the movements in the mass of establishments during the ten year period 1953 - 1963 this may be a rather rough approximation. (See section 5).

The base unit for location of the establishments is as pointed out in section 3 the municipality. The municipalities are, however gouped into 25 districts according to geographical and administrative criterions. We want to construct variables that may unveil any differences in productivity between different locations. We have then gouped the 25 districts into 3 "regions" mainly according to the degree of urbanization and industrialization. This grouping also represents a rough division of the country into "pressure" and "depressure" regions.

So we apply the following "regionvariables".

22) $R_1 \begin{cases} = 1 \text{ for establishments in more industrialized districts outside the "Oslo-region"} \\ = 0 \text{ otherwise} \end{cases}$

23) $R_2 \begin{cases} = \text{ for establishments in less industrialized districts outside the "Oslo-region"} \\ = 0 \text{ otherwise} \end{cases}$

The Oslo-region is the base-region, and the estimates of the coeffisients of R_1 and R_2 tell us something about the average level of productivity in the two corresponding regions compared with the productivity in the "Oslo-region" (i.e. if the productivity is below or above and by how much)

The productivity may also vary with the size of the establishment. By using number employed in the establishment as size-criterion we can investigate "neutral" differences in productivity between size-groups by applying the variables.

24) $r_1 \begin{cases} = 1 \text{ when } N<10 \\ = 0 \text{ otherwise} \end{cases}$

25) $r_2 \begin{cases} = 1 \text{ when } 50 \leq N < 100 \\ = 0 \text{ otherwise} \end{cases}$

26) $$r_3 \begin{cases} = 1 \text{ when } N \geq 100 \\ = 0 \text{ otherwise} \end{cases}$$

The size-group $10 \leq N < 50$ is the base-group.

Application of variables 24-26 depends, however, on the number of units in each gorup. If there are less than ten units in the size-group $50 \leq N < 100$ and $N \geq 100$, another variable is applied.

27) $$r^{*} = r_2 + r_3 = \begin{cases} 1 \text{ when } 50 \leq N \\ 0 \text{ otherwise} \end{cases}$$

By applying the dummy variable technique, we may also investigate any variations in the elasticity of scale with scale. In the preliminary runs some experiments were carried out about this (See Ringstad [21]), and we decided to limit ourselves in the present study to investigate if there where any differences in the scaleelasticity for the largest units compared with the remaining units in each sample. This can be analysed by means of the variable

28) $r_3 \ln L$ (or $r_3 \ln N$)

or if the number of units in one of the upper sizeclasses is low:

29) $r^{*} \ln L$ (or $r^{*} \ln N$)

Finally we have applied some "industry group dummies", where we expect some differences in the level of productivity within our samples. In a later section, when the samples are presented, we also define the different dummies of this kind applied.

As a conclusion of this section it should be pointed out that the variables are constructed in the way they are of our reasons: 1) The informations actually available. 2) The results of other econometric studies of similiar type. 3) A priori knowledge of Norwegian Manufacturing and 4) Experiences during the preliminary runs which were mainly consentrated on to two industrygroups, 24 and 27.

Section 5

The Data

a) General Description of the Census of Mining and Manufacturing Establishments 1963.

The Census shows that 20994 establishments in Mining and Manufacturing were operated wholly or partly during the year 1963. One-man firms i.e. firms where the owner is the only employed are not included. When valuing the number of establishments one has also to take into consideration that some firms are divided into two or more establishments. These are firms having activities in different areas (as a rule in different municipalities) or different activities in the same municipality.

Compared with the Census of Mining and Manufacturing 1952 there were ca. 4000 establishments less in 1963. The gross reduction is, however, much larger; ca. 8000 establishments were dissolved during the 10-year period, and ca. 4000 new establishments were founded. Consequently there is a substantial movement in the mass of establishments in Mining and Manufacturing in Norway. This is confirmed by an analysis carried out by Wederwang [30] for an earlier period.

The size-distribution of the establishments included in the Census 1963 of Mining and Manufacturing has a typical skew look. About 15000 establishments, or ca. 70%, employed less than 10 persons on the average in 1963. These establishments had, however, only 13% of total employment in Mining and Manufacturing, 11,5% of gross production value and 10% of value added.

Only 642 establishments, or 3%, employed 100 persons or more on the average in 1963, but these establishments had almost 50% of total employment in Mining and Manufacturing, over 50% of total gross production value and value added. Only 73 establishments had 500 or more employed.

The size-distribution of the establishments for gross production value gives almost the same picture as the size-distribution when employment is used as a sizecriterion. About half the number of the establishments had a gross production value less than 0,2mill. kr., and less than 5% had a gross production value over 5 mill. kr. For more detailed informations see the CBS' publication;Census of Establishments, 1963, volume 1 |33|.

In the first set of preliminary runs we included all units, except the ancillary units, in the runs for the industry-groups selected (See Ringstad [21].) We at once, however, run into the problem of "zero-informations" i.e. for a number of units the value of informations of which important regression variables were constructed were reported to be zero, even in cases when it was very reasonable to believe that they could not be zero. The informations about capital were those giving us most trouble. So it became clear that not all units could be used in the runs. In some way or another we had to select the units to be included in our samples.

A lot of experiments of different selection procedures were carried out during the preliminary runs. (See Ringstad [22]). We finally decided to apply in the main runs the one also applied in the last set of preliminary runs.(Ringstad [23]) This is the following: We exclude **all** units with one or more of the following characteristics:

a) Number of wage-earners: $n_1 < 3$
b) Hours worked by wage earners: $h = 0$
c) Payment to wage earners: $W_1 = 0$
d) Insurance value buildings: $K_1 = 0$
e) Insurance value machinery etc: $K_2 = 0$
f) Value added: $V < 0$

In addition also ancillary units were excluded.

The obviously most important exclusion criterions, i.e. the ones reducing the initial number of units most drasticly are a), d) and e). Excluding all units with characteristic a) there should in fact be no units left with characteristics b) and c). To the extent there really are any, it is a result of "bad reporting" i.e. insatisfactory answering of the questions on the forms.

V may be negative, but our experience from the preliminary runs makes us to believe that it is only a very small number, I would guess less than one tenth of a per cent for total manufacturing. But since we are running our regressions in log-values of the variables we have to exclude these units.

As mentioned, the characteristics causing most troubles are those concerning capital. Quite a lot of units report either zerovalue of buildings a zerovalue of machinery. This may to some extent be a result of the way one have posed the questions about capital: One asks for full insurance value. And some units have not insured their capital, and do not understant the questions concerning capital correctly, i.e. that full insurance value should be reported whether they have insured all their capital, only insured it partly, or not insured it at all. In this connection this is, however, a cause of only minor importance, to my opinion. The most important cause is obviously that one asks for capital owned and not capital used in the establishments production. An establishment that lets out buildings and machinery to others has to include the value of these items in its capital value reported. While an establishment renting capital shall not report the value of this. (See section 3) Another important cause of that many units are excluded because of d) and e) may simply be carelessness in answering the questions. More about capital in section 7.

When constructing our samples a lot of industry-groups were also excluded, both two, three and four digets. The main reason for exclusion was either that they included a rather low number of units (as e.g. group 22, Tobacco Manufactures with only 13 units), or they were considered to be rather inhomogeneous (as some "miscellaneous"-groups), or that they were considered not to be truely "production" units (as e.g. group 384 Repair of Motor vehicles.)

In addition to this, also Mining with a gross number of units of 569 was excluded. The groups of Manufacturing excluded have a gross number of units of 5556. So this reduces the number of units in total from 20393 (exclusive ancillary units) to 14268. By applying the criterions above we end up with number of units of 5361.

Table 5.1

Set of data	Sub-ind number	Name of industry	Number of units
20.1	201	Slaughtering and preparation of meat	171
20.2	2021 (Base)	Dairies	231
	2022 (D_1)	Man. of condensed and dried milk	7
	2023 (D_2)	Man. of ice-cream	13
20.3	204 (Base)	Canning of fish and meat	139
	203 (D_1)	Can. and pres. of fruits and veget.	24
20.4	2052 (Base)	Man. of prepared fish dishes and delicatessen	453
	2051 (D_1)	Frozen fish	
	2059 (D_2)	Other processing of fish	
20.5	2061	Local grainmills	48

Set of data	Sub-ind number	Name of industry	Number of units
20.6	2071	Man. of perishable bakery products	352
21	214 (Base)	Soft drinks and carbonated wather	23
	211 (D_1)	Distilling rectifying and blending of spirits	9
	213 (D_2)	Brewries and man. of malt	24
23	232 (Base)	Knitting mills	63
	231 (D_1)	Spinning weaving and finishing of textiles	99
	233 (D_2)	Cordage, rope and twine industries	39
	239 (D_3)	Man. of textiles not net elese-where classif.	22
24.1	241	Man. of footwear	71
24.2	243	Man. of ready-made garnments and taylors shops	185

Set of data	Sub-ind number	Name of industry	Number of units
24.3	2441 2442 2443 (Base)	Man. of fur goods, gloves, hats and caps.	34
	249 (D_1)	Man. of made-up textile goods, except wearing apparel	37
25.1	251	Saw-mills and planing mills	556
25.2	252 253 259	Man. of wood and cork prod. except saw mills and planing mills	195
26.1	2611 (Base)	Man. of wooden furniture	265
	2612 (D_1)	Man. of metal furniture	36
26.2	262	Man. of wooden fixtures	464
	273 274 (Base)	Man. of paper, paperboard cardboard, wall-boards etc.	52
	271 272 (D_1)	Man. of mechanical and chemical pulp	63
	275 (D_2)	Man. of paper-and paperboard-products	75

Table 5.1 (continued)

Set of data	Sub-ind. number	Name of subindustry	Number of units
28	282-2821 (Base)	Printing except, printing of newsp.	103
	2821 (D_1)	Printing of newspapers	51
31.1	311	Basic industrial chemicals	60
31.2	3121 3122	Fish liver oil herring oil and fish-meal fact.	69
31.3	319 (Base)	Man. of misc. chemical products	66
	313 (D_1)	Man. of paints, varnishes and lacquers	29
33.2	335	Man. of cement products	190
33.1	331 332 333	Man. of structural clay products, glass glass products, china and earthenware	70
34	3413	Iron and steel foundries	37

Set of data	Sub-ind. number	Name of subindustry	Number of units
35	35-3511 (Base)	Man. of metal products except man. of wire and wire products	432
	3511 (D_1)	Man. of wire and wire products	43
36	369 (Base)	Man. of mash. not elsewhere classified	157
	361 (D_1)	Man. of mining and industrial machinery	65
37	37-378	Man. of electrial machinery except electro-technical repair shops	102
38	x)	x)	137

x) 3813 Man. of internal-combustion engines
3814 Man. of other marinemachinery
3821 Man. of railroad cars and locomtives
383 Man. of motor vehicles and parts
3851 Man. of motor chycles and bi-chycles
386 Man. of aircraft
389 Man. of transport equipment not elsewhere classified

Sub-industries considered to have similar or related production techniques were pooled into the same sample. Where some differences between the sub-industries in the same sample of some reason or another were expected, appropriate dummy-variables were applied.

In table 5.1 the 27 samples applied in this study are presented, the net number of units, the industry-dummy variables and the composition of the samples.

We have also carried out some runs on samples where either some of the samples in table 5.1 are pooled into one, or for samples which are components of the samples in table 5.1.

Section 6

The Relations Applied in the Regressions.

In this section, when the theoretical frame of the study, the informations available, the regression variables constructed and the data already have been presented, it is due time to specify in details the regressions we are going to run.

Firstly we are going to run simple Cobb-Douglas production functions as presented in section 2 with two "true" production factors, labour and capital and "neutral" production factors ("quality-variables") In section 4 we presented two different measures of labour input and two different measures of capital input. It is four possible ways of combining these measures of the inputs, but we have limited us to two, when both labour - and capital input are unweighted sums of their components, and when both labour - and capital input are weighted sums of their components.

To unveil a general result of the runs we found that the weighted-sum-variant on the average was better than the unweighted, though the difference was in most cases only slight.

So in this section we only present the Cobb-Douglas-regressions and the regressions based on the Kmenta-approximation to the CES-function, for L as the measure of labour input and SK as the measure of capital-input.

As mentioned earlier the only estimation method applied in this study is the simple least square method. In all relations presented below it is, consequently, implicitly understood that the equations do not hold exactly, but that an error term is present. Since our statistical approach is that simple, we do not consider it necessary to write, or to specify the properties of, the error term in each relation.

The first regression to be run is based on the simple Cobb-Douglas relation

$$\ln\frac{V}{L} = \ln A + h\ln L + \alpha_2 \ln\frac{SK}{L} \qquad (6.1)$$

An important assumption for this relation is that the level of efficiency (expressed as lnA) is the same for all units.

The following five ralations are introduced to investigate this, i.e. if there are properties of the establishments that significantly influence the level of efficiency.

Firstly we want to know if there are any neutral variations in efficiency with scale i.e. we will find out if the levels of efficiency in the size groups $N < 10$, $50 \leq N < 100$ $N \geq 100$ are different from the level of efficiency in the size group $10 \leq N < 50$.

So we introduce the relation:

$$\text{(6.2)} \qquad \ln\frac{V}{L} = \ln A_0+(\Delta\ln A)_1 r_1+(\Delta\ln A)_2 r_2+(\Delta\ln A)_3 r_3+h\ln L+\alpha_2\ln\frac{SK}{L}$$

In the same way we want, for the samples were we think there are signifficant differences between the efficiency of the units in different sub-groups in the sample, to investigate this, by introducing industry dummyvariables in the same way as we in (6.2) have introduced the size-group variables.

$$\text{(6.3)} \qquad \ln\frac{V}{L} = \ln A_0+(\Delta\ln A)_1 D_1+(\Delta\ln A)_2 D_2+(\Delta\ln A)_2 D_3+h\ln L+\alpha_2\ln\frac{SK}{L}$$

A priori it is also reasonable to believe that there are differences in efficiency between regions, especially as they are defined in the present study,(see section 4). So we, analogous to (6.2) and (6.3) run:

$$\text{(6.4)} \qquad \ln\frac{V}{L} = \ln A_0+(\Delta\ln A)_1 R_1+(\Delta\ln A)_2 R_2+h\ln L+\alpha_2\ln\frac{SK}{L}$$

The estimate of the coefficient of a dummyvariable in a production function relation tells us something about the deviation of the level of efficiency of the set of units to which the dummyvariable belongs, compared with the base-group's level of efficiency. I.e. we have to add the coefficient of a dummyvariable to the constant term of the relation to obtain the constant term of the corresponding group.

Concerning the other neutral factors we are especially interested in how appropriate our weights of the different components of labour and capital are. So we run a regression with d, g_1 and g_2. Simultanously we include other variables that may tell us something about the quality of the "true" factors of production such as g_3 (and f) that may tell us something about how machinery with high energy consumption influence productivity compared with machinery with low consumption of energy, everything else equal. We'll also include the year of establishing variable that may reflect the age of the capital-stock and consequently may tell us something about its effect on efficiency.

So we run the regression:

$$(6.5) \qquad \ln\frac{V}{L} = \ln A + h\ln L + \alpha_2 \ln\frac{SK}{L} + \delta d + \gamma_1 g_1 + \gamma_2 g_2 + \gamma_3 g_3 + \gamma_4 f + \gamma_5 E$$

For some samples f = 1 for no or very few units (i.e. $g_3>0$ for all or almost all units). So this variable was excluded whenever there were five or less units where f = 0.

As mentioned in section 2 we also want to compare the results we obtain by applying a gross-product-relation with the results obtained by a net-product-relation (value-added-version). In this relation we do not include any quality-variables, but simply run:

$$(6.6) \qquad \ln\frac{Y}{L} = \ln B + \eta \ln L + \beta_2 \ln\frac{SK}{L} + \beta_3 \ln\frac{M}{L}$$

$\eta = \beta_1+\beta_2+\beta_3-1$ where β_1 is the elasticity of labour. As for h in the net production function η is the measure of the gross production functions degree of returns to scale or degree of homogenity, i.e. if it is different from a linear homogeneours law of production or not, and if so, by how mush.

When investigating if the degree of returns to scale is constant, independent of scale, we also include the size-dummy-variables included in relation (6.2) and the variables telling us about the effect of our weights of the components of labour and capital. Consequently we run:

$$(6.7) \qquad \ln\frac{V}{L} = \ln A_0 + (\Delta\ln A)_1 r_1 + (\Delta\ln A)_2 r_2 + (\Delta\ln A)_3 r_3 + h_0 \ln L + \Delta h r_3 \ln L + \ln\frac{SK}{L} + \delta d + \gamma_1 g_1 + \gamma_2 g_2$$

Firstly Δh tells us if the law of production is homogeneous or not (if $\Delta h = 0$ or not) and secondly if the degree of rate of returns in the upper size-group is above ($\Delta h > 0$) or below ($\Delta h < 0$) the degree of rate of returns in the rest of the sample, when the effects of neutral variations in efficiency and the effects of the "composition-variables" of labour and capital are taken care of.

The Kmenta approximation of the CES-function was run in two "versions".

Firstly, when we assume that the "neutral" efficiency is the same for all units in the sample, we run:

$$(6.8) \qquad \ln\frac{V}{L} = a_0 + h\ln L + a_2\ln\frac{SK}{L} - a_3\left(\ln\frac{SK}{L}\right)^2$$

where we have to carry out the corrections of the estimates pointed out in section 2 to obtain the "true" estimates of the elasticity of capital (and consequently also the elasticity of labour) and the elasticity of substitution.

Secondly we run the Kmenta-approximation when all quality-variables also are included, both those included in the relations above and the following three; F, B, and q. q was not included in this regression for all groups since it was zero for all units in some sample (no reparation work)

So the ninth regression to run is:

$$(6.9) \qquad \ln\frac{V}{L} = a_0 + h\ln L + a_2\ln\frac{SK}{L} - a_3\left(\ln\frac{SK}{L}\right)^2 + \text{all "quality variables"}$$

All relations above, except (6.4, 6.6 and 6.7) were also applied in regression-computations when labour input was measured as N and capital input measured as K. (**See section** 4)

Concerning the CES-function as it has been applied in most econometric studies (i.e. applying the 1. order condition for profit maximum with respect to labour) we firstly run the **simple** ACMS relation (see section 2 and the list of references at the end of this paper), namely

$$(6.10) \qquad \ln\frac{V}{L} = a + b\ln W$$

The constant term consists of three parameters, the efficieney parameter γ, the distribution parameter δ and the substitution parameter ρ. Since the substitution parameter must be constant according to (6.10) variations in the constant term must either be due to variations in the efficiency parameter or the distribution parameter.

In the same way as we investigated variations in efficiency in the Cobb-Douglas case we want to investigate the effects of possible variations in efficiency or distribution between labour and capital in the CES case.

Consequently we apply the relations.

(6.11) $\quad \ln\frac{V}{L} = a_0+(\Delta a)_1r_1+(\Delta a)_2r_2+(\Delta a)_3r_3+b\ln W$

(6.12) $\quad \ln\frac{V}{L} = a_0+(\Delta a)_1D_1+(\Delta a)_2D_2+(\Delta a)_3D_3+b\ln W$

(6.13) $\quad \ln\frac{V}{L} = a_0+(\Delta a)_1R_1+(\Delta a)_2R_2+b\ln W$

These tell us about possible differences between size-groups, between sub-goups of units in the same sample, and between regions, concerning either efficiency or distribution or both.

Since we have some difficulties to find out what is capitals share of value added, it seems to be of little value to apply (2.22). So this relation is dropped.

In spite of both simultanous equation problems and difficulties of interpretation we want to investigate the effect of including the lnL-term and the lnV term in the simple ACMS-relation. (see section 2)

(6.14) $\quad \ln\frac{V}{L} = a+b_1\ln W-c_1\ln L$

and

(6.15) $\quad \ln\frac{V}{L} = a+b_2\ln W-c_2\ln V$

We will also try to estimate the elasticity of substitution in the case when we assume profitmaximizing behaviour both for labour and capital.

The sources of errors are numerous in the capital input measure (see section 7) but it is reasonable to believe that they are still more dominating in our measure of the price of capital, g.r.r.* (see section 4) In such a case the systematic errors in our estimate of the elasticity of substitution way be less if we treat the one with largest "errors of measurement" as the dependent variable (i.e. $\ln\frac{g.r.r.^*}{W}$) and treat the variable which is endogenous according to the theory of production ($\ln\frac{K}{L}$) as an exogenous, and independent variable. The systematic effect we may get by applying g.r.r.* instead of g.r.r. is at least partly taken care of by including dg in the regression. We also include δ as an independent variable telling us about the effect of depreciation intensity.

$$(6.16) \qquad \ln\left(\frac{g.r.r.^*}{W}\right) = a + b\ln\frac{K}{L} + c_1\delta + c_2 dg$$

Finally we want to investigate the variations of the net rate returns to capital with scale represented as number employed and sizedummies.

$$(6.17) \qquad n.r.r. = \omega_0 + (\Delta\omega)_1 r_1 + (\Delta\omega)_2 r_2 + (\Delta\omega)_3 r_3 + \psi \ln N$$

These 17 relations are applied for all samples presented in section 5. In addition some other relations are applied for some groups mainly as experiments to investigate the effects of "neutral" variables that seem to be of particular importance in the different samples. These will not be presented here, but some of these results are discussed in section 8, together with selected results of the 17 relations above.

The interpretation of the parameters of our models above depends very much on the assumptions we have made concerning technology, behaviour, market-conditions as well as a lot of other assumptions implicitly present in our relations applied. If our assumptions are far from true we obtain estimates that more or less are dominated by errors caused by misspesification of our models. In worst our models may be completely un-identifyable. Misspesifications may be done because of ignorance. But I guess that the most important errors occours because of quite deliberate misspesifications - because of the limitations of our data and because of analytical tools that have much left to be perfect.

With misspesification made because of ignorance, can, per definition nothing be done. Deliberate misspesification are in this connection a bit different. We know what we have done - and we know what we possibly should have done. By mapping what must be considered to be the most important deliberale misspesifications and calify in what way these may influence our results, we can to some degree "identify" our relations by applying available a priori and external informations.

So before we present the results of our study, we'll discuss possible sources of errors to be better prepared when trying to interprete our results.

Section 7

Possible Sources of Systematic Errors in the Estimates.

The selection of possible sources of errors presented below is to some extent arbitrary. As long as it is impossible to discuss all types of errors possibly present, a selection has to be made and the present one is based on a subjective evaluation - what I believe to be most important. However, some of those presented below are those most commonly discussed, and of which econometric theory in principle can tell us something about.

It is not always possible to say anything sure about the effects of different sources of errors even if we know in what way the bias goes according to theory, and still more difficult it is most cases to say anything about the size of the bias. Still worse, when two or more effects are simultanously present, which is the normal case, it is often difficult to say very much about the net effect on our estimates. All this is due to the character of our problems. They are present more or less in all econometric analyses, so this is not anything particular for the present one.

Even if our knowledge about the sourses of errors is limited it seems to me to be more satisfactory, and obviously to be more honet to discuss them and take them explicitly into consideration when interpreting our results. Limitations of our data and our methods obviously put limits to the validity of our results, and this should not be ignored.

To clarify the effects of the errors that seem to be present, they are discussed either for the simple Cobb-Douglas production function or for the ACMS-relation, or for both. To discuss all types of errors for all relations applied in this study would lead much too far.

The method of analysing these effects is everywhere to investigate the asympthotic behaviour of our estimates i.e. to find the probability limits and investigate in what way the estimates are inconsistent. As I wanted to apply the same method everywhere, I considered this one to be the more convenient.

a) Errors of measurement.

Firstly we have to comment on the selection of units we have made. The exclusion of some industry-groups does not complicate matters, since none of the results obtained are valid for these groups anyway. The way we have selected units within the sample may however, be more serious. The question is of course to what degree the results obtained by means of a sample of selected units in an industry are generally valid for the industry. The results may obviously not be valid for the smal establishments in the industry, since all units with less than three production workers are excluded - as pointed out in section 5. Only one source of errors of any significance, because of selection, is then left, namely the exclusion of units which reported either zero capital, buildings or zero capital, machinery. This is as pointed out previously, to be regarded mainly to be due to the way the questions about capital are posed namely about capital owned, not capital used. There may, however, also be a significant amount of bad reporting here.

Apart from the fact that it is mostly small establishments that are excluded because of this, we have found no other particular properties of these units that may invalidate the generality of our results. It has to be added, however, that any detailed investigation of the excluded units has not been carried out.

Apart from the capital-informations afforded, the quality of the data must be considered to be rather good, at least, compared with similiar micro production data for manufacturing industries available to econometricians. It is true that the CBS has made corrections in the informations reported for a lot of units, in cases when there are obviously impossible combinations of informations. In the process of controls and revisions they may sometimes have got the correct values by contacting the establishments, or they have corrected the number to the more reasonable i.e. so that the consistency of the informations of an establishment is preserved. In most cases it is obvious which number(s) are wrong, and the "guestimates" on these, if not correct, are at least more close to the correct than the reported. So the net effect of the revisions by the CBS of the reported informations is a reduction of the errors in the data, and consequently a reduction of the effects of errors of measurement on our estimates.

In general are informations about <u>total</u> gross production, <u>total</u> consumption of raw materials considered to be of rather good quality. The quality of the components of these two items is more doubtfull, since the establishments more often than not have less difficulties in reporting the sum of gross production value and the sum of raw material consumed than to tell the distribution on different sub-items of these two. Also the reporting on duties and subsidies and traded goods is considered to be of rather good quality. Consequently should not the errors in our value-added variable be intolerable. The same is considered to be true for the components of our labour input concept and such informations as number of cars, HP of machinery installation, type of establishment, pension, social insuranse premiums and location. The year of establishing is also considered to be relatively reliable, though there may be cases when change of ownership is reported instead of the year of establishing.

The conslusion on this must not be that the errors in the variables mentioned are insignificant and unimportant. Much may be left even after a detailed revision of the informations reported. It is, however, generally believed that the quality of the reporting has a signifficant and positive correlation with size. Especially for the very small establishments is the quality rather bad. And this was also the main reason why these were excluded from our samples. By doing this the general quality of the data applied was thus obviously improved. And by this I think we gain more than we loose because our results are not automaticly valid for all establishments in the industries of the corresponding samples.

In 1957 the CBS interviewed 122 firms to obtain more informations about the reliability of the informations reported (i.e. to what degree they answered the questions on the forms in the way they were expected to do). The conclusion of this investigation was that in general the errors were quite insignificant. This conclusion is strictly valid only for large units in Manufacturing since the firms interviewed are among the largest and their establishments are also among the largest in Norway.

If the informations about the charateristics mentioned above are relatively reliable, this is not considered to be so for the informations about capital. Below we'll discuss more in details the main weaknesses of these informations.

Even if we had obtained our informations of capital without errors of measurement these are not very good as measure of the importance of capital in production. This is so especially when using the capital - stock - variable, but also to some degree also when using the "service - of - capital" variable. Firstly we apply the value of capital - not the quantity as is the relevant dimension as we stick to the production function framework. Secondly we have no informations about different vintages of capital though,this way to some extent be reflected in the value of the capital stock. (About the different measures of capital input see Griliches |5| and Johansen/Sørsveen [11]).

Thirdly there may be doubts concerning the "full insurance value" that the establishments are asked to report. The questions in this connection are: 1) What are "full fire insurance values" and 2) To what degree can we expect to get these informations from the establishments?

Decisive for the first question is the insurance practise of the insurance companies. To get more knowledge of this, we asked a representative of one of Norway's largest fire insurance companies the following questions:

1) Do full fire insurance values of the two types of capital, buildings and machinery express the market value of the objects, i.e. what one would have to pay to day for identically the same capital as the existing?

2a) How often is new evaluation of capital carried out, for 1) Buildings and 2) Machinery etc.

2b) Is the insurance-value adjusted for new capital, and deterioration and obsolescence of existing capital between each new evaluation? If so, in which way?

2c) Is the insurance-value corrected for general price-movements? How often, and in which way?

2d) Is the insurance-value corrected for special price-movements on different sub-types of capital e.g. different types of machinery? How often, and in which way?

3) Have tax-rules and writing-off rules and influence on the insurance-value?

4) Do the rules of evaluation vary between industry-groups?

5) Are rules of evaluation the same for all fire insurance companies?

6) To what degree do the establishments really insure the full value of their capital?

On the first question it was answered that the fire insurance companies tried to get as close as possible to the market-value as defined in the question.

New and thorough evaluation is carried out between each fifth and each tenth year. However, the insurance values are usually adjusted each year. What is then taken into account is: 1) General price-movements on a) buildings and b) machinery and other equipment. General price-indexes for these two types of capital are used for this purpose. 2) Special adjustments if the pricemovements for e.g. one type of machinery is apparently different from the general price-movement of machinery. 3) Adjustments for new capital objects. 4) Adjustments for deterioration and obsolescence. This is, however only done if the value of the objects is considered to be reduced with at least 1/3 of it's origianl value. This adjustment procedure is the rule. Exceptions exist, however.

The rules of evaluation do not vary between industry-groups, neither are rules different for different insurance-companies.

The tax-rules and writing-off rules do definitely not influence the evaluation.

Summing - up - full insurance value of capital is in principle a fairly good measure of the market - value of the capital-items i.e. that the values should reflect both the quantity and the quality of the capital stock in the establishments.

There is, however, a tendncy for smaller establishments to insure their capital only partly, while the larger ones - almost all of them - have insured all their capital. This in itself is no source of error, but combined with the way the questions are posed (i.e. full insurance value whether the establishments have insured all their capital or not) may lead to biased capital informations since one may in a lot of cases get only the value insured for - the questions are misunderstood or they who answer the questions do simply not know what realy is the full insurance value of the capital items as long as they are only partly insured. So the "goodness" for the capital informations is, I think very much dependent or to what degree the establishments can give, and really have given the full fire insurance value. There may be much error in the capital variables because of this.

Fourtly since one asks for capital owned and not capital used, one may get a lot of establishments with a substantial amount of their capital let to others. (As pointed out above are those establishments renting their production capital excluded). It has been impossible to get additional informations about the characteristics of these establishment, but the general impression in the CBS is that for Manufacturing this is a minor problem. There may be some establishments of this type, especially those of small and medium size, but the number of these in relation to the total number of establishments is considered to be low.

However, as a general evaluation of the capital informations we must say that they contain a lot of sources of errors, and the question left to discuss is then what effects this may have on our estimates.

Let us clarify this problen in the simple Cobb-Douglas case, writing the correct measures of production, labour and capital in log-values as y, x_1 and x_2^* respectively.

We have then the "true" relation:

(7.1) $$y = \alpha_0+\alpha_1 x_1+\alpha_2 x_2^*+u$$

where u is a stochastic variable, independently distributed with expected value $E(u) = 0$ and standarddeviation σ_u.

We assume that we observe and apply a measure of capital x_2 that contain errors in the following way:

(7.2) $$x_2 = x_2^*+v$$

where x_2^* as pointed out above is the correct measure of capital and v is an error variable with $E(v) = 0$ and constant standard deviation σ_v, we instead of (7.1) run:

(7.3) $$y = \alpha_0+ {}_1x_1+\alpha_2 x_2+w \qquad \text{where } w = u-\alpha_2 v$$

Since in (7.3) x_2 is dependent on W, we do not by means of the ordinary least square method obtain consistent estimates on the parameters in the production function. (See e.g. Durbin [2] or Malinvand [16] ch 10).

Now, what interests us is then the character of the bias in the estimates when applying the simple least square method in a situation with errors in the measurement of capital: Especially the bias in the capital elasticity but also the bias in the labour elasticity, and thus also the bias in the estimate of the scale-elasticity.

We will then build on the simplifying assumption above and further assume that the simple least square conditions are full-filled for (7.1) i.e. that u is uncorrelated with x_1 x_2^*, and also assume that v is uncorrelated with x_1, x_2 and u.

The least square estimates on α_1 and α_2 from (7.3) are

(7.4) $$\hat{\alpha}_1 = \frac{M_{1y}M_{22}-M_{2y}M_{12}}{M_{11}M_{22}-M_{12}^2}$$

and

(7.5) $$\hat{\alpha}_2 = \frac{M_{2y}M_{11}-M_{1y}M_{12}}{M_{11}M_{22}-M_{12}^2}$$

Where $\quad M_{kj} = \frac{1}{n} \sum_{i=1}^{n} (x_{ki}-\bar{x}_k)(x_{ji}-\bar{x}_j) \qquad k,j = 1,2$

and $\quad M_{j.y} = \frac{1}{n} \sum_{i=1}^{n} (y_i-\bar{y})(x_{ji}-\bar{x}_j) \qquad j = 1,2$

After some tiring algebra we find the probability limits of our estimates as:

$$\text{(7.6)} \qquad \underset{n\to\infty}{\text{plim}}\, \hat{\alpha}_1 = \alpha_1 + \alpha_2 \frac{\sigma_{12}\sigma_v^2}{\sigma_1^2(\sigma_2^2+\sigma_v^2)-\sigma_{12}^2}$$

and

$$\text{(7.7)} \qquad \underset{n\to\infty}{\text{plim}}\, \hat{\alpha}_2 = \alpha_2\left(1- \frac{\sigma_1^2\sigma_v^2}{\sigma_1^2(\sigma_2^2+\sigma_v^2)-\sigma_{12}^2}\right)$$

Where

$$\text{(7.8)} \quad \begin{cases} \sigma_1^2 = \lim\limits_{n\to\infty}\frac{1}{n} \sum\limits_{i=1}^{n} (x_{1i}-\bar{x}_1)^2 \\ \sigma_2^2 = \lim\limits_{n\to\infty}\frac{1}{n} \sum\limits_{i=1}^{n} (x_{2i}^*-\bar{x}_2^*)^2 \\ \sigma_{12} = \lim\limits_{n\to\infty}\frac{1}{n} \sum\limits_{i=1}^{n} (x_{1i}-\bar{x}_1)(x_{2i}^*-\bar{x}_2^*) \\ \sigma_u^2 = \underset{n\to\infty}{\text{plim}}\frac{1}{n} \sum\limits_{i=1}^{n} (u_i-\bar{u})^2 \\ \sigma_v^2 = \underset{\to\infty}{\text{plim}}\frac{1}{n} \sum\limits_{i=1}^{n} (v_i-\bar{v})^2 \end{cases}$$

Thus the estimate of the coefficient of the variable containing errors of measurement is negatively biased and the estimate of the coefficient of the variable not containing errors of measurement is also affected. If assuming, as usualy is true, that labour and capital are positively correlated and that the marginal productivity of capital is positive, then the estimate of the elasticity of labour get a positive bias because of errors of measurement in capital input. As the biases in our two estimates go in oposite directions (under very reasonable assumptions about intercorrelation between labour and capital, and capital productivity) the bias in the scale-elasticity must be expected to be minor. The bias is:

$$\underset{n\to\infty}{\text{plim}}\,\hat{\varepsilon} = \varepsilon + \frac{\alpha_2(\sigma_{12}-\sigma_1^2)\sigma_v^2}{\sigma_1^2(\sigma_2^2+\sigma_v^2)-\sigma_{12}^2} \tag{7.9}$$

and we could in fact test if $\sigma_{12}-\sigma_1^2 \neq 0$ and thus get an direct test of the bias in the scaleelasticity. (This is not done in the computations carried out till now, but may be carried out later on)

The conclusions obtained about the effects of errors of measurement in capital is based on not too restrictive assumptions. However, it should be added that labour input hardly is free of errors of measurement either as assumed, and that this may modify the biases computed above. One may also doubt that the relative error is, in probabilistic sense, the same for all units, as assumed. As the quality of informations is considered to be better for large establishments than for small, this may not be true. But I think the analysis above in any case throw light on the main effects of out estimates because of errors of measurement.

Before the discussion of errors of measurement is concluded, it should be pointed out that there are possibly also some systematic errors in our capital data. The interview with a representative of a fire insurance company told us that almost all large establishments insure all their capital, and that most of them even have a 10-15% "safity margin" above the true market value of capital, to be sure they do not loose anything on the insurance in case of fire accident. The small establishments very often insure their capital only partly. These differences between small and large establishments should not matter if all establishments reported the full five insurance value of their capital, whether all capital is insured or not. But if there is a tendency of reporting only the insurance value, and this may not be uncommon, then we get a systematic bias in our capital data: The capital reported from small units is on the average to low, while for larger establishments it is on the average to high.

To analyse the effect of this we may instead of (7.2) apply:

(7.10) $x_2 = \eta x_2 + v$ where $\eta > 1$

(See Malinvand |16| ch 10)

In the same way as above we now get

$$(7.11) \qquad \underset{n\to\infty}{\text{plim}}\ \hat{\alpha}_1 = \alpha_1 + \alpha_2 \frac{\sigma_{12}\sigma_v^2}{\eta^2\sigma_1^2\sigma_2^2 + \sigma_1^2\sigma_v^2 - \eta^2\sigma_{12}^2}$$

and

$$(7.12) \qquad \underset{n\to\infty}{\text{plim}}\ \hat{\alpha}_2 = \alpha_2\left(1 - \frac{\sigma_1^2\sigma_v^2}{\eta^2\sigma_1^2\sigma_2^2 + \sigma_1^2\sigma_v^2 - \eta^2\sigma_{12}^2}\right)$$

As $\sigma_1^2\sigma_2^2 - \sigma_{12}^2$ must be positive we see that the systematic errors in the capital data will bias our estimate on the labourelasticity still more upwards and our estimate of the capitalelasticity still more downwards, in addition to the effects of unsystematic errors in our capital data.

Even if the last effect analysed of errors in our capital data may be rather doubtfull because of limited knowledge of systematic errors possibly present, I think it is a rather safe conclusion that because of errors of measurement the estimates obtained of the labour-elasticity are too high and the estimates obtained on the capital-elasticity are too low, and that the estimates on the elasticity of scale are relatively little affected of these errors.

b) The assumption of the same parameters for all units in a sample.

To illustrate this problem we repeat the simple Cobb-Douglas production function (written in logs, see 7.1)

(7.13) $y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2$

A basic assumption made in the analysis is that the parameters α_j (j=0,1,2) are identical for all units in each sample. If this is not true we have made an spesification error that may make the interpretation of the parameters difficult, and it may lead to large standard-deviations of our estimates, which consequently leads to low degree of explanation power of out models. If both α_1 and α_2 are different for different units, the estimates we obtain on these two parameters are weighted averages of the micro-parameters for both labour and capital. The weights of the corresponding microparameters (i.e. the weights of α_{1i} in the estimate of α_1 and the weights of α_{2i} in the estimate of α_2) sum up to 1 while the weights of non corresponding microparameters (i.e. the weights of α_{1i} in the estimate of α_2 and the weights of α_{2i} in the estimate of α_1) sum up to zero. So only when one of the parameters is the same for all units is the same for all units is the estimate of the other dependent on corresponding microparameters only. (See Zellner [31])

It is little we can do with this problem in the present case, when only purely cross-section samples are available. We have, however, tried to group the units into sub-industries in a way that should make the assumption of identical parameters in the samples not too unrealistic. But the effects pointed out above may still be present, and may therefore be the main cause of poor fit and large standard deviations on our estimates for some groups.

c) Aggregation problems

A problem related to the one above is aggregation over inputs and outputs. Turning again to our simple Cobb-Douglas production function for illustration purpose, we know that both value added, labour input and capital input are aggregated variables, and that the method of aggregation is arithmetical sums. For the inputs, both, weighted and unweighted. What we should have done according to theory when aggregating inputs was to use geometric sums with weights proportional to the elasticities of the respective inputs. The general aggregation problems are analysed in a lot of publications (see e.g. Griliches [3], Theil [26] , Solow [25]), so it should not be necessary to repeat them here. It should, however, be pointed out that what we have done may lead to erroneous conslusions unless one inportant condition is fullfilled, namely that there are no substitution possibilities between the different components of our input variables. Even if we use linear logarithmic production functions, arithmetic aggregation is appropriate in that case. Then the estimate of the constant term may be affected only. And to assume nonsubstitutability between the different components of our labour and capital variables seems to me to be fairly reasonable.

For our labour measure the properitors and unpaid family members may be a problem, but in total they do count for a very little part of the labour power, so I think they do not cause much trouble in this context.

For capital there are hardly any substitution possibilities between buildings and machinery. For cars it may, however, be different, since our production-measure is a value concept and as this value is measured, it can be increased substantially by increasing the number and application of cars for transportation.

As a conclusion I think we can say that there are some possibilities for substitution between the components of our production factors but that they are not of such an importance that this invalidates our analysis.

Most of the units in our samples produce more than one type of product. The most statisfactory way of analysing these would therefore be to apply multiproduct productions functions. However, the econometric theory in this field is almost completely lacking, (see however, Mundlak [19]) and the informations making such an analysis possible are also lacking.

When applying aggregated output, the production function is no longer single valued and the parameters depend in general on the composition of output which, in turn, depends, among other things, on the prices of the products in question. (See Mundlak [19]) To say something about the effects of this is in the present case impossible since the informations that could tell us something are completely lacking.

d) Differences in quality

Differences in quality are also a kind of error of measurement, but we want to discuss it separately since we believe that we can say something more spesicic about quality differences than if they just were considered as "errors".

Writing the Cobb-Douglas production function.

$$(7.14) \qquad y = \alpha_0+\alpha_1x_1+\alpha_2x_2+w$$

where $y=\ln V$, $x_1=\ln L$ and $x_2=\ln SK$ as previously, we may have differences in quality both for labour and capital. Since our capital measure in principle is the market value it should also reflect difference in quality. Substantial errors of measurement may however, make this reflection rather vague, but this is another story, and is discussed in details above. What is left is then to discuss differences in quality concerning labour. Neither our N-variable or our L-variable reflect quality differences. The L-variable may, however, tell us something about the effect of the differences in quality of wage-earners and employees. But the general level of labour-quality in an establishment is not taken care of by these variables.

The quality-differences in labour-input may both be due to differences in the quality of the hired labour and to proprietors and familymembers working in the establishment.

If we assume that there exists an quality index Q such as if multiplied with the quantity of labour input L gives the true measure of labour input, we should in fact have run: (See Griliches [3])

$$(7.15) \qquad y = \alpha_0+\alpha_1(x_1+q)+\alpha_2x_2+u$$

where $q = \ln Q$, instead of (7.14).

By running (7.14) we get biased estimates since $w=u+\alpha_1q$. As previously we are interested in what way we get inconcistent estimates when applying the least square method where the conditions for obtaining consistent estimates are not fullfilled, because of differences in quality of labour input.

By applying the least-square formulas (7.4) and (7.5) in this case, and taking probability limits, we get:

$$\text{(7.16)} \qquad \operatorname*{plim}_{n\to\infty} \hat{\alpha}_1 = \alpha_1\left(1+\frac{\sigma_{q1}\sigma_2^2-\sigma_{q2}\sigma_{12}}{\sigma_1^2\sigma_2^2-\sigma_{12}^2}\right)$$

and

$$\text{(7.17)} \qquad \operatorname*{plim}_{n\to\infty} \hat{\alpha}_2 = \alpha_2+\alpha_1\frac{\sigma_{q2}\sigma_1^2-\sigma_{q1}\sigma_{12}}{\sigma_1^2\sigma_2^2-\sigma_{12}^2}$$

where $\sigma_{qj} = \lim_{n\to\infty} \frac{1}{n}\sum_{i=1}^{n}(q_i-\bar{q})(x_{ji}-\bar{x}_j) \qquad j = 1,2$

For the definitions of $\sigma_1\sigma_2$ and σ_{12}, see (7.8).

If we argue along the same lines as Griliches |3|, that the quality of labour may be a substitute for quantity ($\alpha_{q1}<0$), and that establishments with high labour-quality tend to use more capital since high labour quality increases the marginal productivity of capital, we have negative bias for $\hat{\alpha}_1$ (estimate of the labour elasticity) and positive bias for $\hat{\alpha}_2$ (estimate of the capital elasticity) - if labour and capital are positively correlated ($\sigma_{12}>0$), as is reasonable to assume.

The probability limit the estimate of the elasticity of scale, as defined previously is:

$$\text{(7.18)} \qquad \operatorname*{plim}_{n\to\infty} \hat{\varepsilon} = \varepsilon+\alpha_1\frac{\sigma_{q1}(\sigma_2^2-\sigma_{12})+\sigma_{q2}(\sigma_1^2-\sigma_{12})}{\sigma_1^2\sigma_2^2-\sigma_{12}^2}$$

and we see that nothing general can be said about the direction of the bias in this case.

If we, however, also consider the quality of labour as a factor of production, and as in (7.15) assume it has the same elasticity as quantity of labour in production, it may be natural to define the elasticity of scale as (See Griliches [3])

$$\text{(7.19)} \qquad \varepsilon' = 2\alpha_1+\alpha_2$$

and the asympthotic bias in our estimate of the elasticity of scale as defined in (7.19) is:

$$(7.20) \qquad \alpha_1 \left(\frac{\sigma_{q1}(\sigma_2^2 - \sigma_{12}) + \sigma_{q2}(\sigma_1^2 - \sigma_{12})}{\sigma_1^2\sigma_2^2 - \sigma_{12}^2} - 1 \right)$$

and we can conclude that in this case we consistently underestimate the elasticity of scale even if we assume $\sigma_{q1} < 0$.

The problem of omitted variables is related to the one discussed here. The "factor" one in most cases is thinking of in this connection is the managerial ability. This is to some extent included in the quality of labour discussion since properitors are included in our labour-input variable. The **effects are generally the same**, and we can say equally much or equally little as in the case with differences in labour quality. (See Griliches [3] . His discussion conserns agricultural production units but seems to me to be equaly valid for manufacturing).

Differences in the quality of labour may also complicate the estimation of the elasticity of substitution from the ACMS-relation. (See Griliches [4])

We have:

$$(7.21) \qquad \ln\frac{V}{L} = a + b\ln W + u$$

If the proper measure of the labour input should be QL, following relation should have been applied instead of (7.21): (See Griliches [4])

$$(7.22) \qquad \ln\frac{V}{QL} = a + b\ln W^{*} + u$$

where $W^{*} = \dfrac{\text{Total payroll}}{QL}$

Our measure of the wage-rate is $W = \dfrac{\text{total payroll}}{L}$ (this is, however, only approximately true) we have the following relation between u and v:

$$(7.23) \qquad u = v + (1-b)q \qquad \text{where} \quad q = \ln Q.$$

As quality of labour obviously is positively correlated with the wagerate i.e. covar(q,lnW) = $\sigma_{qW}>0$, we get a biased estimate on the elasticity of substitution when applying the least square method on (7.21).

The probability limit of this estimate is in fact:

$$(7.24) \qquad \operatorname*{plim}_{n\to\infty} \hat{b} = b+(1-b)\frac{\sigma_{qW}}{\sigma_W^2}$$

When the elasticity of substitution is above one the bias is negative and when it is below one it is positive. So ignoring quality differences in labour input when estimating the elasticity of substitution from the ordinary ACMS-relation, bias our estimate towards one. And still worse; if the only cause of variation in the wage rate is differences in quality of labour, we get plim $\hat{b}$ = 1 (since we then have $\sigma_{qW}=\sigma_W^2$),and we have complete loss of identification. (See Minasian [18])

e) Assumptions concerning the production function

Most of the relations applied for regressions are homothetic i.e. the marginal rates of substitution depend only on input proportions, and not on the scale of production. Our assumptions are, however, a bit stronger in most cases since we also assume a constant elasticity of scale. A homothetic production function may have a variable scale-elasticity if it depends only on the level of production (See Ringstad [24]).

But even in cases when both the scale-elasticity and the elasticity of substitution are constants they may have values different from those supposed. The Cobb-Douglas production function pre-supposes an elasticity of substitution of one. If this is not true we may get biased estimates on both the elasticity of labour and the elasticity of capital. I have found no other way of analysing this than by applying the Kmenta-approximation of the CES-function, which permits us to make a direct comparison of the estimates on the factor elasticities obtained when assuming the elasticity of substitution equal to one and when allowing it to be different from one but still constant.

When we in the ACMS-relation (6.10) assume the elasticity of scale to be one we get a problem related to the one above. The problem is perhaps a bit worse in this case since we have to introduce a endogenous variable to investigate the effect of the elasticity of substitution of our assumptions concerning the scale-properties and/or homotheticity of production. We then run into simultaneous equation problems, but these will be discussed later.

If either the elasticity of scale or the elasticity of substitution, or both in some, way or another vary, we have a situation similiar to the one discussed in point b) above. By applying a Cobb-Douglas or a CES-function in this case may not be disastrous if we are interested in the level of the two elasticities for the sample. This seems generally to be true according to Mundlak's analysis |19| and it seems to be true for a special case (though under rather restrictive assumptions) for the scale-elasticity, Ringstad |24|.

A way of investigating our assumtions about homotheticity is to apply the ACMS-relations when the lnL term or the lnV term is included. As shown in section 2; if the degree of non-homotheticity is slight (i.e. $m \simeq 1$) will the estimate of the elasticity of scale be approximately equal to the estimate of μ. And as pointed out, in this case it is also reasonable to assume that the estimate of the elasticity of substitution will be approximately equal to $\sigma = \frac{1}{1+\rho}$. But as long as these relations suffer from simultaneous equations errors will this way of investigating the homotheticity assumptions be of relatively little value.

f) Non-observable prices.

There are two, possibly three prices we would have liked to have informations about, but that are either not available or have to be "constructed". These are the price of output and capital, but the price of raw material could also have been of some value for us. For labour we have constructed a "price" as the average payment pr. hour for production workers. We have also tried to construct a "price" of capital, but this variable is obviously dominated of errors of measurement and is thus of limited value. For gross production and raw materials (and consequently for value added) we have no possibility to construct such a price. Thus value added is as the name indicate a value concept while the appropriate measure is a quantity concept. To analyse possible effects of applying a value-concept instead of a quantity concept for production we apply the simple Cobb-Douglas production function once more:

(7.25) $$y = \alpha_1+\alpha_1 x_1+\alpha_2 x_2+u$$

The correct spesification of this production function should however be:

(7.26) $$y-p = \alpha_0+\alpha_1 x_1+\alpha_2 x_2+v$$

where P = antilog p is a price index of value added. If model (7.26) have all properties necessary for obtaining unbiased estimates when applying the simple least square method this is not necessarely so for modell (7.25) since we have

(7.27) $$u = v + p$$

and the conditions necessary to obtain unbiased estimates are simply that

(7.28) $$\text{covar } x_1 p = \text{covar } x_2 p = 0$$

If (7.25) is true or not depends very much on behaviour of establishments. If they try to maximize profit with respect to one or both production factors will not (7.25) be true, but then, without additional assumptions, will not even (7.26) give unbiased estiamtes.

Simultanous equation problems will be discussed below, but assume that the conditions are fullfilled for independence between the errorterm in the production function and the inputs even when the behaviour is profit maximation with respect to labour (this last assumption will also be commented on below) Then we'll have:

(7.29) $$\text{covar } x_1 p > 0$$

and in addition we assume covar $x_2 p = 0$.

Applying: the least square formulas in (7.4) and (7.5) and taking probability limits, we get:

(7.30)
$$\operatorname*{plim}_{n\to\infty} \hat{\alpha}_1 = \alpha_1 + \frac{\sigma_{1p}\sigma_2^2}{\sigma_1^2\sigma_2^2 - \sigma_{12}^2}$$

$$\operatorname*{plim}_{n\to\infty} \hat{\alpha}_2 = \alpha_2 - \frac{\sigma_{1p}\sigma_{12}}{\sigma_1^2\sigma_2^2 - \sigma_{12}^2}$$

where:

(7.31) $$\sigma_{1p} = \lim_{n\to\infty} \frac{1}{n} \sum_{i=1}^{n} (x_{1i} - \bar{x}_1)(p_i - \bar{p})$$

Thus even if the profitmaximizing behaviour with respect to labour is assumed not to imply interdependence between the factor inputs and the error term in the production function, will variations in the price of output imply biased estimates. And the bias is positive for the estimate of the elasticity of labour and assuming labour and capital positively correlated, a negative bias for the elasticity of capital.

The bias in the scale-elasticity will in this case be:

(7.32) $$\operatorname*{plim}_{n\to\infty} \hat{\varepsilon} = \varepsilon + \frac{(\sigma_2^2 - \sigma_{12})\sigma_{1p}}{\sigma_1^2\sigma_2^2 - \sigma_{12}^2}$$

and as in the case of errors of measurement in capital we could in fact thest if $\sigma_{22} \neq \sigma_{12}$ and thus get an direct test of the bias in the scale-elasticity.

The price-problem is also present in the other main type of relations in our study, namely the ACMS-relation for estimation of the elasticity of substitution:

$$(7.33) \qquad \ln\frac{V}{L} = a_0 + b\ln W + u$$

As pointed out in section 2 the correct spesification of this modell should be:

$$(7.34) \qquad \ln\frac{V^*}{L} = a_0 + b\ln\frac{W}{P} + v \qquad \text{where } V^* = \frac{V}{P}$$

and we then get the following relation between u and v:

$$(7.35) \qquad u = v + (1-b)\ln p$$

Much of the variation in the measured wagerate is certainly due to the same causes as the variation in price, namely location. So even if there are forces complicating this picture, we may expect that there is some positive correlation between the wage-rate as measured above and the price i.e. covar $p\ln W = \sigma_{WP} > 0$. So even our estimates of the elasticity of substitution are in general biased, and the probability limit can be shown to be:

$$(7.36) \qquad \underset{n\to\infty}{\text{plim}}\ \hat{b} = b + (1-b)\frac{\sigma WP}{\sigma_W^2}$$

i.e. when the elasticity of substitution is above one then the bias is negative, and when the elasticity of substitution is below one, then the bias is positive. So when ignoring price-differences in output we must expect our estimates of the elasticity of substitution to be biased towards one.

In the same way as for quality differences labour input we in this case will get complete loss if identification in relation (7.33) if all variation in the wage-rate is due to variations in the price of output. Then $\sigma_{WP} = \sigma_W^2$ and plim $\hat{b} = 1$.

If the price variations mainly are due to differences in location, the effect on our estimates of ignoring these differences in estimation may to some extent be eliminated by including region variables in both the production relation and the ACMS-relation applied in estimation. These region variables are, however, in a sense complex as not only price variations may be included in them, but also such elements as regional differences in productivity. They may also be correlated with the size-distribution of establishments and they may therefore also reflect differences in productivity with size. But the region variables are the only ones that can tell us anything abour pricevariations. But on background of what is said above, the interpretation of the corresponding stimates is difficult.

g) Problems of imperfect markets.

Some authors have argued that imperfect markets may make the estimation of the elasticity of substitution from a simple ACMS-relation invalid. Below we'll show that this is not true under rather reasonable assumptions about the character of the imperfections.

When applying the ACMS-relation one usually assumes perfect competition and in this case we have:

$$(7.37) \qquad \ln\left(\frac{\partial V}{\partial L}\right) = \ln W + u$$

(where u is a samdom variable)

If we assume that there exist a constant elasticity of supply of labour and a constant elasticity of demand of the product, both different from zero, we get instead of (7.37) (See e.g. Klein [13])

$$(7.38) \qquad \ln\left(\frac{\partial V}{\partial L}\right) = \ln\left(\frac{1+\frac{1}{\eta}}{1+\frac{1}{\xi}}\right) + \ln W + u$$

where η is the elasticity of supply and ξ is the elasticity of demand. In case of the CES-function we then get:

(7.39) $\ln\frac{V}{L} = a + b\ln W + U$

where $a = \frac{1}{1+\rho}\ln\left(\frac{\gamma}{\delta}^{-\rho}\frac{(1+\frac{1}{\eta})}{(1+\frac{1}{\xi})}\right)$

Consequently only the constant term is affected in the incomplete competition case compared with the perfect competition case.

h) Simultanous equations problems.

The different relations applied are based on different assumptions about behaviour. As pointed out previously it seems to be reasonable in the present case to assume that capital is predetermined and subject to long run considerations concerning profit. The same may to some extent be true for labour, but as this is a more mobile factor of production the possibility to adjust this factor to existing conditions is better.

When running relations founded on the Cobb-Douglas production function, either of two assumptions must be true, least we get biased estimates. a) There is no economic behaviour - neither, profit maximation nor cost minimation etc. b) The units maximize the expected value of profits i.e. profit-maximation with respect to labour is carried out in terms of expected prices for labour and product. (See Irvin Hoch [9] or Irwin Hoch and Yair Mundlak |10|). In general if the error in the production function affects only output and is not transmitted to the other variables in the system, then there is no simultaneous equations bias i.e. the conditions for applying the simple least square method on the production function are fullfilled.

So if the error in the production function is fully or partly transmitted to the first order condition for profit maximum, then the conditions for obtaining unbiased estimates by applying the ordinary least square method on the production function are <u>not</u> fullfilled. Write the Cobb-Douglas production function as:

(7.40) $y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + u$

and the first order condition:

(7.41) $$y - x_1 = \ln\alpha_1 + x_3 + v$$

where x_3 = log wage-rate and u and v are error terms, independently distributed.

If the error term in (7.40) is fully transmitted to (7.41) it can be shown that we when applying the ordinary least square method on (7.40), get estimates with the following asymthotic properties:

(7.42) $$\operatorname*{plim}_{n\to\infty} \hat{\alpha}_1 = \alpha_1 + \frac{(1-\alpha_1)\sigma_u^2}{\sigma_3^2 - \frac{\sigma_{23}^2}{\sigma_2^2} + \sigma_u^2 + \sigma_v^2}$$

and

(7.43) $$\operatorname*{plim}_{n\to\infty} \hat{\alpha}_2 = \alpha_2 - \frac{(\alpha_2\sigma_2^2 - \sigma_{23}^2)\sigma_u^2}{\sigma_2^2(\sigma_3^2 + \sigma_u^2 + \sigma_v^2) - \sigma_{23}^2}$$

As we must have α_1 and α_2 both less than 1 (second order conditions for profit maximum) we see from (7.37) that the elasticity of labour will be biased upwards. From (7.38) we see that for the elasticity of capital the bias can bee both positive and negative, it depends on the size of the elasticity of capital, the variance of capital and the intercorrelation between wages and capital. If this intercorrelation is strong, then we can expect to get a positive bias.

For the elasticity of scale we have:

(7.44) $$\operatorname*{plim}_{n\to\infty} \hat{\varepsilon} = \varepsilon + \frac{\sigma_u^2\left((1-\varepsilon) + \frac{\sigma_{23}^2}{\sigma_2^2}\right)}{\sigma_3^2 + \sigma_u^2 + \sigma_v^2 - \frac{\sigma_{23}^2}{\sigma_2^2}}$$

If it is strongly increasing returns to scale the bias may be negative, while for constant returns to scale and decreasing returns to scale the bias is positive. The bias - in case of constant returns to scale is simply

$$\frac{\sigma_u^2\sigma_{23}^2}{\sigma_2^2(\sigma_3^2+\sigma_u^2+\sigma_V^2)-\sigma_{23}^2}$$

Thus the simultanous equations effects of our single equation estimates tend to equalize the returns to scale estimates - i.e. large returns to scale are biased downvards and small are biased upwards.

To sum up this section is difficult. We have, though under simplifying assumptions, analysed different sources of systematic errors that seem to be the most important in the present study. The analysis is partial and to conclude about the total effect of two or more sources of errors is a bit dangerous, since we cannot without additional assumptions add the errors together. There may be a substantial interaction and interdependence between the different types of errors. But I think it is fairly safe guesses that a) In the Cobb-Douglas case do we get estimates of the elasticity of labour that are too high and estimates on the elasticity of capital that are too low, b) In the ACMS-case do we get estimates on the elasticity of substitution that are biased towards unity. c) Unless we define the elasticity of scale also to include the elasticity of labour-quality, is it impossible to say anything about the probable bias in the elasticity of scale. d) These conclusions are also more or less valid for the other relations in this study, not only to the simple Cobb-Douglas production function and the simple ACMS-relation which are those two relations we have analysed in conection to the discussion of different types of systematic errors in our estimates.

Section 8

The Results

In this section some selected results are presented and discussed. To present all results seems to be of no use, and it would have made this section almost unreadable. To some degree the selection is arbitrary, but the main principles for selection are everywhere the same. Firstly we have consentrated the presentation around the five main types of production functions in this study. Namely the value added Cobb-Douglas production function, the gross production Cobb-Douglas production function, the Kmenta approximation, the ACMS-relation (relation 6.10) and finally one or two production functions where the log-linearity and/or the homotheticity assumptions of the "CES"-function are investigated. (relations 6.14 and 6.15) These relations are denoted Net C.D, Gross C.D. Appr. CES, CES and "CES" respectively, also when one or more quality-variables are included. It should be added, however, that the Kmenta-approximation often leads to insensible results concerning the elasticity of substitution (negative estimates), and in these cases, and in cases when the estimate of the coefficient of the square-term is very low in relation to its estimated standard devivation, this relation is not included among those presented.

Secondly we have included in some runs those quality-variables that seem to explain a significant part of the variations in the value added per labour input unit. To know which variables this might be, we have applied (6.5) and (6.9) for "pilot-runs", and rerun some relations including these variables. This "fishing" in the data makes of course the statistical interpretation difficult and the usual t-and F-tests are not strictly valid in this case. I will, however, apply the terms "significant" and "insignificant". And then simply as a short hand description of the explanation power of the variables whose corresponding estimated coefficients are above or below two times their estimated standard deviations, respectively.

For all regressions included in the presentation we give estimates, standard deviations, multiple correlation coefficients and mean square of the deviation from regression (unexplained variation denoted M.SQ). All runs are carried out on an IBM 360 in double precision.

In this section we firstly present some results for "Total Manufacturing" i.e. for all units included in the present study pooled into one sample. Secondly we comment some regressions run for most samples, but not included in the discussion elsewhere. Thirdly we present and comment some selected results for the different samples, mainly those samples presented in table (5.1), but also some others.

The discussion is not as detailed and complete as it should be, mainly because of limited time available. But a reason for incompleteness is also that we still are at a relatively early stage of the project, and consequently have only partly managed to exhaust all possible informations about the different manufacturing industries present in our data and available from external sources.

A) Results for "Total Manufacturing".

In addition to the "merged" sample consisting of all units in the 27 groups presented in table (5.1) we also applied a sample consisting of of all units in Manufacturing not excluded because of the criterions listed on p. 32 in this paper. So we in this sample have 1786 units in addition to those 5361 in our 27 groups.

The differences in the results of these two sets of data were all minor: The estimates on the elasticity of scale were allmost identical, the estimates on the elasticity of substitution (both for the Kmenta approximation and the ACMS-relation) were slightly higher for the larger sample, the estimates on the labour elasticity a bit lower, and the estimate on the capital elasticity a bit higher for the larger sample. The differences of the estimates on the coefficients of the qualityvariables were also ignorable. So on the average the units not excluded because of the criterions on p. 32, but nevertheless excluded of other reason are not much different from those we have included in the runs presented in this section. There may, however, be large variations between individual groups of those excluded, and I think, larger variations than between those groups included in the present study. (See p. 33 where our main arguments for exclusion of groups are presented)

In section 4 two measures of labour input and two measures of capital input are presented. We have N and K as unweighted sums of the components of labour and capital respectively, and L and SK as weighted sums. Even if we are going to present the results only when L and SK are used, it may be of some interest to compare the results we obtain for the "weighted-sum-input" version with those obtained for the "unweighted-sum-input version".

In table (8.1) we present the results for three relations, the simple Cobb-Douglas relation, (1) the same relation when qualityvariables for labour and capital are included (3) and for the Kmenta-approximation to the CES-function (2). It should be noted that for the N-K version, $\ln\frac{V}{N}$ is applied as the dependent variable while $\ln\frac{V}{L}$ is applied in the L-SK case.

It is interesting to note that in this case, where we have pooled all units into one sample the standard deviations of the estimates are very small in relation to the size of the corresponding estimates. This indicates that the differences between the different manufacturing industries are much less significant than one could have expected. This is, however, not the case for g_3f and E, that on the average seem to have no influence on value added in the manufacturing industries.

Table 8.1

The effects of different measures of labour and capital input.

	The N,K-version				The L, SK version		
	1	2	3		1	2	3
lnN	0.072 (0.006)	0.072 (0.006)	0.057 (0.007)	$\ln^{T}$	0.064 (0.005)	0.064 (0.005)	0.052 (0.006)
$\ln\frac{K}{N}$	0.229 (0.009)	0.336 (0.055)	0.244 (0.009)	$\ln\frac{SK}{L}$	0.199 (0.009)	0.236 (0.023)	0.199 (0.009)
$(\ln\frac{K}{N})^2$		-0.013 (0.007)		$(\ln\frac{SK}{L})^2$		-0.012 (0.007)	
d			-0.541 (0.073)	d			-0.428 (0.070)
g_1			0.175 (0.038)	g_1			0.004 (0.038)
g_2			1.796 (0.197)	g_2			0.621 (0.180)
g_3			0.001 (0.001)	g_3			0.001 (0.001)
f			0.024 (0.033)	f			0.048 (0.032)
E			-0 (0.001)	E			+0 (0.001)
Inter-cept	2.045	1.837	1.968	Inter-cept	1.920	1.897	1.956
R	0.394	0.394	0.420	R	0.351	0.352	0.362
M.SQ	0.224	0.224	0.219	M.SQ	0.203	0.203	0.202
		$\hat{\alpha}=0.229$ $\hat{\delta}=0.880$				$\hat{\alpha}=0.200$ $\hat{\delta}=0.877$	

The differences in the effects for the "true" factors of production, labour and capital, are as we see only minor. The estimated elasticity of capital is slightly lower for the L-SK version than for the N-K version, while the opposite is true for the estimated elasticity of labour, but the difference is smaller. So the estimated elasticity of scale is somewhat lower for the L-SK version.

The main differences of the N-K, and L-SK versions can, however, be read from the estimates on the coefficients of our ratio-variables. The estimated effect of our g_1-variable (that tells us if the **machinery** capital is correctly weighted in our capital-input measure or not) is reduced to almost nothing in the L-SK version. A substantial reduction in the effect of our g_2-variable (value of cars in relation to total capital value) is also worth noting. The gains in weighting the labour input components in the way we have done seem, however, to be much smaller. To impute an average number of hours worked for owners and family-members equal to the average number of hours worked for production workers in manufacturing seems to overstate, highly significant, either quantity or quality (or both) of the work done by these. This is an interesting finding in itself, and may lead to another, and lower, weight given to this type of labour input.

Even if there are large individual variations between the samples we have divided the manufacturing industries into, the application of the L-SK version instead of the N-K version leads to a lot of cases more when the ratio-variables are of insignificant importance (in the sense of this term pointed out previously). This, together with other differences of any interest between the two versions will, however, be discussed when the results for each sample are presented.

Even if the variations between industry groups seem to be minor, we have also run some regressions containing dummy-variables for two-digit industry groups. We have then used industry-group 20 as the base group. In table 8.2 we present results for Net C.D. Gross C.D. and Appr. CES. and in table 8.3 we present results for the CES and "CES" relation. The "a" tables contain results when no industrydummies are used, and the "b" tables contain results for the same regressions when industry dummies are included. Finally we in table 8.4 present the estimates on the coefficients of the industrydummies for three cases; for the net and gross Cobb-Douglas production functions when only "true" factors of production are included in addition to the industry-dummies, and for the simple ACMS-relation where only the logwage-rate is included in addition to the industry dummies.

As we see does not the introduction of such industry-dummies change the results very much. The inprovement of the fit is slight and the changes in the estimates are all minor. The estimates on the coefficients of the industry-dummies are in most cases significant and there are relatively good correspondance both in sign and size between the sets of estimates obtained for the net and gross Cobb-Douglas production function, while for the CES-function compared with the two other relations there are substantial divergenses, especially for the groups 28-38. It is difficult to get a reasonable explanation for this.

More interesting it is to compare the results obtained for different types of relations. Firstly we see that in addition to the results obtained for the quality -variables in the regressions presented in table 8.1, table 8.2 and 8.3 tells us that "type of establishment" on the average is of significant importance for production. Establishments belonging to mulitunit firms have slightly but significantly higher production value per labour input unit. On the average is also region of importance. As production is measured by us (value added or gross production value) is output per labour input unit in the Oslo-region significantly higher than in the two other regions. When using the CES and related production functions this is, however, much less clear. The way we have measured the wage-rate seems to have taken care of much of the regional effects in the production value.

If the regioanl differences in the value added mainly are due to differences in the pricelevel of value added or the efficiency of labour, the differences of the effects concerning our regionvariabeles in the Cobb-Douglas production functions and the Kmenta-approximation compared with those in the ACMS and related functions may be due to that the variations in the wage-rate are mainly a reflection fo differences in efficiency and prices of output. This is a very probable explanation to my opinion, but it is not comfortable as this, as pointed out in section 7, may lead to identification problems concerning the elasticity of substitution. There seems, however, also to be some other sources of variation in the wage-rate, since the ACMS-relation, both with - and without "quality" variables give an elasticity of subsitution significantly below one (though with slight margin) Since our estimates of the elasticity of substitution obtained by means of the ACMS-relation obviously are biased towards

Table 8.2

Estimates based on the net and gross Cobb-Douglas production functions and the approximated CES function.

Table 8.2a Industry-dummies not included

	Net C.D.		Gross C.D.			Appr.	CES
$\ln L$	0.064	0.058	0.022	0.006		0.064	0.057
	(0.005)	(0.008)	(0.003)	(0.004)		(0.005)	(0.008)
$\ln\frac{SK}{L}$	0.199	0.192	0.101	0.090		0.236	0.235
	(0.009)	(0.009)	(0.005)	(0.005)		(0.023)	(0.023)
$\ln\frac{M}{L}$			0.560	0.554	$(\ln\frac{SK}{L})^2$	-0.012	-0.015
			(0.004)	(0.004)		(0.007)	(0.007)
d		-0.363		-0.227			-0.372
		(0.072)		(0.040)			(0.072)
g_1		-0.006					0.001
		(0.038)					(0.038)
g_2		0.533					0.526
		(0.180)					(0.180)
B		0.039		0.051			0.041
		(0.014)		(0.008)			(0.014)
r_3		-0.098					-0.095
		(0.031)					(0.031)
R_1		-0.082		-0.042			-0.082
		(0.015)		(0.009)			(0.015)
R_2		-0.108		-0.036			-0.108
		(0.015)		(0.009)			(0.015)
Intercept	1.920	2.021	1.654	1.760		1.897	1.996
R	0.351	0.377	0.920	0.023		0.352	0.378
MSQ	0.203	0.199	0.067	0.066		0.203	0.199
						$\hat{\alpha}=0.200$	$\hat{\alpha}=0.192$
						$\hat{\sigma}=0.877$	$\hat{\sigma}=0.851$

Table 8.2b. Industry dummies included

$\ln L$	0.067	0.057	0.017	0.003		0.067	0.056
	(0.006)	(0.008)	(0.003)	(0.004)		(0.006)	(0.008)
$\ln\frac{SK}{L}$	0.184	0.176	0.085	0.076		0.216	0.213
	(0.009)	(0.010)	(0.005)	(0.006)		(0.023)	(0.023)
$\ln\frac{M}{L}$			0.571	0.568	$(\ln\frac{SK}{L})^2$	-0.011	-0.013
			(0.004)	(0.004)		(0.007)	(0.007)
d		-0.363		-0.215			-0.370
		(0.072)		(0.039)			(0.072)
g_1		-0.020					-0.014
		(0.039)					(0.040)
g_2		0.345					0.338
		(0.180)					(0.180)
B		0.042		0.040			0.043
		(0.014)		(0.008)			(0.014)
r_3		-0.071					-0.069
		(0.030)					(0.030)
R_1		-0.082		-0.042			-0.082
		(0.015)		(0.008)			(0.015)
R_2		-0.098		-0.034			-0.098
		(0.015)		(0.009)			(0.015)
Intercept	1.924	2.043	1.672	1.763		1.908	2.025
R	0.398	0.417	0.928	0.929		0.398	0.418
M.SQ	0.196	0.193	0.061	0.060		0.196	0.192
						$\hat{\alpha}=0.184$	$\hat{\alpha}=0.176$
						$\hat{\sigma}=0.884$	$\hat{\sigma}=0.855$

Table 8.3

Estimates based on the CES-and related functions.

Table 8.3a. Industry-dummies not included

	CES				"CES"			
lnW	0.950 (0.024)	0.918 (0.024)	0.941 (0.025)	0.896 (0.025)	0.913 (0.024)	0.888 (0.025)	0.682 (0.023)	0.693 (0.023)
lnL					0.044 (0.005)	0.022 (0.006)		
lnV							0.150 (0.004)	0.163 (0.005)
d				-0.450 (0.060)		-0.348 (0.066)		0.379 (0.059)
B				0.077 (0.012)		0.070 (0.013)		0.018 (0.011)
r_1		-0.066 (0.013)						
r_2		0.056 (0.023)						
r_3		0.056 (0.023)						
R_1			-0.019 (0.015)	-0.021 (0.014)		-0.017 (0.014)		0.011 (0.013)
R_2			-0.018 (0.015)	-0.022 (0.014)		-0.014 (0.015)		0.042 (0.013)
Intercept	0.611	0.691	0.641	0.730	0.529	0.659	0.242	0.090
R	0.473	0.482	0.473	0.494	0.484	0.496	0.614	0.619
M.SQ	0.180	0.178	0.180	0.176	0.178	0.175	0.145	0.143

Table 8.3b. Industry-dummies included

lnW	0.973 (0.026)	0.946 (0.026)	0.963 (0.026)	0.921 (0.027)	0.943 (0.026)	0.914 (0.027)	0.671 (0.025)	0.682 (0.025)
lnL					0.032 (0.006)	0.018 (0.006)		
lnV							0.150 (0.004)	0.176 (0.005)
d				-0.355 (0.060)		-0.283 (0.065)		0.412 (0.058)
B				0.034 (0.013)		0.029 (0.013)		-0.021 (0.012)
r_1		-0.048 (0.013)						
r_2		0.046 (0.022)						
r_3		0.029 (0.023)				-0.021 (0.014)		-0.003 (0.013)
R_1			-0.019 (0.014)	-0.023 (0.014)		-0.023 (0.015)		0.012 (0.013)
R_2			-0.024 (0.015)	-0.026 (0.015)				
Intercept	0.638	0.705	0.674	0.755	0.589	0.708	0.295	0.162
R	0.520	0.523	0.520	0.527	0.524	0.528	0.640	0.645
M.SQ	0.170	0.169	0.170	0.168	0.169	0.168	0.137	0.136

Table 8.4

Estimates on the coefficients of the industry-dummies

	Group	Intercept	21	23	24	25	26	27
1	Simple net C.D.	1.924	0.126 (0.061)	-0.153 (0.032)	-0.143 (0.028)	-0.044 (0.020)	-0.011 (0.020)	-0.130 (0.036)
2	Simple gross C.D.	1.672	0.410 (0.034)	-0.116 (0.019)	-0.022 (0.017)	-0.083 (0.011)	-0.080 (0.012)	-0.101 (0.020)
3	Simple CES	0.638	0.183 (0.056)	-0.006 (0.030)	-0.106 (0.026)	-0.166 (0.019)	-0.198 (0.019)	-0.006 (0.032)

(continued)

	28	31	33	34	35	36	37	38
1	0.031 (0.038)	0.228 (0.033)	0.191 (0.030)	0.085 (0.074)	0.089 (0.024)	0.045 (0.032)	0.100 (0.046)	0.026 (0.040)
2	0.070 (0.022)	0.082 (0.018)	0.143 (0.017)	0.078 (0.042)	0.060 (0.014)	0.012) (0.019)	0.049 (0.026)	0.015) 0.023)
3	-0.118 (0.035)	0.248 (0.030)	-0.026 (0.028)	-0.100 (0.069)	-0.097 (0.022)	-0.127 (0.030)	-0.024 (0.043)	-0.142 (0.037)

one (see section 7) it is of interest to look at the estimates on this parameter obtained by means of the Kmenta-approximation. The coefficient of the square term is on the verge of being significantly different from zero in three of the four cases presented in table 8.2, and in the fourth case it is significant with slight margin. By computing the estimated elasticity of substitution in the way pointed out on p.9 we get the highest estimate $\hat{\sigma}$ = 0.884 in the case industry-dummies but not quality-variables are included and the lowest estimate $\hat{\sigma}$ = 0.851 when the quality-variables are included, but not the industry-dummies. These estimates indicate that our suspicions concerning the sources of variations in the wage-rate are true and that the estimates obtained by means of the ACMS-relations really are biased towards one.

In this case, when we have a vast number of units, the Kmenta-approximation seems to lead to sensible results concerning the elasticity of substitution, and thus it is valid to use this relation as a control on the results obtained for the elasticity of substitution elsewhere. This is, however, not so for our sub-samples applied in this study. Very often the Kmenta-approximation leads to negative elasticities of substitution, even in cases when the coefficient of the square term is significant. In almost all of the rest of the samples the coefficient of the squareterm is insignificant, and/or lead to an elasticity of substitution substantially above one when the ACMS relation gives an elasticity of substitution below one - or substantially below one when the ACMS-relation leads to an estimate above one.

The lack of success in obtaining reliable informations about the substitution conditions between labour and capital in production by means of the Kmenta-approximation is to my opinion very much due to errors of measurement in capital. And this of course makes this relation almost valuless as a "cross-check" on other relations validity as a base for getting informations about the substitution properties of the production factors.

About the gross-production regressions not bery much is to be said. The most striking result is perhaps the reduction in the estimate on the elasticity of scale when treating rawmaterials as a factor of production in the same way as labour and capital i.e. assuming substitutability instead of "fixed coefficient". As could be expected, whether the estimate on the elasticity of scale was reduced or not, the elasticities of labour and capital are substantially reduced. These two findings are easily confrimed in table 8.2, and they are generally present in our subsample-results also.

The interpretation of the results obtained by means of the "CES"-relations is as pointed out in section 2, difficult since there are at least two possible reasons why the coefficients of the lnL or lnV terms are significantly different from zero. Either non-constant returns to scale or nonhomotheticity may lead to this.

If we have homotheticity the coefficient of the lnW term, when lnV also is included, still is the elasticity of substitution (see relation (2.28)). If, thus this coefficient is insignificantly different from the elasticity of substitution in the simple ACMS-relation it is at least not too inreasonable to assume that if the coefficient of the lnV term is significant it is due to non-constant returns to scale and not because of non-homotheticity. On the other hand, if we have significantly different coefficients of the lnW term in the simple ACMS-case and the case when lnV is also added we may believe that the production function is non-homothetic. If we then assume that $\mu = 1$ (this does of course not mean that we have constant returns - simply since the production function is non-homothetic), we can compute m from the relation where lnL is included in addition to lnW (see relation 2.30). This is, however, a rather "inconsistent estimation" of m if the coefficient of the lnV term is significant, since it will be zero when $\mu = 1$. (see relation 2.32), and more often than not this coefficient really is significant.

But if we assume $\mu = 1$ we get by means of relation 2.30 $\hat{m} \approx 1.50$ for total manufacturing when no industry-dummies are included and $\hat{m} = 1.56$ when industry-dummies are included (but in both cases no quality - variables are included.). This and the results presented in table 8.3 in general indicate that the assumptions on which the simple ACMS relation is based, are not strictly fullfilled and thus that the estimates on the elasticity of substitution obtained from this relation are unreliable also because of this. However, if the elasticity of substitution really is constant, all results for total manufacturing, indicate that it is below one on the average. And this conclusion, at least, seems to be rather safe.

B. Results for sub-samples not presented elsewhere.

When discussing the results for each industry-group constructed, we have, as pointed out, made a selection. There may, however, be some results not selected that are of some interest, and thus they will be presented here. These are the results obtained by means of relations (6.7), (6.16) and (6.17)

The main purpose of relation (6.7), we note, is to investigate any significant difference in the level of the scale elasticity for different size-groups. This is another way of investigating our assumptions about the scale-properties of production made for most of the other relations. The results concerning the quality-variables are not much different from those obtained elsewhere, and will not be commented here.

Table 8.5

Estimates on the parameters in relation (6.16) (Dependent variable $\ln(\frac{g.r.r^{*}}{W})$).

Sample	Estimates						Estimate on the elasticity of sub.	Estimate on the el. of sub. from the simple ACMS-relation.
	$\ln\frac{K}{L}$	δ	dg	Intercept	R	M.SQ		
Total Manufacturing	-0.523 (0.016)	0.962 (0.338)	-2.678 (0.035)	-2.162	0.753	0.705	1.912	0.950
20.1	-0.939 (0.101)	0.866 (1.852)	-2.953 (0.273)	-0.437	0.754	0.699	1.065	1.022
20.2	-0.799 (0.116)	2.214 (2.474)	-2.846 (0.347)	-0.746	0.593	0.587	1.252	0.660
20.3	-0.478 (0.095)	5.590 (3.022)	-2.439 (0.169)	-2.161	0.812	0.778	2.092	1.134
20.4	-0.568 (0.050)	0.207 (1.254)	-2.610 (0.106)	-1.865	0.792	0.690	1.761	0.933
20.5	-0.415 (0.120)	-0.337 (3.558)	-1.786 (0.182)	-2.746	0.854	0.293	2.410	1.560
20.6	-0.705 (0.094)	0.823 (1.552)	-2.647 (0.167)	-1.634	0.692	0.807	1.418	0.964
21	-0.911 (0.210)	2.260 (3.719)	x)	-0.651	0.684	0.685	1.098	1.074
23	-0.750 (0.079)	0.353 (2.342)	-2.486 (0.175)	-1.241	0.768	0.525	1.333	1.028
24.1	-0.672 (0.160)	2.486 (3.560)	-2.963 (0.283)	-1.888	0.798	0.440	1.488	1.563
24.2	-0.639 (0.112)	0.473 (2.694)	-2.857 (0.223)	-1.633	0.749	0.668	1.565	1.101
24.3	-0.614 (0.123)	-0.756 (1.413)	-2.911 (0.312)	-1.427	0.797	0.611	1.629	1.343
25.1	-0.685 (0.059)	0.059 (0.849)	-2.809 (0.080)	-1.574	0.846	0.618	1.460	0.736
25.2	-0.470 (0.080)	2.343 (1.577)	-2.677 (0.172)	-2.473	0.787	0.657	2.128	0.949
26.1	-0.594 (0.102)	0.723 (1.901)	-2.658 (0.186)	-2.009	0.684	0.638	1.684	1.002
26.2	-0.445 (0.078)	2.675 (1.219)	-2.495 (0.090)	-2.964	0.780	0.553	2.247	0.985
27.	-0.661 (0.070)	-1.856 (2.219)	-2.240 (0.131)	-1.409	0.829	0.422	1.513	1.111
28	-0.474 (0.115)	-5.858 (2.905)	-2.536 (0.201)	-1.937	0.741	0.662	2.110	0.593
31.1	-0.376 (0.284)	5.152 (7.145)	x)	-2.942	0.173	1.263	2.660	2.171
31.2	-0.726 (0.116)	9.335 (4.787)	-1.730 (0.231)	-2.088	0.807	0.522	1.377	1.545
31.3	-0.770 (0.205)	0.292 (4.664)	-3.371 (0.463)	-0.564	0.651	1.001	1.299	1.203
33.1	-0.592 (0.204)	12.634 (5.504)	x)	-3.435	0.412	0.993	1.689	1.029
33.2	-0.535 (0.093)	1.812 (1.147)	-3.729 (0.241)	-1.907	0.753	0.590	1.869	1.376
34	-0.472 (0.261)	11.488 (4.899)	x)	-3.634	0.516	0.631	2.119	1.173
35	-0.506 (0.063)	-0.552 (1.235)	-2.785 (0.142)	-2.176	0.699	0.681	1.976	0.901
36	-0.473 (0.101)	-2.040 (2.204)	-2.477 (0.187)	-2.310	0.711	0.731	1.114	0.858
37	-0.329 (0.112)	4.361 (3.186)	-2.695 (0.271)	-2.968	0.766	0.634	3.040	0.827
38	0.673 (0.118)	1.461 (2.561)	-2.779 (0.222)	-1.858	0.772	0.790	1.486	0.445

x) Less than five units in the sample have dg=0, and so this variable is excluded.

For Total Manufacturing we found that the elasticity of scale is significantly lower (but with slight margin) in the upper size group, (estimate: - 0.083, est. standard deviation 0.040 when no industry-dummies were included and est = 0.103 and est. st.dev.= 0.039 when industry-dummies are included.) This seems to confirm the assumption often made in the theory of production that the elasticity of scale is decreasing, implying an U-shaped average costcurve.

The corresponding results for the subsamples are unfortunately not equally uniform. In many cases the estimates on the coefficient of the $r_3 \ln L$ term (or $r^* \ln L$ term) is positive, and significantly positive in one case (sample 31.1). In only two cases it is significantly negative (samples 27 and 38). Often the absolute value of the estimate is rather large, but then, with correspondingly large estimated standarddeviation. This is another indication that the "non-identified" variations in our data is at least equally large within industry-groups as between industry-groups.

The results for relation (6.16) are presented in table 8.5. As the coefficient of the $\ln\frac{K}{L}$-term is $-\frac{1}{\sigma}$ where σ is the elasticity of substitution, we for all samples get an estimate on this parameter above one. This does not, as we see, correspond very good with the results for the elasticity of substitution obtained by means of the simple ACMS-relation. Taking the substantial errors of measurement in the variables in relation (6.16) into consideration (this led, as pointed out in section 6, to treat $\ln(\frac{g.r.r.^*}{W})$ as the dependent variable as this one was considered to contain larger errors of measurement) the reliablility of the results of this relation is rather dubious.

The third relation worth some comments in this connection is the net rate of returns - relation (6.17). The results are all rather poor. For total manufacturing the estimate on the coefficient of the lnN-variable is positive and the coefficient is significant with slight margin. (est. = 0.021 st.dev.=0.009) The estimates on the coefficients of the size-group variable are all negative, but only the coefficient of the larger size-group variable is significant (est = - 0.064 st.dev. 0.028). For the sub-samples are there only there (24.3, 26.2 and 36) where the coefficient of the lnN-variable is significantly positive. In a lot of samples the estimte on this coefficient is negative, but in no cases is the coefficient significantly negative. There are in some samples coefficients of the size-group variables or industrygroup-variables that are significant, but more often than not are most or all of the coefficients not significant. So it seems not to be of much value to present the estimates here.

C. Results for Industry Group 20; Food Manufacturing Industries.

a) Results for Sample 20.1: Industry Group 201: Slaughtering and Preparation of Meat.

In table 8.6a and b we present some selected results for this sample - consisting of 171 units.

Firstly we note that the estimated elasticity of capital is rather low, both considered isolated and compared with the average for the manufacturing industries. In fact it is not significant either in the value added Cobb-Douglas case or in the gross production Cobb-Douglas case. The coefficient of the $\ln\frac{SK}{L}$ - variable in the Kmenta-approximation-relation is not significant either. (As pointed out in section 2 certain corrections have to be made to obtain the estimates on the elasticity of capital and the elasticity of substitution. And it is therefore impossible to say if these two parameters (whose estimates are presented below the Appr. CES regression as $\hat{a}$ and $\hat{\sigma}$) are significant or not by means of the computations carried out by us.)

Secondly we note that we have slightly increasing but not significant, returns to scale in the value added Cobb-Douglas case. In the gross production case it is slightly decreasing, but neither here significant.

Thirdly the results obtained by means of the ACMS-relation do not give an elasticity of substitution significantly different from one. The results about this parameter obtained by means

Table 8.6

Estimates for Sample 20.1

Table 8.6a

	Net C.D.			Gross C.D.	Approx. CES	
$\ln L$	0.062 (0.035)	0.061 (0.034)	0.010 (0.037)	-0.017 (0.015)		0.063 (0.035)
$\ln \frac{SK}{L}$	0.078 (0.056)	0.095 (0.055)	0.103 (0.053)	0.028 (0.024)		0.057 (0.138)
$\ln \frac{M}{L}$				0.727 (0.018)	$(\ln \frac{SK}{L})^2$	0.007 (0.044)
d			-1.487 (0.459)			
R_1		-0.087 (0.092)				
R_2		-0.296 (0.086)	-0.208 (0.069)			
Inter-cept	2.259	2.379	2.570	1.400		2.268
R	0.168	0.296	0.370	0.955		0.169
M.SQ	0.214	0.203	0.192	0.038		0.215

$\hat{\delta}=0.078$
$\hat{\sigma}=1.223$

Table 8.6b

	CES			"CES"	
$\ln W$	1.022 (0.144)	0.972 (0.145)	0.890 (0.147)	1.009 (0.148)	0.716 (0.145)
$\ln L$				0.013 (0.031)	
$\ln V$					0.150 (0.026)
d			-0.869 (0.389)		
R_1		-0.030 (0.083)			
R_2		-0.168 (0.079)	-0.147 (0.063)		
Inter-cept	0.641	0.818	0.999	0.621	0.308
R	0.479	0.505	0.525	0.480	0.595
M.SQ	0.169	0.165	0.160	0.170	0.142

of the Kmenta-approximation is very unreliable since the standard deviation is much larger than the estimate on the coefficient of the square-term.

Fourthly, we see from our "CES" relations that the assumptions on which the simple ACMS-relation is based may not be strictly fullfilled since the coefficient of the lnV-term is significantly positive. We also note that the coefficient of the lnL term is also positive, but not significant. This difference between the coefficients for the lnL and the lnV terms can possibly be explained by a $\mu > 1$ and therefore $(1-\mu) < 0$ and $m < 1$ so that $(1-\mu m) \simeq 0$. This is not strongly founded, however, and cannot be so, due to the identification problems we have.

Fifthly we note that the region variables and the "labour-composition variable" d are the most important in this industry according to our results. The R_1 variable seems, however, not to have significant influence on value added. In slaughtering and preparation of meat it seems to be especially low productivity of owners and family members. The estimates have a very high absolute value, and the coefficients are significant. The effect of the R_2 variable is also present in the CES-relation but does at least partly disappear when switching from production functions estimation to behaviour relation estimation, as it did for "Total Manufacturing".

b) Results for Sample 20.2: Industry Groups (2021-2023); Dairies, Manufacturing of Condensed and Dried Milk, and Manufacturing of Ice-Cream.

In this sample it is slightly decreasing return to scale (but not significantly decreasing) both in the value-added and gross production Cobb-Douglas case. The estimate on the elasticity of capital is of reasonable height in the value added case, but does almost completely disappear in the gross production case. This is as pointed out in the discussion of the results of "Total Manufacturing" a general finding for all samples, and is of course not surprising.

Even if we have only 7 units producing dried and condenced milk and only 13 ice-cream factories in our sample, the corresponding industry dummies (see table 5.1) are the only quality-

Table 8.7

Estimates for Sample 20.2

Table 8.7a

	Net C.D.		Gross C.D.
lnL	-0.045 (0.038)	-0.043 (0.034)	-0.030 (0.010)
$\ln\frac{SK}{L}$	0.233 (0.059)	0.329 (0.063)	0.028 (0.021)
$\ln\frac{M}{L}$			0.719 (0.017)
D_1		0.332 (0.151)	
D_2		0.471 (0.124)	
Intercept	2.440	2.186	å.520
R	0.271	0.373	0.962
M.SQ	0.165	0.155	0.015

Table 8.7b

	CES				"CES"	
lnW	0.660 (0.138)	0.649 (0.137)	0.686 (0.137)	0.686 (0.138)	0.649 (0.137)	0.567 (0.128)
lnL					-0.062 (0.034)	
lnV						0.194 (0.029)
r_1		-0.068 (0.061)				
r^*		-0.247 (0.092)				
R_1			0.106 (0.088)			
R_2			0.175 (0.083)			
D_1				0.276 (0.153)		
D_2				0.272 (0.115)		
Intercept	1.571	1.629	1.391	1.502	1.816	0.499
R	0.291	0.334	0.320	0.340	0.311	0.473
M.SQ	0.163	0.159	0.161	0.158	0.161	0.138

variables of significant importance for value added in the production relations cases, according to our results. Because of this we run some regressions separately for the basegroup in Sample 20.2, Dairies, containing 231 units. The results of these regressions (which are net value added and simple ACMS-relations, only) are presented in a separate table, table 8.8.

Table 8.8

Estimates for Industry Group 2021; Dairies.

	Net C.D			CES	
lnL	-0.036 (0.034)	-0.031 (0.024)	lnW	0.673 (0.143)	0.683 (9.142)
$\ln\frac{SK}{L}$	0.326 (0.066)	0.318 (0.066)	-		
R_2		0.095 (0.050)	R_2		0.125 (0.050)
Intercept	2.168	2.118		1.673	1.435
R	0.329	0.350		0.296	0.335
M.SQ.	0.142	0.141		0.145	0.142

The fit is as we see some-what better when running Dairies alone, than in the case when the 21 dried and condused milk-and icecream factoris also are included.

In most cases the coefficients of R_1 and R_2 are negative, and very often significantly negative, especially in the production functions regressions. In sample 20.2 both coefficients are positive and in the behaviour relation regressions the coefficient of the R_2 variable is even significantly positive. Finally, concerning quality - variables the size-group-dummies seem to be of significant importance in the behaviour relations (ACMS - relations) with the level of the constant term of the upper size-group (in this case $50 \leq N$) significantly below the level of the basegroup.

Both for sample 20.2 and for Dairies run alone we get an elasticity of substitution significantly below one by means of the ACMS-relations. So at least for this group there seems to be "enough" variations in the wage rate not due to price-differences or differences in efficiency of labour to identify the substitution parameter. (Variations are mostly due to supply conditions.)

Looking at the "CES" relations the coefficient of the lnL-term in the first relation is negative but not significant, while the coefficient of the lnV-term in the second relation is significantly positive. Now, in case of a homothetic production function with non-constant returns to scale the coefficients of the lnL and lnV-terms must have the same sign (see relations 2.24 and 2.25) So in this sample there seems to be non-homotheticity, but it must be "slight" since the coefficient of the lnL term is non-significant. We note that in this case we must have $\mu > 1$ to obtain the a coefficient of the lnV term that is positive and we must also have $1 - m\mu > 0$ i.e. $m < 1$ to obtain a negative coefficient of the lnL term as the level of the elasticity of substitution seems to be below one.

c) Results for Sample 20.3: Industry Groups 203 and 204; Canning and Preserving of Fruits and Vegetables, and Canning of Fish and Meat.

In table 8.9 we present the results for sample 20.3. As for most of the samples there are in this one slightly increasing returns to scale, according to our value added Cobb-Douglas relations. But when no quality - variables are included, we have not significantly increasing returns to scale. The estimate on the elasticity of scale is rather low, but it is, however, significantly positive. The ACMS-relations indicate that the elasticity of substitution is above one, and so do the results obtained by means of the Kmenta-approximation. But neither is the elasticity of substitution in the ACMS-relations significantly above one, nor is the coefficient of the square-term of the Kmenta approximation significantly positive. It is thus not possible to obtain any safe conclusions concerning the elasticity of substitution by means of these relations.

Table 8.9

Results for sample 20.3

Table 8.9a

	Net C.D.				Gross C.D.	Appr. CES	
$\ln L$	0.067	0.083	0.058	0.100	-0.007		0.079
	(0.041)	(0.041)	(0.039)	(0.041)	(0.018)		(0.044)
$\ln\frac{SK}{L}$	0.151	0.132	0.088	0.131	0.007		0.080
	(0.055)	(0.054)	(0.056)	(0.057)	(0.026)		(0.114)
$\ln\frac{M}{L}$					0.714	$(\ln\frac{SK}{L})^2$	0.031
					(0.029)		(0.044)
g_2				4.014			
				(1.675)			
R_1		-0.406		-0.175			
		(0.114)		(0.083)			
R_2		-0.283					
		(0.121)					
D_1			0.446	0.337			
			(0.119)	(0.121)			
Inter-cept	1.631	1.887	1.673	1.509	1.286		1.607
R	0.238	0.335	0.365	0.428	0.904		0.244
M.SQ	0.283	0.265	0.262	0.250	0.054		0.284

$\alpha=0.153$
$\delta=1.793$

Table 8.9b.

	CES				"CES"		
$\ln W$	1.134	1.081	1.008	1.012	1.122	0.995	0.858
	(0.144)	(0.151)	(0.151)	(0.150)	(0.144)	(0.150)	(0.134)
$\ln L$					0.036	0.056	
					(0.036)	(0.036)	
$\ln V$							0.189
							(0.028)
g_2							
R_1		-0.211		-0.125		-0.156	
		(0.105)		(0.073)		(0.075)	
R_2		-0.086					
		(0.112)					
D_1			0.260	0.224		0.214	
			(0.108)	(0.109)		(0.109)	
Inter-cept	0.162	0.385	0.335	0.396	0.043	0.226	-0.491
R	0.528	0.549	0.552	0.563	0.532	0.572	0.662
M.SQ.	0.215	0.211	0.209	0.206	0.215	0.205	0.168

The results of the "CES" relations are especially difficult to interpret in this case. If the homotheticity - assumptions are true will the coefficients of both the lnL term and the lnV term be positive either if we have increasing returns to scale and an elasticity of substitution below one, or if we have decreasing returns to scale and an elasticity of substitution above one. Now, our results elsewhere indicate that we have slightly increasing returns to scale and an elasticity of substitution above one, which should have implied negative coefficients of both the lnL and the lnV terms. But as we, as pointed out, neither has significantly increasing returns to scale, nor an elasticity of substitution significantly above one, our findings concerning the "CES" relations may very well be explained by either that we have decreasing returns to scale or an elasticity of substitution below one.

The results of the quality variables tell us that cars have got much to low weitht in our capital measure even when applying SK as we have done. (The results when K is applied instead give a still higher estimate on the coefficient of the g_2 - variable, as could be expected). The differences in productivity of cars between establishment seem to be rather substantial as the estimated standarddeviation of the corresponding estimate is high. There are also substantial differences in productivity (or pricelevel of value added) between regions. Some of the effects of the region variables does also survive in the CES - relation. But at least some of the regional variations in value added seem to be due to price - differences - if our assumption is true that the wage-rate is positively correlated with the price-level. But there must also be other forces operating since we get lower (though not significantly lower) elasticity of substitution when introducing the region variables than in the simple ACMS - case.

The level of productivity is, according to our results, significantly higher in Industry Group 203 than in the base group, Industry Group 204 since we get an significantly positive coefficient of the D_1 - variable.

This variable does, however, only indicate "neutral" differences in productivity. But it may also reflect "non-neutral" differences i.e. differences in the productivity of labour and capital etc. To investigate this we run some regressions separately for Industry Group 204, containing 139 units. The results of these regressions are presented in table 8.10.

Table 8.10

Results for Industry Group 204; Canning of fish and meat.

	Net CD		Appr. CD			CES		"CES"	
$\ln L$	0.054 (0.043)	0.103 (0.045)	0.064 (0.047)	0.110 (0.048)	$\ln W$	1.024 (0.165)	1.047 (0.171)	1.013 (0.166)	1.027 (0.161)
$\ln\frac{SK}{L}$	0.109 (0.058)	0.146 (0.058)	0.053 (0.111)	0.103 (0.109)	$\ln L$			0.030 (0.039)	0.073 (0.040)
$(\ln\frac{SK}{L})^2$			0.025 (0.043)	0.019 (0.042)	-				
g_2		3.467 (1.741)		3.521 (1.750)	g_2		2.310 (1.511)		2.668 (1.511)
R_1		-0.207 (0.090)		-0.202 (0.091)	R_1		-0.151 (0.076)		-0.200 (0.081)
Intercept	1.669	1.508	1.645	1.488		0.310	0.323	0.214	0.098
R	0.186	0.311	0.193	0.313		0.469	0.567	0.473	0.523
M.SQ	0.259	0.246	0.261	0.248		0.208	0.201	0.209	0.198

$\alpha=0.107$ $\alpha=0.145$

$\sigma=1.991$ $\sigma=1.385$

By comparing the results in tables 8.9 and 8.10 we find that the differences are slight, no estimates lead to significantly different coefficients of corresponding variables in corresponding regressions.

d) Results for Sample 20.4: Industry Groups 2051, 2052 and 2059; Frozen Fish, Manufacturing of Prepared Fish Dishes and Delicatessen, and Other Processing of Fish.

In this sample it is, according to our results, no quality variables that significantly affect the value added (or gross production.) None of the regressions presented for this sample does therefore contain any quality - variables.

The results, presented in table 8.11 tell us that also for processing of fish - establishments there are slightly increasing, but not significantly increasing returns to scale.

This industry is one of the few where we obtain sensible results by means of the Kmenta - approximation concerning the elasticity of substitution. Both the coefficients of the $\ln\frac{SK}{L}$-term and the squared term are significant and whether we assume constant returns to scale or not, we obtain an estimate on the elasticity of substitution slightly below o.5. And this time the Kmenta-approximation gives a rather reliable control on the results obtained by means of the ACMS - relation. As we see, do we not get an elasticity of substitution significantly below one by means of this relation, and this is obviously, as pointed out in section 7, because the estimates on the elasticity of substitution by the ACMS-relation are biased towards one.

Table 8.11

Estimates for Sample 20.4

	Net C.D	Gross C.D		Appr. CES			CES	"CES"	
$\ln L$	0.019 (0.028)	-0.011 (0.013)		0.011 (0.028)	0	$\ln W$	0.933 (0.090)	0.942 (0.090)	0.653 (0.084)
$\ln\frac{SK}{L}$	0.183 (0.033)	0.061 (0.015)		0.405 (0.086)	0.406 (0.086)	$\ln L$		-0.027 (0.026)	
$\ln\frac{M}{L}$		0.573 (0.013)	$(\ln\frac{SK}{L})^2$	-0.078 (0.028)	-0.079 (0.028)	$\ln V$			0.221 (0.021)
Intercept	2.015			1.928	1.963		0.629	0.694	-0.049
R	0.250			0.280	0.280		0.441	0.443	0.597
M.SQ	0.303			0.298	0.298		0.260	0.260	0.208

$\hat{a}=0.175$ $\hat{a}=0.173$

$\hat{\sigma}=0.483$ $\hat{\sigma}=0.475$

As pointed out previously when the estimates on the coefficients of the lnL and lnV-terms in the "CES" - relations have different signs this cannot be due to non-constant returns to scale, if both coefficients are significant. In the present case, the estimate on the coefficient of the lnL term is negative but the coefficient is not significantly negative, so the question is still open. But both the value added Cobb-Douglas production function and the Kmenta-approximation indicate that on the average there are constant returns to scale. So the most reasonable conclusion seems to be that the production function is "slightly nonhomothetic", and as it is reasonable to assume $\rho<0$, we must have $\mu>1$ and $1>\mu m$ i.e. $m<1$.

e) Results for Sample 20.5: Industry Group 2061: Local Grain Mills

The results for this group are rather poor. The returns to scale for the value added production function is decreasing but not significantly. For the gross-production version, however, the returns to scale is significantly decreasing. For only one case in addition to the present one do we obtain a similar result. The estimate on the elasticity of capital is very low, and it has a large standard deviation which implies that according to our results is not the elasticity of capital significantly different from zero.

Table 8.12

Estimates for Sample 20.5

	Net C.D	Gross C.D		Appr. CES			CES	"CES"	
$\ln L$	-0.035 (0.185)	-0.174 (0.069)		-0.115 (0.192)	0	$\ln W$	1.560 (0.403)	1.567 (0.407)	0.657 (0.313)
$\ln\frac{SK}{L}$	0.049 (0.138)	0.036 (0.052)		1.204 (0.862)	1.042 (0.812)	$\ln L$		-0.058 (0.160)	
$\ln\frac{M}{L}$		0.599 (0.026)	$(\ln\frac{SK}{L})^2$	-0.213 (0.157)	-0.184 (0.148)	$\ln V$			0.539 (0.078)
Intercept	2.331	2.175		1.048	0.989		-0.608	-0.483	-1.445
R	0.061	0.970		0.209	0.189		0.496	0.498	0.795
M.SQ	0.362	0.045		0.355	0.350		0.268	0.273	0.134

$\hat{a}=0.086$ $\hat{a}=0.073$

$\hat{\sigma}=0.139$ $\hat{\sigma}=0.306$

Both when assuming constant returns to scale and when not doing this, the Kmenta-approximation leads to an estimate on the elasticity of substitution that is very low, while the ACMS-relation gives an estimate on this parameter substantially above one. This is a typical case when these two ways of estimating the elasticity of substitution lead to opposite results. But even if the estimates in any of the two cases are far from one, are neither the coefficients of the $\ln\frac{K}{L}$-term and the square term in the Kmenta-approximation significantly different from zero, nor is the elasticity of substitution in the ACMS-relation significantly different from one. So the results concerning the elasticity of substitution are inconclusive in this sample.

For the "CES" relation we have almost the same situation as for the previous sample. It is, however, in this case much more difficult to say anything about the size of ρ, since the results concerning the elasticity of substitution are inconclusive. But as the "CES"-relations are very near related to the ACMS-relations we may expect ρ to be negative And we thus have $\mu<1$ and $1-\mu m$ slightly positive i.e. $m>1$.

Finally it should be added that no quality - variables have any significant influence on productivity in this industry, and thus no results for this type of variables are presented in table 8.12.

f) Results for Sample 20.6: Industry Group 2071; Manufacturing of Perishable Bakery Products.

In this industry we get significantly increasing returns to scale both when applying the simple value added, and simple gross production Cobb-Douglas functions and the Kmenta-approximation. But it does not survive the introduction of quality-variables with significant influence on productivity. The elasticity of capital has an reasonable height in the value added realtions. In the gross production case much of the effect of capital seems to be transfered to raw materials, but the elasticity of capital is not far from being significantly positive even in this case.

The Kmenta-approximation gives reasonable results concerning the elasticity of substitution compared with the results obtained by means of the ACMS-relations, even if the coefficient of the squareterm in the former is not significant. The simple ACMS-relation does not give an elasticity of substitution significantly below one, while when d and R_2 are included it is significantly below one (though with slight margin). As it is reasonable to assume that the ACMS-estiamtes are biased towards one (see section 7), the Kmenta-approximation estimates may in this case a better indication on the level of the elasticity of substitution than the former.

The results of the "CES" relations indicate the assumptions on which the ACMS-relation is based are not strictly fullfilled even in this case. This may be very well explained by increasing returns to scale, which is also confirmed by the simple value added Cobb Douglas production function. The difference between the estimates on the coefficient of the lnW - term in the cace when lnV is included, compared with the simple ACMS-relation, is, however, significant. And this may indicate that the production function really is non-homothetic. Since it is reasonable to assume $\mu > 1$ and $\rho > 0$ in this case, we must have $m > 1$.

Two results by means of quality-variables indicate that machinery is of greater importance in production than the weight of this component in our capital measure. Firstly the estimate on the coefficient of the g_1-variable both in the value added Cobb-Douglas case and in the Kmenta approximation indicate that machinery is given too low weight in our capital measure, since this coefficient in both cases is significantly possible. Secondly the estimate on the coefficient of the g_3 variable indicate that machinery with large energy-consumption in relation to its value is the more productive.

This group is the one where productivity of proprietors and familymembers seems to be lowest. We get a strongly negative estimate on the coefficient of the d-variable and the coefficient is highly significant. There are also some differences between regions. The level of value added is significantly

Table 8.13

Estimates for sample 20.6

Table 8.13a

	Net C.D		Gross C.D		Appr. CES	
lnL	0.136 (0.035)	0.032 (0.035)	0.056 (0.014)		0.136 (0.035)	0.032 (0.035)
$\ln\frac{SK}{L}$	0.257 (0.043)	0.255 (0.042)	0.032 (0.019)		0.361 (0.124)	0.378 (0.118)
$\ln\frac{M}{L}$			0.806 (0.025)	$(\ln\frac{SK}{L})^2$	-0.040 (0.045)	-0.047 (0.042)
d		-1.275 (0.198)				-1.723 (0.198)
g_1		0.392 (0.170)				0.398 (0.170)
g_3		0.073 (0.024)				0.076 (0.024)
R_2		-0.192 (0.046)				-0.126 (0.046)
Intercept	1.647	1.979	0.949		1.593	1.909
R	0.340	0.496	0.888		0.343	0.499
M.SQ	0.175	0.151	0.027		0.175	0.151
					$\hat{\alpha}=0.244$	$\hat{\alpha}=0.241$
					$\hat{\sigma}=0.729$	$\hat{\sigma}=0.668$

Table 8.13b

	CES		"CES"		
lnW	0.964 (0.075)	0.838 (0.076)	0.945 (0.075)	0.839 (0.076)	0.637 (0.067)
lnL			0.071 (0.030)	0.015 (0.031)	
lnV					0.266 (0.021)
d		-0.852 (0.173)		-0.821 (0.185)	
R_2		-0.095 (0.041)		-0.092 (0.041)	
Intercept	0.569	0.946	0.404	0.896	-0.203
R	0.567	0.611	0.576	0.611	0.737
M.SQ	0.134	0.124	0.132	0.125	0.090

lower in the R_2-region according to the value added Cobb-Douglas production function. But as the effect of R_2 is very much reduced when turing to the ACMS-relation we may believe that much of the differences are due to differences in the price-level of value added.

D. Results for Industry Group 21; Beverage Industries.

In table 8.14 we present the results for our sample from the 21 group. Both the net value added and the gross production Cobb-Douglas production functions indicate increasing, and significantly increasing returns to scale. The elasticity of substitution is not significantly different from one, according to our ACMS-estimates. In the "CES" relations both the coefficients of the lnL and lnV-terms are significantly positive. As the estimates are of approximately equal size it is not probable that it is non-constant returns to scale which is the cause of signiffically positive coefficients. We note from relations (2.24) and (2.25) that the coefficients of the lnL and the lnV-terms are equal only when $\mu=1$ i.e. when both are zero. So the results indicate that we really have a non-homothetic production structure, and as it is reasonable to assume $\mu>1$ (according to the value-added Cobb-Douglas results) we must have $\rho>0$ and consequently $m>1$.

Table 8.14

Estimates for sample 21

	Net C.D		Gross C.D			CES		"CES"		
lnL	0.114 (0.035)	0.177 (0.042)	0.167 (0.025)	0.116 (0.026)	lnW	1.074 (0.242)	1.101 (0.249)	0.898 (0.249)	0.890 (0.239)	0.673 (0.235)
$\ln\frac{SK}{L}$	0.141 (0.076)	0.165 (0.074)	0.193 (0.064)	0.121 (0.060)	lnL			0.072 (0.034)	0.126 (0.040)	
$\ln\frac{M}{L}$			0.434 (0.048)	0.493 (0.046)	lnV					0.114 (0.028)
D_2		-0.289 (0.116)		0.286 (0.076)	D_2		-0.052 (0.094)		-0.249 (0.107)	
Intercept	1.951	1.763	1.582	1.675		0.620	0.591	0.667	0.556	0.627
R	0.458	0.542	0.898	0.921		0.516	0.520	0.569	0.623	0.664
M.SQ	0.127	0.115	0.055	0.044		0.115	0.117	0.329	0.100	0.090

Another findings in our results worth noting are the relatively small differences between the degree of returns to scale and the elasticity of capital in the net and gross Cobb Douglas cases. Usually both the degree of returns to scale, the elasticity of labour and the elasticity of capital are lower in the gross than in the net case. In this case, only the elasticity of labour is lower. In addition we note that the elasticity of raw materials is rather low in the gross production case in the present industry group.

Another puzzling result is that the level of efficiency for industry group 213: Breneries and manufacturing of malt, seems to be substantially lower than for the rest of the Beverage Industries, when applying the value added Cobb-Douglas production function, while the gross production value Cobb Douglas production function leads to opposite results. It is also a bit strange that as the industry-group variable has a insignificant effect in the ACMS-relation, it has a significantly negative effect when lnL is added.

E. Results for Industry Group 23; Manufacture of Textiles.

Also for this group we have, according to our results (presented in table 8.15), slightly, and significantly increasing returns to scale in the value added Cobb-Douglas case, while there seem to be constant returns to scale in the gross production value Cobb Douglas case. The elasticity of capital is low but significantly positive both in the net and the gross prodduction case. Also for this industry is the elasticity of raw materials below the average for all manufacturing industries.

Table 8.15

Estimates for sample 23

	Net C.D		Gross C.D		CES		"CES"		
lnL	0.043 (0.019)	0.049 (0.019)	0.002 (0.012)	lnW	1.028 (0.120)	0.943 (0.118)	1.004 (0.125)	0.883 (0.124)	0.796 (0.124)
$\ln\frac{SK}{L}$	0.175 (0.038)	0.151 (0.036)	0.079 (0.024)	lnL			0.012 (0.018)	0.028 (0.018)	
$\ln\frac{M}{L}$			0.487 (0.019)	lnV					0.079 (0.017)
D_3		0.383 (0.079)				0.281 (0.074)		0.305 (0.075)	
q		-0.172 (0.118)							
Intercept	1.889	1.872	1.883		0.534	0.657	0.524	0.644	0.426
R	0.341	0.466	0.885		0.500	0.545	0.502	0.551	0.565
M.SQ	0.130	0.117	0.052		0.110	0.104	0.110	0.103	0.101

We do not get an elasticity of substitution significantly different from one by means of the ACMS-relation. The lnL term does not have a significant effect in the "CES" relations while lnV as usual has, and as both corresponding coefficients are positive, the interpretation may be the same as for sample 20.6.

There seems to be significantly higher efficiency in industry group 239 than in the rest of the Textile Industries as the coefficient of D_3 in the value added Cobb Douglas production function is significantly positive. These differences between the subgroups can only partly be due to price-differences as the effect of D_3 also is present in the ACMS and the "CES" relations. In both cases the estimate has a high positive value and the corresponding coefficient is strongly significant.

In this industry we have one of the few cases when q seems to have any effect on the level of value added. The corresponding coefficient is as we not significant, but it was singificantly negative in the "pilot regression" (6.9) when applying the unweighted versions of labour and capital input.

F. Results for Industry Group 24; Manufacture of Footwear, other Wearing Apparel and Made-Up Textile Goods.

a) Results for Sample 24.1: Industry Group 241; Manufacture of Footwear.

According to our results, presented in table 8.16, there are for manufacture of footwear significantly increasing returns to scale both in the value added case and in the gross production case. The elasticity of capital is of modest height in the value added case, but as is the case for most industries, it is very low and insignificantly positive in the gross production case. The elasticity of raw material is also in this group significantly below the average for all industries.

Industry 241 is another example on diverging results concerning the elasticity of substitution when applying the ACMS-relation and the Kmenta-approximation to estimate this parameter. The estimate on the coefficient of the squareterm in the Kmenta-approximation is as we see negative and have rather high absolute value, but the coefficient is not significant. The introduction of quality-variables does not change this. By means of the Kmenta-approximation we get a very low point estimate on the elasticity of substitution, 0.368 and 0.404 when quality-variables not are included, and when they are included respectively. The simple ACMS relation does, however, give an estimate substantially above one, and even if the standard deviation is large, the elasticity of substitution is significantly greater than one.

Also in this case it is difficult to explain the effects of the lnL and lnV-terms in the "CES"-relations. Since the coefficient of the squareterm in the Kmenta approximation is insignificant, the estimate obtained by means of the ACMS-relation concerning the elasticity of substitution must be considered to be the more reliable.

Table 8.16

Estimates for sample 24.1

Table 8.16a

	Net C.D		Gross C.D			Appr. CES	
$\ln L$	0.158 (0.046)	0.152 (0.047)	0.062 (0.024)	0.064 (0.026)		0.146 (0.047)	0.139 (0.048)
$\ln\frac{SK}{L}$	0.193 (0.088)	0.265 (0.096)	0.044 (0.045)	0.062 (0.051)		0.458 (0.223)	0.562 (0.226)
$\ln\frac{M}{L}$			0.437 (0.039)	0.433 (0.042)	$(\ln\frac{SK}{L})^2$	-0.155 (0.120)	-0.171 (0.118)
g_3		0.515 (0.272)		0.0115 (0.145)			0.545 (0.271)
F		0.155 (0.144)		0.004 (0.080)			0.152 (0.143)
Inter-cept	1.389	1.126	1.701	1.662		1.374	1.100
R	0.456	0.505	0.832	0.834		0.477	0.528
M.SQ	0.162	0.157	0.043	0.044		0.161	0.155
						$\hat{\alpha}=0.189$ $\hat{\sigma}=0.368$	$\hat{\alpha}=0.265$ $\hat{\sigma}=0.404$

Table 8.16b

	CES	"CES"	
$\ln L$	1.563 (0.206)	1.420 (0.214)	1.058 (0.208)
$\ln L$		0.077 (0.039)	
$\ln V$			0.148 (0.031)
g_3			
F			
Inter-cept	-0.625	-0.684	-0.646
R	0.675	0.697	0.770
M.SQ	0.110	0.106	0.084

Thus $\rho<0$ in the case when the production function is homothetic and the same should be expected to be true even if the production function is non-homothetic. As we have significantly increasing returns to scale according to our value added Cobb-Douglas estimates, we should expect both the coefficients of the lnL and lnV-terms to be negative. If, however, we have a non homothetic production function of the type specified in section 2 (see relation 2.27) we may get a positive coefficient of the lnV term if $m>1$

such that $1+\rho m<0$,but the coefficient of the lnL-term is then still negative. Even if the coefficient of the lnL term is not significant in the present case, these findings are a bit puzzling and one may doubt if my specification of non-homotheticity is even approcimately correct.

Two characteristics of the establishements seem to have positive influence on productivity. These are the energy-consumption of the machinery in relation to the value of machinery, and the age of the establishements. Neither of the two variables has, however, significant coefficients.

b) Results for Sample 24.2: Industry Group 243; Manufacture of Ready-Made Garnments and Taylors Shops.

As for sample 24.1 we get in this one also significantly increasing returns to scale both in the value added and gross production value cases. Also in this sample is the elasticity of capital of modest size, but in opposition to our findings in the previous sample it is only slightly lower in the gross production value case, and it is in this case significant. It is also worth noting that industry group 243 is the one where we get the lowest estimate on the elasticity of raw material, slightly above 0.3.

In table 8.17 where the results for the present sample are presented, we have not included the results obtained by means of the Kmenta approximation since the estimate on the coefficient of the square term has an absolute value of less than one fifth of its estimated standarddeviation. The computed elasticity of substitution from this relation is, however, reasonable compared with the results obtained by means of the ACMS-relation, namely $\hat{\sigma}=1.105$. But the elasticity of substitution in the ACMS relation is not significantly above one, so the results concerning the substitution - conditions are inconclusive.

Since it is more probable to assume an elasticity of substitution below one in the present sample than in the previous

Table 8.17

Estimates for sample 24.2

	Net C.D		Gross C.D			CES		"CES"	
lnL	0.142 (0.025)	0.127 (0.025)	0.099 (0.019)	0.095 (0.020)	lnW	1.101 (0.097)	1.049 (0.101)	1.019 (0.099)	0.805 (0.097)
$\ln\frac{SK}{L}$	0.186 (0.052)	0.155 (0.052)	0.147 (0.039)	0.132 (0.039)	lnL			0.061 (0.021)	
$\ln\frac{M}{L}$			0.308 (0.013)	0.304 (0.016)	lnV				0.120 (0.017)
R_1		-0.184 (0.077)		-0.124 (0.057)	R_1		-0.037 (0.067)		
R_2		-0.208 (0.068)		-0.115 (0.051)	R_2		-0.118 (0.059)		
F		0.035 (0.079)		-0.002 (0.059)					
Intercept	1.429	1.630	1.754	1.879		0.314	0.468	0.201	0.052
R	0.417	0.469	0.883	0.887		0.643	0.655	0.663	0.731
M.SQ	0.139	0.134	0.075	0.073		0.098	0.097	0.095	0.078

one, it is a bit easier to explain the results obtained by means of the "CES"-relations. (See discussion of the results for sample 24.1)

In the net Cobb-Douglas cases both region variables have significantly negative effects both on value added and gross production. In the ACMS-relation their effect are much lower, but the coefficient of R_2 is, as we see still significantly negative. According to the arguments presented previously in analogous situations we interpret the regional differences to be at least partly due to price-differences. The year of establishment variable seems to have no, or little effect on value added and gross production.

c) Results for Sample 24.3: Industry Groups 244-2444 and 249; Manufacture of Fur Goods, Gloves, Hats Caps and Made Up Textile Goods, Except Wearing Apparel.

The results for this industry, concerning the quality variables, are rather poor. No one of these have, according to our results any significant influence on production. The estimates indicate increasing returns to scale in the value added case (though the corresponding coefficient is significantly positive only with slight margin). In the gross production case the law of production is not significantly different from a constant returns to scale one - if it is of linear-logarithmic type.

The ACMS-relation indicates an elasticity of substitution above one, but it is not significantly above one. Thus looking

Table 3.18

Estimates for sample 24.3

	Net C.D	Gross C.D		CES	"CES"	
lnL	0.123 (0.065)	0.014 (0.039)	lnW	1.343 (0.242)	1.330 (0.245)	0.988 (0.231)
$\ln\frac{SK}{L}$	0.257 (0.076)	0.074 (0.049)	lnL		0.025 (0.057)	
$\ln\frac{M}{L}$		0.531 (0.037)	lnV			0.192 (0.045)
Intercept	1.641	1.745		-0.014	-0.075	-0.476
R	0.391	0.899		0.556	0.558	0.676
M.SQ	0.243	0.081		0.195	0.198	0.156

at the results of the "CES" relations the interpretation of these must be approximately identical to the corresponding results in sample 24.2.

d) Results for Industry Group 24: Manufacture of Footwear, other Wearing Apparel and Made-up Textile Goods.

Even if there are some dissimilarities between the results obtained for the three samples in the 24-group, they seem not to be greater than that a merging of these three samples into one can be defended. This is done, and the results for this merged sample, thus consisting of 327, are presented in table 8.19. To take care of at least some of the differences between our three samples we have introduced two dummies, Δ_1 which is one for sample 24.1, and zero otherwise and Δ_2 which is one for sample 24.3, and zero otherwise. Thus sample 24.2 is base in our merged sample for the 24-group.

As the results of the sub-samples are commented previously, only a few remarks are necessary in this connection. The effects of the "true factors of production" in the value added and gross production Cobb-Douglas cases are as expected, as we know the results of the sub-samples. As conserns the elasticity of substitution we note that according to the ACMS-relation it is significantly greater than one (though the margin is slight both when including and when not including quality variables.) We also note that we for this merged sample get better correspondance between the results concerning the elasticity of substitution obtained by means of the Kmenta - approximation and the ACMS relation. But as we see is the reliability of the results of the Kmenta-approximation rather low, when applying significance and insignificance of the parameters as criterion for this.

The year of establishment variable is in no cases of significant importance, neither is R_1. The effect of R_2 is negative, but only in the value added Cobb-Douglas case and in the Kmenta approximation significantly negative. Δ_1 has negative effect for all types of relations presented in table 8.19, but only in the CES and "CES" cases is it significantly negative. Almost the oposite is true for Δ_2 whose effect is positive and significantly positive for all cases except for the ACMS case.

Table 8.19

Estimates for Industry Group 24, (Samples, 24.1-3)

Δ_1 = 1 for sample 24.1, Δ_1 = 0 otherwise
Δ_2 = 1 for sample 24.3, Δ_2 = 0 otherwise

	Net C.D		Gross C.D			Appr. CES			CES		Related CES	
$\ln L$	0.124 (0.021)	0.132 (0.022)	0.056 (0.01[illegible])	0.069 (0.016)		0.127 (0.021)	0.133 (0.022)	$\ln W$	1.185 (0.084)	1.202 (0.090)	1.144 (0.086)	1.141 (0.091)
$\ln\frac{SK}{L}$	0.245 (0.037)	0.203 (0.038)	0.141 (0.027)	0.125 (0.027)		0.143 (0.071)	0.128 (0.070)	$\ln L$			0.039 (0.017)	0.056 (0.019)
$\ln\frac{M}{L}$			0.360 (0.013)	0.351 (0.014)	$(\ln\frac{SK}{L})^2$	0.054 (0.032)	0.040 (0.032)					
F		0.008 (0.071)		-0.043 (0.048)			0.009 (0.071)			-0.040 (0.061)		-0.059 (0.061)
R_1		-0.094 (0.057)		-0.076 (0.039)			-0.096 (0.057)			-0.012 (0.050)		-0.012 (0.049)
R_2		-0.141 (0.058)		-0.063 (0.040)			-0.142 (0.058)			-0.077 (0.050)		-0.060 (0.050)
Δ_1		-0.005 (0.059)		-0.032 (0.041)			-0.002 (0.059)			-0.140 (0.052)		-0.126 (0.052)
Δ_2		0.167 (0.064)		0.115 (0.045)			0.156 (0.064)			0.064 (0.051)		0.123 (0.054)
Intercept	1.511	1.547	1.867	1.909		1.523	1.561		0.169	0.223	0.085	0.100
R	0.407	0.461	0.875	0.881		0.416	0.465		0.616	0.638	0.623	0.651
M.SQ	0.170	0.163	0.079	0.077		0.169	0.163		0.126	0.123	0.125	0.120

$\hat{a}=0.229$ $\hat{a}=0.192$
$\hat{\delta}=2.101$ $\hat{\delta}=1.796$

The results of the merged sample compared with the results for the sub-samples indicate also that the number of observations in the sample applied for estimation is more important for "good results" than homogeneous production structure of the units in the sample. As pointed out are the dissimiliarities between the three sub-samples in the 24-group modest. But I think the results of these samples and the merged sample confirm the findings for Total Manufacturing presented in the beginning of this chapter, that number of units is more important than technical homogeneity.

G Results for Industry Group 25: Manufacture of Wood and Cork, except Manufacture of Furniture.

a) Results for Sample 25.1: Industry Group 251; Saw Mills and Planing Mills.

The results of this sample deserve only a few comments. Even if we have a large number of units in the sample, the results are relatively poor, especially for the quality variables. When running the pilot-relation (6.9) we found that our type of establishment-variable was the only one with significant importance for productivity. Its coefficient was in this regression negative, and significantly so according to our criterion for this. And this, thus, indicates that establishments in single-unit firms are better off than establishments in multunit firms, in this industry.

The results presented for this group, in table 8.20, do not include any of the quality-variables. The results of the Kmenta-approximation are not included either, since the standard-deviation of the estimate on the coefficient of the squareterm os about nine times larger than the estimate itself. The estimated elasticity of substitution is, however, of reasonable height, slightly above one. But we get by means of the ACMS-relation an elasticity of substitution significantly below one. Concerning the "CES"-relations we may explain the results along the same lines as previously when both the coefficient of the lnL-term and the lnV-term are significantly positive, when the ACMS-relation indicates that the elasticity of substitution is below 1 - and when the value added Cobb-Douglas production function indicates that the level of the elasticity of scale is above one.

Table 8.20

Estimates for sample 25.1

	Net C.D	Gross C.D		CES	"CES"	
lnL	0.067 (0.024)	0.003 (0.009)	lnW	0.736 (0.093)	0.701 (0.094)	0.381 (0.083)
$\ln\frac{SK}{L}$	0.123 (0.035)	0.038 (0.013)	lnL		0.049 (0.023)	
$\ln\frac{M}{L}$		0.678 (0.012)	lnV			0.245 (0.016)
Intercept	1.934	1.369		0.897	0.816	0.269
R	0.202	0.929		0.317	0.326	0.598
M.SQ	0.218	0.030		0.204	0.203	0.146

The estimated elasticity of capital in the value added Cobb-Douglas relation is rather low, and it is still lower in the gross production value case. It is, however, significant in both cases. As we see, we have slightly increasing returns to scale in the value-added case but approximately constant returns to scale in the gross production value case.

b) Results for Sample 25.2: Industry Groups 252, 253 and 259; Manufacture of Wood and Cork Products except Saw Mills and Planning Mills.

Also for this sample we have rather low elasticity of capital in the value-added case. In the gross-production case it is as in all other cases still lower, and in this case not significantly different from zero. The elasticity of scale seems to be slightly higher in this case, than in the previous sample, both for the value added and the gross production cases, but in the gross production value case we have not significantly increasing returns to scale.

Table 8.21

Estimates for sample 25.2

	Net C.D	Gross C.D	Appr. CES			CES		"CES"	
lnL	0.129	0.028		0.131	lnW	0.949	1.033	0.842	0.458
	(0.033)	(0.018)		(0.033)		(0.129)	(0.132)	(0.135)	(0.122)
$\ln\frac{SK}{L}$	0.155	0.040		0.052	lnL			0.078	
	(0.040)	(0.021)		(0.105)				(0.033)	
$\ln\frac{M}{L}$		0.613	$(\ln\frac{SK}{L})^2$	0.031	lnV				0.211
		(0.020)		(0.029)					(0.024)
					R_1		0.126		
							(0.067)		
					R_2		0.174		
							(0.071)		
Intercept	1.815	1.559		1.877		0.593	0.345	0.558	0.373
R	0.394	0.930		0.400		0.468	0.497	0.492	0.667
M.SQ	0.168	0.044		0.168		0.155	0.151	0.151	0.111

$\hat{a}=0.141$

$\hat{\sigma}=1.797$

In the Kmenta-approximation neither the coefficient of the $\ln\frac{K}{L}$-term nor the coefficient of the square term are significant. So the results of this relation are rather unreliable in the present case. But we note that we obtain an estimate on the elasticity of 1.797, while we according to the ACMS-relation have an elasticity of substitution not significantly different from one.

Even if the coefficient of R_2 is significantly positive in the ACMS-relation, and the coefficient of R_1 is on the verge of being significantly positive, the introduction of these variables does not shange the estimate of the elasticity of substitution significantly. The interpretation of the results of the "CES" relations must be the same as for the previous sample, but note that we in this case get inconclusive results by means of the ACMS-relation about the substitution parameter ρ i.e. if it is positive or negative.

c) Results for Sample 25, (25.1+25.2): Manufactures of Wood and Cork, except Manufacture of Furniture.

As samples 25.1 and 25.2 belong to the same two-digit industry group (as the sample-numbers indicate) and as the results of the two samples, presented above, are not substantially much different, we have merged these two samples into one. The results for this sample are presented in table 8.22. We note that an industry-dummy variable is constructed: $\Delta = 1$ for industry group 251 (sample 25.1) and $\Delta = 0$ otherwise. This type of variable does as pointed out previously, take care of any "neutral differences between sub-group of units in the sample - in this case differences between two sub-industries. Table 8.22 tells us that, according to our results, there is a significantly lower level of efficiency in industry group 251 (Saw mills and Planing mills) than in the base industry (Other Wood and Cork Manufacturing) This is a uniform result for all relations presented for this sample.

The type of establishment - variable seems to be of the most significant importance among the quality-variables. In all relations presented the coefficient of this variable is significantly negative. As pointed out, this was also the case for the pilot-relation (6.9) for sub-sample 25.1. We got the same result for sub-sample 25.2, but in this case the coefficient was not significant. The 25-group is in fact the only one for which we obtain this result. We note that the results for Total Manufacturing indicated that on the average were establishments in multi-unit firms better off than establishments in single-unit firms. According to our results the opposite seems to be true for the Manufactures of Wood and Cork-industries.

As our results for the merged sample of the 25-group are some kind of averages of the results of the sub-samples they do not deserve many comments in addition to those above. We note that the ACMS-relation, as for sub-sample 25.1 gives an elasticity of substitution significantly below one, and that this result and the results obtained by means of the Kmenta-approximation diverge.

Table 8.22

Estimates for Industry Group 25 (Samples 25.1-2)

Δ = 1 for sample 25.1

Δ = 0 otherwise

	Net C.D		Gross C.D			Appr. CES			[illegible] CES		[illegible] "CES"	
lnL	0.087	0.097	0.013	0.011		0.089	0.100	lnW	0.[illegible]	0.829	0.760	0.778
	(0.019)	(0.020)	(0.008)	(0.008)		(0.019)	(0.020)		(0.[illegible]7)	(0.078)	(0.078)	(0.078)
$\ln\frac{SK}{L}$	0.140	0.151	0.047	0.042		0.050	0.066	lnL			0.060	0.073
	(0.027)	(0.027)	(0.011)	(0.011)		(0.070)	(0.069)				(0.019)	(0.019)
$\ln\frac{M}{L}$			0.637	0.656	$(\ln\frac{SK}{L})^2$	0.031	0.030					
			(0.010)	(0.010)		(0.022)	(0.023)					
B		-0.101					-0.107	B		-0.076		-0.108
		(0.038)					(0.038)			(0.035)		(0.036)
Δ		-0.117					-0.110	Δ		-0.108		-0.103
		(0.038)					(0.038)			(0.036)		(0.036)
Intercept	1.881	1.951	1.470	1.506		1.927	1.987		0.775	0.850	0.697	0.735
R	0.259	0.297	0.926	0.930		0.264	0.301		0.362	0.383	0.377	0.403
M.SQ	0.208	0.204	0.035	0.034		0.208	0.204		0.193	0.191	0.116	0.187

$\hat{\alpha}$=0.136 $\hat{\alpha}$=0.149

$\hat{\sigma}$=1.939 $\hat{\sigma}$=1.7[illegible]8

But as the coefficients of the $\ln\frac{SK}{L}$ and the square term in the Kmenta-approximation also in the merged sample are not significantly different from zero, the ACMS-relation must be considered to be the more reliable as concerns the elasticity of substitution.

H. Results for Industry Group 26; Manufacture of Furniture and Fixtures.

a) Results for Sample 26.1: Industry Group 261; Manufacture of Furniture.

Also for this industry group do we get very low estimates on the elasticity of capital, I would say unreasonably low, while the elasticity of labour is approximately equal to one. And this is almost equally unreasonable. These results, and similar results for a lot of other samples in this study seem to indicate that our discussion concerning biased estimates on the factor-elasticities, presented in section 7 has substantial relevance.

We have, according to our results, significantly increasing returns to scale, both in the value added and gross production value Cobb-Douglas cases. The estimates of the ACMS relations indicate that the elasticity of substitution is not significantly different from one. The Kmenta approximation gives quite other results, but neither for this sample do we get significant coefficients of the $\ln\frac{SK}{L}$ - and square-terms.

The interpretation of the "CES"-relations must be the same as for the sub-samples of the 25 group.

As to the results of the quality-variables, the results for the present sample indicate that efficiency is significantly lower for the lowest sizegroup ($N<10$) compared with the base-group, and that the efficiency is higher for the upper size-group ($N\geq 50$), but not significantly so. The coefficient of the r^* - variable is, however, on the verge of being significant. The estimates on the coefficient of the d-variable in different regression indicate all that proprietors and family members are

Table 8.23

Estiamtes for sample 26.1

	Net C.D		Gross C.D			CES			"CES"		
lnL	0.151	0.121	0.048	0.032	lnW	1.002	0.897	0.888	0.861	0.824	0.621
	(0.020)	(0.023)	(0.010)	(0.012)		(0.085)	(0.085)	(0.094)	(0.085)	(0.092)	(0.078)
$\ln\frac{SK}{L}$	0.127	0.109	0.045	0.034	lnL				0.100	0.093	
	(0.038)	(0.038)	(0.020)	(0.019)					(0.018)	(0.021)	
$\ln\frac{M}{L}$			0.579	0.582	lnV						0.157
			(0.017)	(0.017)							(0.014)
d		-0.432		-0.230				-0.537		-0.144	
		(0.190)		(0.097)				(0.153)		(0.174)	
r_1							-0.119				
							(0.034)				
r^*							0.100				
							(0.057)				
R_1		-0.127		-0.092				-0.026		-0.026	
		(0.042)		(0.022)				(0.041)		(0.040)	
R_2		-0.163		-0.062				-0.041		-0.041	
		(0.050)		(0.026)				(0.049)		(0.047)	
Intercept	1.757	2.023	1.539	1.683		0.470	0.711	0.766	0.415	0.549	0.309
R	0.445	0.489	0.910	0.917		0.564	0.600	0.588	0.618	0.621	0.726
M.SQ	0.091	0.087	0.024	0.023		0.077	0.073	0.075	0.070	0.070	0.054

significantly over-valued in our labourinput measure. For all relations, except the "CES"-one is the coefficient of the d-variable significantly negative. Both in the value-added and in the gross-production Cobb-Douglas cases are the coefficients of R_1 and R_2 significantly negative. Most of their effect disappears, however, when turning to the CES and "CES" relations, indicating, when arguing along the same lines as previously on this point, that much of the regional differences in value added are due to price differences

b) Results for Sample 26.2: Industry Group 262 Manufacture of Wooden Fixtures.

The elasticity of scale seems to be slightly lower in the present sub-sample of the 26-group than in the one firstly presented, while the elasticity of capital seems to be somewhat greater. This implies also that the elasticity of labour is lower in the present sample. This is apparent in the value added case, but it seems to be true for the gross production case also, especially as the elasticity of raw materials is greater in the present sample.

Table 8.24

Estimates for sample 26.2

	Net C.D		Gross C.D			CES	"CES"	
lnL	0.126 (0.025)	0.123 (0.025)	0.030 (0.012)	0.029 (0.012)	lnW	0.985 (0.071)	0.955 (0.074)	0.587 (0.070)
$\ln\frac{SK}{L}$	0.176 (0.035)	0.177 (0.035)	0.064 (0.016)	0.066 (0.016)	lnL		0.032 (0.023)	
$\ln\frac{M}{L}$			0.614 (0.014)	0.612 (0.014)	lnV			0.210 (0.018)
R_2		-0.067 (0.032)		-0.032 (0.014)	R_2			
Intercept	1.727	1.760	1.468	1.486		0.358	0.326	0.074
R	0.304	0.318	0.912	0.913		0.543	0.546	0.680
M.SQ	0.111	0.110	0.022	0.022		0.086	0.086	0.066

In both the value added and the gross production cases are all factor elasticities significantly positive, and in both cases are there also significantly increasing returns to scale.

The ACMS-relation does not lead to an elasticity of substitution different from one. This together with the findings that the coefficient of the lnL term in the first "CES"-relation is positive, but not significant make the interpretation of the "CES"-relations difficult. The coefficient of the lnV term in the second "CES"-relation is as always significantly positive. (See previons discussion of related situations)

The only quality-variable that seems to have any significant importance for the production result is, according to our results R_2. Its coefficient is in the present case significantly negative, but with slight margin. R_2 was also included in the ACMS-relation and the effect was here substantially lower. The interpretation of this must be the same as for the previous sample.

c) Results for Sample 26, (26.1+26.2): Manufacture of Furniture and Fixtures.

As for industry group 25 there are also for industry group 26 some differences between the sub-samples, but not greater differences than that a merging of the sub-samples can be accepted. This should be confirmed by the results in tables 8.23 and 8.24. As also done previously we apply a industry-dummy variable Δ which is one for units of one subsample and zero for units of the other subsample (as we have only two sub-samples in this case)

The results of the merged set of data are presented in table 8.25. In general we get, as expected, lower estimated standard deviations for the estiamtes of the merged set of data. And as expected we also get estimates on the elasticity of scale, the factor elasticities and the elasticity of substitution not far from the level of the corresponding estimates of the sub-samples.

As the effect of the d-variable in subsample 26.2 is very insignificant (but also in this sample negative); we get in the merged set non-significant effects of this variable, in spite of the results in sample 26.1

The effects of R_1 and R_2 are also in the merged set of data significantly negative for both the value-added and gross production value case, while the effects of these variables are negligible in the CES and "CES" relations. (When an estimate is 0 or -0

Table 8.25

Estimates for Industry Group 26 (Sample 26.1-2)

Δ=1 for 2611+2612, Δ=0 otherwise.

	Net C.D		Cross C.D			CES		"CES"	
lnL	0.148 (0.015)	0.127 (0.018)	0.044 (0.007)	0.033 (0.009)	lnW	0.953 (0.056)	0.970 (0.058)	0.862 (0.056)	0.914 (0.059)
$\ln\frac{SK}{L}$	0.155 (0.026)	0.153 (0.026)	0.058 (0.012)	0.055 (0.012)	lnL			0.095 (0.014)	0.075 (0.016)
$\ln\frac{M}{L}$			0.597 (0.011)	0.600 (0.011)					
d		-0.115 (0.110)		-0.062 (0.052)	d		-0.132 (0.091)		0.064 (0.099)
R_1		-0.083 (0.029)		-0.052 (0.014)	R_1		-0		0.002 (0.026)
R_2		-0.116 (0.030)		-0.049 (0.014)	R_2		-0.011 (0.028)		-0.009 (0.028)
Δ		0.045 (0.025)		0.024 (0.012)	Δ		0.138 (0.022)		0.105 (0.023)
Intercept	1.708	1.839	1.485	1.546		0.477	0.409	0.373	0.283
R	0.382	0.409	0.910	0.913		0.527	0.567	0.565	0.583
M.SQ	0.103	0.101	0.023	0.023		0.087	0.082	0.082	0.080

it means that it has an absolute value of less than 0.0005.)

As we see is the coefficient of Δ highly significant, and positive in the CES and "CES"-relations, while it is on the verge of being significant in the value added and gross production value cases.

H. Results for Industry Group 27: Manufacture of Paper and Paper Products.

Firstly we run a set of regressions for all units of industry group 27 not excluded because of those criterions presented in section 5. These results, of which some selected are presented in table 8.26, indicate that there may be some fundamental differences between the sub-industries this sample consists of. So it was divided into two; one containing industry groups 271 and 272; Manufacture of mechanical and chemical pulp, and the other, containing industry-groups 273, 274 and 275; Manufacture of paper, paperboard, cardboard, wallboards, and paper- and paperboard products. The results of these sub-samples are presented in table 8.27.

According to our results for the 27-group we have on the average diminishing, but not significantly diminishing returns to scale both in the value added case and in the gross production value case.

When assuming constant returns to scale for the base-group (then the coefficient of the lnL term in the Cobb-Douglas is zero) we get a significantly lower elasticity of scale for the upper size-group, when also allowing for neutral differences between size-groups. As we have assumed constant returns to scale for the base which in this case is $N<100$, this means that for the upper size-group is the elasticity of scale significantly below one. The levels of efficiency for different size-groups are also significantly different from the one of the base-group. We note that the point-estimate of the level of efficiency of the upper size-group is very much higher than for the base-group. This is a uniform finding when the estimated elasticity of scale for the same size-group is below the level for the rest of the units in the sample.

The elasticity of substitution seems, according to our ACMS-relations-results to be above one, but not significantly so. Also for this type of relation are there some significant differences between the sizegroups. The constant term of the upper

Table 8.26

Estimates for Sample 27

	Net C.D		Gross C.D		CES		"CES"	
lnL	-0.028	0	-0.018	lnW	1.111	1.163	1.325	0.681
	(0.029)		(0.010)		(0.169)	(0.191)	(0.195)	(0.208)
$\ln\frac{SK}{L}$	0.264	0.233	0.055	lnL			-0.062	
	(0.050)	(0.048)	(0.019)				(0.029)	
$\ln\frac{M}{L}$			0.666	lnV				0.095
			(0.017)					(0.028)
$r_3 \ln L$		-0.194						
		(0.083)						
r_1		0.298		r_1		0.322		
		(0.112)				(0.109)		
r_2		0.359		r_2		0.317		
		(0.101)				(0.099)		
r_3		1.274		r_3		0.018		
		(0.506)				(0.082)		
Intercept	2.072	1.880	1.510		0.357	0.162	0.238	0.504
R	0.372	0.479	0.962		0.432	0.514	0.454	0.484
M.SQ	0.208	0.189	0.024		0.195	0.179	0.191	0.185

Table 9.27

Estimates for Industry Groups (271+272) and (273+274+275)

	271+272		273+274+275			271+272		273+274+275	
	Net C.D	Appr. CES	Net C.D	Appr. CES		CES	"CES"	CES	"CES"
lnL	-0.053	-0.068	-0.033	-0.036	lnW	1.714	1.983	1.078	1.246
	(0.067)	(0.072)	(0.032)	(0.033)		(0.574)	(0.592)	(0.183)	(0.213)
$\ln\frac{SK}{L}$	0.163	0.446	0.323	0.115	lnL		-0.103		-0.049
	(0.097)	(0.496)	(0.063)	(0.288)			(0.065)		(0.032)
$(\ln\frac{SK}{L})^2$		-0.054		0.051					
		(0.092)		(0.069)					
Intercept	2.447	2.176	1.979	2.176		-0.909	-0.927	0.436	0.340
R	0.225	0.237	0.439	0.443		0.357	0.403	0.467	0.482
M.SQ	0.231	0.233	0.197	0.198		0.209	0.204	0.187	0.187

$\hat{\alpha}=0.154$ $\hat{\alpha}=0.340$

$\hat{\sigma}=0.527$ $\hat{\sigma}=1.936$

size-group seems, however, not to be much different from the one of the base-group.

Turning to the results of the subsamples we see that the estimated degree of returns to scale is approximately identical for the two samples. The factor elasticities are, however, different. The estimated elasticity of capital for pulp-production is less than half of the one for the other sub-sample. And as the estimates on the scale-elasticity are approximately equal in the two cases, the elasticity of labour is correspondingly greater for pulp-production.

There seems also to be substantial dissimilarities as concerns the elasticity of substitution. According to our ACMS-relations it seems to be substantially greater in the pulp-production than in the other subsample. But according to the results obtained by means of the Kmenta-approximation the opposite seems to be true. But as we, as usual, do not get significant coefficients when applying the Kmenta-approximation, it is fairly reasonable to assume that the ACMS-results are the more reliable. But even if the point-estimates of the elasticity of substitution are much different in the ACMS-relations, we see that none of the coefficients are significantly different from one. So our results are on this point inconclusive.

I Results for Industry Group 28: Printing, Publishing and Allied Industries.

The only industry of the 28-group analysed is 282; Printing. We expected that printing of newspapers - elastibilisments had another structure than establishments engaged in other printing activities. So we have applied an ind ustry-dummy for industry 2821; Printing of newspapers.

The results of this sample,presented in table 828 tell us that there may be substantial differences between these two types of printing. So we run some regressions separately on the two sub-samples; Printing of newspapers (2821) and other printing activities (2822, 2823 and 2829). The results of these regressions are presented in table 8.29.

Table 8.23

Estiamtes for sample 28

	Net C.D				Gross C.D		CES			"CES"		
lnL	0.020 (0.028)	0.002 (0.029)	0.016 (0.026)	0.010 (0.027)	-0.017 (0.019)	lnW	0.593 (0.103)	0.650 (0.114)	0.676 (0.107)	0.630 (0.115)	0.764 (0.113)	0.418 (0.117)
$\ln\frac{SK}{L}$	0.199 (0.048)	0.186 (0.048)	0.200 (0.047)	0.184 (0.046)	0.081 (0.033)	lnL				-0.027 (0.028)	-0.046 (0.026)	
$\ln\frac{M}{L}$					0.485 (0.031)	lnV						0.088 (0.026)
R_1		-0.183 (0.067)		-0.145 (0.057)		R_1			-0.096 (0.054)		-0.097 (0.054)	
R_2		-0.101 (0.074)				R_2						
r_1						r_1		0.135 (0.059)				
r^*						r^*		0.092 (0.087)				
D_1			-0.174 (0.058)	-0.180 (0.057)		D_1			-0.268 (0.055)		-0.282 (0.055)	
Intercept	2.090	2.269	2.158	2.262	2.026		1.303	1.116	1.256	1.318	1.274	1.138
R	0.327	0.387	0.397	0.439	0.822		0.406	0.440	0.543	0.412	0.556	0.472
M.SQ	0.122	0.117	0.115	0.111	0.054		0.113	0.110	0.097	0.113	0.095	0.106

According to our results there seems to be approximately constant returns to scale in the printing industries. This seems to be true both for the value added case and the gross production case. The ACMS-relations give strong indications of that the elasticity of substitution is below one. Both when certain quality-variables are included an when not, the coefficient of the lnW-term is significantly below one. The Kmenta-approximation gives opposite results ($\hat{\sigma}$ = 1.212), but as usual the coefficients of this relation are non-significant, and thus we have not included these results among those presented in table 8.28.

The regional variables are of some importance in the value added Cobb-Douglas case, but at least some of their effects are away in the ACMS-relations, which as previously pointed out probably is due to price-differences between regions. The size-group-variables have no significant effects in the value-added Cobb-Douglas case (these results are not presented here) but in the ACMS-case the r_1 variable has a significant effect while r^* has not.

The level of productivity is significantly lower in the 2821 rest of the printing industry. This is indicated by the results of all types of relations.

Table 8.29

Estimates for Industry Group 2821 and (282-2821)

	Net C.D			CES		"CES"	
	2821	282-2821		2821	282-2821	2821	282-2821
lnL	0.068 (0.038)	-0.002 (0.035)	lnW	0.620 (0.113)	0.782 (0.148)	0.641 (0.131)	0.860 (0.155)
$\ln\frac{SK}{L}$	0.148 (0.046)	0.247 (0.073)	lnL			-0.012 (0.037)	-0.055 (0.034)
Intercept	1.907	2.133		1.075	1.006	1.070	1.041
R	0.487	0.320		0.616	0.464	0.617	0.485
M.SQ	0.054	0.145		0.043	0.125	0.044	0.123

When investigating the two sub-samples separately (see table 8.29) we find, however, no striking differences.

The level of the elasticity of scale seems to be approximately the same, though perphaps a bit lower in the "Other printing activities" - industries. The estimated elasticities of substitution are neither much different. The elasticity of capital is possibly a bit greater for other printing activities, but the elasticity of labour seems to be substantially greater for Printing of newspapers.

J Results for Industry Group 31: Manufacture of Chemicals and Chemical Products.

a) Results for sample 31.1: Industry Group 311; Basic Industrial Chemicals, Including Fertilizers.

The results of this industry deserves only a few comments. No quality-variables seem to have any significant influence on productivity. So the results presented in table 8.30 do not include any regressions with this type of variables. The value added Cobb-Douglas relation indicates that the elasticity of capital is fairly high. The standard-deviation is also relatively high, and consequently is the confidence-region of the elasticity of capital rather wide. But the point-estimate on this parameter is in fact the largest obtained for all

Table 8.30

Estimates for sample 31.1

	Net C.D	Gross C.D		CES	"CES"	
$\ln L$	-0.079 (0.050)	-0.073 (0.023)	$\ln W$	2.171 (0.672)	2.684 (0.677)	1.930 (0.760)
$\ln \frac{SK}{L}$	0.410 (0.129)	0.201 (0.059)	$\ln L$		-0.123 (0.050)	
$\ln \frac{M}{L}$		0.536 (0.041)	$\ln V$			0.038 (0.055)
Intercept	2.419	2.034		-1.522	-2.046	-1.303
R	0.412	0.887		0.390	0.484	0.399
M.SQ	0.418	0.086		0.419	0.386	0.423

samples applied in the presented study. And as the estimate on the elasticity of scale is below one, we for this group also obtain the lowest estimate on the elasticity of labour. Another finding work noting is that for the gross production value case we get significantly decreasing returns to scale. For only two other sub-samples of manufacturing do we get a similiar result.

The ACMS-relation leads to a rather high estimate on the elasticity of substitution. But the coefficient of the lnW-term is as we see, not significantly different from one. The Kmenta-approximation leads in this case to insensible results, as we get an negative point-estimate on the elasticity of substitution. But the coefficients of this relation are also for the present sample non-significant.

b) Results for Sample 31.2: Industry Groups 3121 and 3122; Fish Liver Oil, and Herring Oil and Fish-meal Factories.

The results indicate that we also for this industry have approximately constant returns to scale. We get an extraordinarily low pointestimate on the elasticity of capital. When introducing certain quality-variables it is even negative in the value-added Cobb-Douglas case. This finding may at least partly be explained by substantial over-capacity of this industry in 1963, and the rules of distribution of the raw material (fish and hering) to the different establishments.

Table 8.31
Estimates for sample 31.2

	Net C.D		Gross C.D		CES		"CES"		
lnL	0.036 (0.075)	-0.018 (0.077)	0.021 (0.041)	lnW	1.545 (0.399)	1.416 (0.437)	1.700 (0.430)	1.554 (0.452)	0.668 (0.426)
$\ln\frac{SK}{L}$	0.012 (0.077)	-0.027 (0.078)	0.024 (0.039)	lnL			-0.071 (0.073)	-0.083 (0.073)	
$\ln\frac{M}{L}$			0.548 (0.046)	lnV					0.234 (0.060)
d		-1.486 (0.940)		d		-0.164 (0.857)		-0.362 (0.873)	
R_2		0.281 (0.128)		R_2		0.232 (0.118)		0.239 (0.118)	
Intercept	2.384	2.557	1.822		-0.486	-0.363	-0.537	-0.334	-0.204
R	0.062	0.325	0.857		0.427	0.478	0.441	0.494	0.580
M.SQ	0.295	0.273	0.073		0.239	0.232	0.239	0.231	0.197

The elasticity of substitution seems to be above one according to the ACMS-relations, but not significantly so.

The "pilot-regressions" told us that only two quality-vaiables seemed to have any effects on the production result, namely d and R_2 (in this sample there are no units in the R_1-region). When we add d and R_2 to the "true" factors of production in a Cobb-Dougals relation we do not, however, get a significant estimate on the coefficient of the d-variable. This is also true for the CES and the "CES" relations. While the coefficient of R_2 is significantly positive in the value-added Cobb-Douglas case, this is not so for the CES-relation and hardly so for the "CES"-relation either. As we see is not the point-estimates much lower in these cases than in the value added Cobb-Douglas case, and the regional differences are probably not due to differences in prices, as it is reasonable to assume for a lot of other samples.

c) Results for Sample 31.3: Industry Groups 313 and 319; Manufacture of Paints, Varnishes and Lacquers, and Manufacture of Misc. Chemical Products.

The results of this sample do not deserve many comments either. They indicate that we possibly have slightly increasing returns to scale - and that we possibly have an elasticity of substitution greater than one. But the results are as we see inconclusive. For the present sample does the Kmenta-approximation lead to rather insensible results, but the results obtained by means of this relation are as usual quite unreliable.

This is one of the few cases when the year-of-establishment-variable, E affects productivity significantly.

*

We also run some regressions for a sample consisting of industry - group 311 and 313. The results, containing regressions on the simple value added Cobb-Dougals relation, the CES and the "CES" relations, were not much different from those obtained for corresponding relations in sample 31.1 (see table 8.30)

Table 8.32

Estimates for sample 31.3

	Net C.D		Gross C.D		CES	"CES"	
lnL	0.086 (0.054)	0.114 (0.052)	0.014 (0.032)	lnW	1.203 (0.279)	1.186 (0.277)	0.873 (0.238)
$\ln\frac{SK}{L}$	0.320 (0.111)	0.287 (0.106)	0.008 (0.074)	lnL		0.082 (0.051)	
$\ln\frac{M}{L}$			0.667 (0.053)	lnV			0.234 (0.036)
E		0.025 (0.008)					
Intercept	1.996	1.127	1.673		0.538	0.236	-0.454
R	0.329	0.449	0.828		0.409	0.435	0.652
M.SQ	0.314	0.285	0.111		0.291	0.286	0.203

K. Results for Industry Group 33: Manufacture of Non-Metallic Mineral Products, Except Products of Petroleum and Coal.

a) Results for Sample 33.1: Industry Groups 331, 332 and 333; Manufacture of Structural Clay Products Glass and Glass Products, and Pottery, China and Earthenware.

The results of this sample, presented in table 8.33 do not contain any regressions with quality-variables, as this type of variables according to our "pilot-regressions" do not have any significant effects on production.

About the results presented not very much is to be said. The value added Cobb-Dougals relation indicates slightly but significantly increasing returns to scale, while we in the gros-production value case get results indicating approximately constant returns to scale. The ACMS-relation gives as a result that the elasticity of substitution is not significantly different from one.

Table 8.33

Estimates for sample 33.1

	Net C.D	Gross C.D		CES	"CES"	
lnL	0.075 (0.037)	0.027 (0.022)	lnW	1.029 (0.199)	0.958 (0.212)	0.709 (0.208)
$\ln\frac{SK}{L}$	0.210 (0.075)	0.097 (0.048)	lnL		0.035 (0.036)	
$\ln\frac{M}{L}$		0.462 (0.033)	lnV			0.105 (0.031)
Intercept	1.767	1.928		0.366	0.362	0.317
R	0.416	0.891		0.530	0.540	0.623
M.SQ	0.138	0.050		0.119	0.119	0.103

b) Results for Sample 33.3: Industry Group 335; Manufacture of Cement Products.

For the value added Cobb-Douglas case when no quality-variables are included, we have significantly increasing returns to scale, while we have still increasing, but not significantly increasing returns to scale when certain quality-variables are included (See table 8.34). Most of the reduction in the estimate on the elasticity of scale is due to reduction in the elasticity of capital. In the gross production value case there seems to be approximately constant returns to scale.

As usual does not the Kmenta approximation give significant coefficients of the $\ln\frac{SK}{L}$ and square-term-variables. But the results obtained concerning the elasticity of substitution are reasonable, and at relatively good correspondance with the results obtained by means of the ACMS-relation. The later indicates elasticity of substitution above one as the coefficient of the lnW-term is significantly above one when no quality-variables are included. When certain quality variables are included, however, is the elasticity of substitution no longer significantly different from one.

Concerning the effects of the quality-variables the present industry is one of the many where proprietors and family members seem to have a negative effect on value added, in addition

Table 8.34

Estimates for sample 33.2

	Net C.D		Gross C.D		Appr. CES			CES		"CES"		
$\ln L$	0.132 (0.042)	0.063 (0.043)	0.011 (0.019)		0.139 (0.043)	0.068 (0.044)	$\ln W$	1.376 (0.130)	1.188 (0.134)	1.374 (0.137)	1.217 (0.138)	0.827 (0.136)
$\ln\frac{SK}{L}$	0.298 (0.049)	0.249 (0.047)	0.056 (0.024)		0.169 (0.105)	0.189 (0.101)	$\ln L$			0.002 (0.039)	-0.038 (0.040)	
$\ln\frac{M}{L}$			0.673 (0.019)	$(\ln\frac{SK}{L})^2$	0.056 (0.040)	0.026 (0.039)	$\ln V$					0.224 (0.030)
d		-0.942 (0.278)				-0.930 (0.279)			-0.737 (0.239)		-0.805 (0.250)	
ε_2		-1.192 (0.486)				-1.138 (0.494)			-0.842 (0.439)		-0.825 (0.439)	
R_1		-0.130 (0.063)				-0.129 (0.063)			-0.067 (0.057)		-0.070 (0.057)	
Intercept	1.886	2.342	1.619		1.918	2.349		-0.161	0.358	-0.162	0.416	-0.290
R	0.442	0.541	0.950		0.452	0.543		0.613	0.653	0.613	0.655	0.719
M.SQ	0.189	0.169	0.036		0.188	0.169		0.146	0.136	0.147	0.136	0.114

$\hat{\alpha}=0.308$ $\hat{\alpha}=0.254$
$\hat{\sigma}=1.768$ $\hat{\sigma}=1.336$

to the effect of this type of labour power taken care of in the labour input concept. But it is one of the few cases when the coefficient of the d-variable is significantly negative. This is, as we see of our results in table 8.29 true for all relations. But this sample is also the only one for which we obviously have given cars a too high weight in the capital input concept. There are some other cases when the coefficient of g_2 is negative but in so other cases is it significantly negative. In the present case it is true only for the value added Cobb-Douglas case and the Kmenta-approximation case, and not for the CES and "CES" cases.

The coefficient of the R_1-variable is significantly negative both in the value added Cobb-Douglas case and in the Kmenta approximation case, while it is negative but not significant in the CES and "CES" cases. The interpretation of this must be the same as for similiar cases discussed previously.

c) Results forIndustry Group 33 (Samples 33.1 and 33.2)

Since the results of samples 33.1 and 33.2 are not too dissimiliar, (results not presented above, give still stronger indications of this) these two samples were pooled into one. Simultaneously an industry-dummy variable was introduced: $\Delta=1$ for units in industry group 335 and $\Delta=0$ otherwise.

The results of this sample are presented in table 8.35.

There are no "surprising" findings of this merged sample. As we have a larger number of units the estimated standard deviations of the estimates (when comparisons are possible) are slightly lower.

We note that the ACMS-relations gives almost the same point estimates on the elasticity of substitution as for sub-sample 33.2 even if the point estimate on this parameter in the 33.1-sample is much lower. For the merged sample we get, however, a substantially greater point-estimate on the elasticity of substitution by means of the Kmenta-approximation. But the increased number of units does not "save" the significance of the parameters of this relation.

Table 8.35

Estimates for Industry-Group 33 (Samples 33.1-2)

$\Delta=1$ for sample 33.2, $\Delta=0$ otherwise

	Net C.D		Appr. CES			CES		"CES"	
lnL	0.011	0.052	0.013	0.055	lnW	1.330	1.149	1.358	1.163
	(0.027)	(0.029)	(0.027)	(0.028)		(0.110)	(0.113)	(0.113)	(0.117)
$\ln\frac{SK}{L}$	0.228	0.242	0.076	0.074	lnL			-0.028	-0.014
	(0.044)	(0.040)	(0.105)	(0.093)				(0.023)	(0.027)
$(\ln\frac{SK}{L})^2$			0.060	0.067					
			(0.038)	(0.034)					
d		-1.174		-1.159			-0.886		-0.916
		(0.242)		(0.241)			(0.215)		(0.222)
R_1		-0.100		-0.101			-0.025		-0.026
		(0.052)		(0.052)			(0.048)		(0.049)
Δ		0.461		0.468			0.238		0.222
		(0.065)		(0.065)			(0.054)		(0.061)
Intercept	2.238	1.875	2.302	1.934		-0.110	0.157	-0.076	0.186
R	0.316	0.549	0.316	0.558		0.600	0.651	0.603	0.651
M.SQ	0.204	0.160	0.204	0.158		0.144	0.132	0.144	0.132

$\hat{\alpha}=0.236$ $\hat{\alpha}=0.253$

$\hat{\sigma}=2.892$ $\hat{\sigma}=2.955$

The effect of the d-variable is still significantly negative for all types relations presented for this sample. The same is not true for R_1, the effect of which is still negative, but not significantly so in any relation. But the reduction of its effect when turning from production functions estimation to behaviour-relations estimation is still present.

There seems to be a significantly higher level of efficiency in the 335-industry than in the rest of the sample as the coefficient of the Δ-variable in all types of relations is significantly positive.

L. Results for Industry Groups 34 and 35: Basic Metal Industries and Manufacture of Metal Products, except Machinery and Transport Equipment.

a) Results for Industry Group 34; Basic Metal Industries.

As no quality-variables seem to have any significant effect on production only the results of the simple versions of our main relations are presented for this sample.

Table 8.36

Estimates for Sample 34

	Net C.D	Gross C.D		CES	"CES"	
lnL	0.098	0.059	lnW	1.173	0.803	0.482
	(0.038)	(0.025)		(0.296)	(0.362)	(0.346)
$\ln\frac{SK}{L}$	0.087	0.029	lnL		0.065	
	(0.095)	(0.061)			(0.038)	
$\ln\frac{M}{L}$		0.531	lnV			0.100
		(0.067)				(0.032)
Intercept	2.015	1.715		0.112	0.595	0.850
R	0.538	0.849		0.557	0.603	0.680
M.SQ	0.063	0.026		0.059	0.056	0.048

We note that also for this industry is the point-estimate on the elasticity of capital extremely low, and not even significantly different from zero. We have, however, increasing returns to scale, slight but significant, both for the value added and gross production value cases. This implies for the value-added case that the elasticity of labour is very high. As the elasticity of raw materials is modest, this is also true for the gross production value case.

In addition to this we note that the elasticity of substitution according to the results of the ACMS-relation is not significantly different from one, while the results of the Kmenta-approximation (not presented here) concerning the elasticity of substitution are without any sense.

b) Results for Industry Group 35: Manufacture of Metal Products, except Machinery and Transport Equipment.

The results for this industry are presented in table 8.37. We have according to our results significantly increasing returns to scale both for the value added and the gross production Cobb-Douglas cases. Also in this sample is the point-estimate on the elasticity of capital rather low but it is at least significantly different from zero both in the net and the gross Cobb-Douglas cases, in opposition to the results obtained for the previous industry. The point estimate on the elasticity of substitution in the ACMS relation is below one, but the elasticity of substitution is not, according to this relation, significantly below one.

Concerning quality variables, the year of establishment variable F seems to have some effects, but the coefficient of this variable is not, however, significantly different from zero. Some effects do also the region variables seem to have in the production function regressions, while they have almost no effect in the behaviour relation regressions (The later results are not presented here) An interpretation of this is presented previously.

Table 8.37

Estimates for Sample 35

	Net C.D			Gross C.D		CES		"CES"	
$\ln L$	0.063 (0.015)	0.058 (0.015)	0.051 (0.015)	0.028 (0.010)	$\ln W$	0.901 (0.076)	0.887 (0.076)	0.851 (0.079)	0.645 (0.076)
$\ln\frac{SK}{L}$	0.155 (0.029)	0.140 (0.029)	0.139 (0.029)	0.077 (0.019)	$\ln L$			0.034 (0.014)	
$\ln\frac{M}{L}$				0.414 (0.014)	$\ln V$				0.108 (0.012)
F			0.057 (0.049)		D_1		0.127 (0.056)		
q			-0.190 (0.068)						
R_1		-0.085 (0.040)							
R_2		-0.084 (0.047)							
Intercept	2.069	2.151	2.124	2.032		0.686	0.702	0.664	0.544
R	0.322	0.338	0.354	0.841		0.476	0.485	0.487	0.585
M.SQ	0.144	0.143	0.142	0.062		0.124	0.123	0.123	0.106

The present industry is the only one for which we get a significant effect of our production value composition variable q. And in fact it is the only industry of those selected that have a fairly large number os establishments carrying out reparation work for customers. Thus, the results as concerns q for the present sample are not surpr.sing.

Finally we note that in the behaviour relation regression get a significant effect of D_1 (industry dummy for sub-group 3511, Manufacture of wire and wire products) the effect of this variable is, however, insignificant in the production function regressions.

c) Results for Industry Groups 34 and 35

There are substantial similiarities between the results of industry groups 34 and 35, especially concerning the results to scale and the elasticity of substitution which in neither case is significantly different from the according to the ACMS relation. The results concerning the factor-elasticities are, however, a bit different. This is also the case for the elasticity of raw materials.

As we have only 37 units in our 34-sample (which infact is only the four-digit industry 3413; Iron and steel foundries,)and 475 units in our 35-sample our results of the merged sample must be very much dominated by the structure of the later one. This is easily confirmed by comparing the results of the merged sample presented in table 8.38 with the results of our 35-sample in table 8.37.

Table 8.38

Estimates for Sample 34+35

Δ=1 for sample 34, Δ=0 otherwise

	Net C.D	Appr. CES		CES	"CES"
lnL	0.065 (0.013)	0.066 (0.014)	lnW	0.909 (0.074)	0.851 (0.076)
$\ln\frac{SK}{L}$	0.153 (0.027)	0.056 (0.092)	lnL		0.037 (0.013)
$(\ln\frac{SK}{L})^2$		0.035 (0.032)			
Δ	0.003 (0.065)	0.005 (0.065)		0.003 (0.060)	-0.032 (0.060)
Intercept	2.065	2.116		0.669	0.655
R	0.337	0.340		0.482	0.494
M.SQ	0.139	0.138		0.120	0.118

$\hat{\alpha}$=0.152

$\hat{\theta}$=1.990

We also note that the effects of our industry-dummy Δ are completely ignoreable.

M. Results for Industry Groups 36 and 37: Manufacture of Machinery, Electrical Machinery, Apparates Appliances and Supplies.

a) Results for Industry Group 36: Manufacture of Machinery, except Electrical Machinery.

According to our results is the elasticity of scale significantly above one both in the value added, gross production value and Kmenta-approximation-cases. The elasticity of capital is significantly positive but the corresponding point-estimates are very low both in the net and the gross cases, and both when certain quality variables are included and when they are not. This is also the case when applying the Kmenta-approximation of the CES-function.

The point-estiamte on the elasticity of substitution of the ACMS relation is below one both when R_2 is included and when it is not. But the elasticity of substitution is according to this relation not significantly below one. In the present case we may, however, consider the relation obtained by means of the Kmenta-approximation to be fairly reliable as a check on the results obtained by means of the ACMS-relation, since all coefficients of the former relation are significantly different from zero, which they usually are not. As we see does the Kmenta approximation lead to a substantially lower point-estimate on the elasticity of substitution than the ACMS-relation, and this finding, together with similiar findings for total manufacturing indicate that the estimates on the elasticity of substitution obtained by means of the ACMS-relation really are biased towards one.

The results concerning the quality-variables indicate that the level of efficiency is significantly lower for the upper size class than for the rest of the sample. The estimate on the coefficient of R_2 is also negative for all types of relations, and the coefficient is significantly negative for all cases except for the gross production value case. As the point-estiamte on the coefficient considered is only slightly lower in the behaviour relation regressions than in the value added Cobb-Douglas regression we may argue along the same lines as previously that the regional differences in productivity are not so much due to price-differences as to other causes.

Table 8.39

Estimates for Sample 36

	Net C.D		Gross C.D			Appr. CES			CES		"CES"		
$\ln L$	0.091 (0.019)	0.133 (0.025)	0.028 (0.012)	0.028 (0.011)		0.086 (0.019)	0.126 (0.025)	$\ln W$	0.858 (0.134)	0.813 (0.134)	0.698 (0.143)	0.646 (0.143)	0.409 (0.134)
$\ln\frac{SK}{L}$	0.113 (0.040)	0.114 (0.040)	0.065 (0.023)	0.056 (0.023)		0.412 (0.125)	0.348 (0.125)	$\ln L$			0.058 (0.020)	0.060 (0.020)	
$\ln\frac{M}{L}$			0.526 (0.018)	0.528) (0.018)	$(\ln\frac{SK}{L})^2$	-0.108 (0.043)	-0.084 (0.042)	$\ln V$					0.124 (0.017)
r_3		-0.252 (0.098)					-0.230 (0.098)						
R_2		-0.169 (0.064)		-0.069 (0.038)			-0.151 (0.065)			-0.133 (0.064)		-0.139 (0.063)	
Intercept	1.985	1.874	1.772	1.800		1.831	1.762		0.745	0.857	0.849	0.969	0.876
R	0.363	0.425	0.909	0.912		0.395	0.442		0.398	0.417	0.435	0.454	0.573
M.SQ	0.119	0.114	0.040	0.039		0.116	0.112		0.115	0.114	0.111	0.110	0.092

$\hat{\alpha}=0.093$ $\hat{\alpha}=0.098$

$\hat{\theta}=0.299$ $\hat{\theta}=0.374$

b) Results for Industry Group 37: Manufacture of Electrical Machinery (except Electro-Technical Repair Shops.)

In opposition to our results for our sample of the 36 industry our results for the 37-industry, presented in table 8.40 tell us that for this industry we have an elasticity of scale not significantly above one, either for the value-added Cobb-Douglas case the gross production value, or Kmenta-approximation cases. And neither do we get an elasticity of capital significantly positive in the gross production value case. The level of the point-estimates are, however, not much different for these relations for industries 36 and 37.

Also the point-estimates of the elasticity of substitution, both the one obtained by means of the ACMS-relation and the one obtained by means of the Kmenta-approximation, have approximately the same level for the two samples considered. Thus the differences between the results concerning the elasticity of substitution obtained by means of the two types of relations are also present in the 37-industry. And also in this case are all parameters of importance of the Kmenta-approximation significantly different from zero. (The scale-parameter is as we have pointed out not significant, but this does not matter for the reliability of the results obtained by means of this relation.) So the results of this sample does also indicate that we, when applying the ACMS-relation, get a serious bias towards one in our estimates of the elasticity of substitution.

Concerning the effects of qualityvariables, high energy-consumption in relation to the value of the machinery seems to have a positive effect on production. But the corresponding variable g_3, does have a significantly positive coefficient in Kmenta-approximation case only. As for industry 36 does R_2 seem to have a negative effect, but for no types of relations is its coefficient significantly negative.

c) Results for Industry Group 36 and 37 (Sample 36+37).

In spite of the differences concerning the significance of the scale parameter there are, as pointed out under the discussion of the results of the 37-industry, **striking** similiarities between the results obtained for industry 36 and industry 37. So we have merged the two corresponding samples

Table 3.40

Estiamtes for Sample 37

	Net C.D		Gross C.D			Appr. CES			CES		"CES"		
lnL	0.056 (0.028)	0.053 (0.028)	0.011 (0.020)	0.009 (0.021)		0.041 (0.028)	0.033 (0.028)	lnW	0.827 (0.188)	0.779 (0.193)	0.784 (0.199)	0.745 (0.202)	0.557 (0.194)
$\ln\frac{SK}{L}$	0.161 (0.055)	0.193 (0.059)	0.053 (0.040)	0.056 (0.041)		0.425 (0.127)	0.572 (0.134)	lnL			0.020 (0.029)	0.017 (0.029)	
$\ln\frac{M}{L}$			0.421 (0.021)	0.411 (0.031)	$(\ln\frac{SK}{L})^2$	-0.094 (0.041)	-0.123 (0.041)	lnV					0.091 (0.026)
g_3		0.270 (0.178)					0.422 (0.178)	–					
R_2		-0.204 (0.134)		-0.087 (0.103)			-0.229 (0.128)	R_2		-0.152 (0.132)		-0.144 (0.133)	
Inter-cept	2.107	2.042	2.164	2.199		2.041	1.893		0.911	1.023	0.908	1.016	0.817
R	0.333	0.396	0.843	0.844		0.396	0.484		0.402	0.415	0.407	0.419	0.507
M.SQ	0.160	0.155	0.081	0.081		0.154	0.142		0.150	0.149	0.150	0.150	0.134

$\hat{\alpha}=0.148$ $\hat{\alpha}=0.194$

$\hat{\delta}=0.413$ $\hat{\delta}=0.389$

Table 8.41

Estimates for Sample 36+37

$\Delta=1$ for Sample 37, $\Delta=0$ otherwise

	Net C.D		Gross C.D		Appr. CES			CES		"CES"	
$\ln L$	0.081 (0.015)	0.074 (0.016)	0.028 (0.010)	0.023 (0.010)		0.074 (0.015)	$\ln W$	0.840 (0.109)	0.800 (0.109)	0.717 (0.115)	0.693 (0.116)
$\ln\frac{SK}{L}$	0.134 (0.032)	0.126 (0.032)	0.057 (0.021)	0.055 (0.021)		0.380 (0.085)	$\ln L$			0.050 (0.016)	0.043 (0.016)
$\ln\frac{M}{L}$			0.482 (0.016)	0.478 (0.016)	$(\ln\frac{SK}{L})^2$	-0.088 (0.028)	-				
R_2		-0.170 (0.059)		-0.071 (0.039)			R_2		-0.137 (0.059)		-0.136 (0.058)
Δ		0.042 (0.044)		0.045 (0.029)			Δ		0.094 (0.042)		0.067 (0.043)
Intercept	2.007	2.056	1.903	1.928		1.896		0.813	0.883	0.864	0.938
R	0.357	0.391	0.882	0.884		0.392		0.394	0.429	0.424	0.449
M.SQ	0.132	0.129	0.055	0.054		0.128		0.127	0.124	0.124	0.122

$\hat{a}=0.170$
$\hat{\delta}=0.394$

into one, and at accordance with what is done previously for similiar situations we construct a variable Δ which in this case is one for units of the 37-industry and zero for units of the 36 sample.

The results of this merged sample are presented in table 8.41. As we get some kind of an average of the results of the two sub-samples, and as these are discussed above, not many comments should be necessary in this connection.

We note that an increased number of units does not make the elasticity of substitution of the behaviour relation significantly less than one. It is also worth noting that the coefficient of Δ is significantly positive only in the ACMS-relation, while the coefficient for the R_2-variable is significantly negative in all types of relations except in the gross production value case.

N. Results for Industry Group 38: Manufacture of Transport Equipment.

The results concerning capital for this industry are very poor. The estimates are very small, and in no case is the elasticity of capital significantly positive In spite of this we have significantly increasing returns to scale both for the value added and the gross production value cases, when no quality-variables are included. This implies a very high elasticity of labour, in fact is the point estimate above one in the unrestricted value added Cobb-Dougals case. When assuming constant returns to scale we do not obtain very much different results for capital. This does, however, have some rather strange effects on the size-dummies also included in this relation compared with the results for these variables when unrestricted estimation is carried out.

Worth noting, but difficult to explain, is also the finding that the results concerning the size-dummies of the ACMS-relation correspond much better to the results obtained when restricted estimation is carried out than when unrestricted estimation is carried out. A simple but possibly not quite safe explanation is that the ACMS-relation presupposes constant returns to scale. An easy way to investigate this explanation would have been to include the size-dummies in the "CES"-relations. This is, hower, not d one.

Table 8.42

Estimates for sample 38

	Net C.D			Gross C.D		CES		"CES"	
lnL	0.124 (0.024)	0.094 (0.072)	0	0.060 (0.015)	lnW	0.445 (0.120)	0.291 (0.119)	0.280 (0.119)	0.139 (0.106)
$\ln\frac{SK}{L}$	0.035 (0.050)	0.029 (0.050)	0.031 (0.050)	0.016 (0.031)	lnL			0.108 (0.025)	
$\ln\frac{M}{L}$				0.411 (0.026)					0.155 (0.019)
r_1		0.046 (0.124)	-0.079 (0.078)				-0.034 (0.078)		
r_2		0.238 (0.124)	0.348 (0.091)				0.332 (0.090)		
r_3		0.097 (0.207)	0.328 (0.107)				0.310 (0.104)		
Inter-cept	1.931	1.986	2.335	1.982		1.559	1.780	1.478	1.202
R	0.417	0.455	0.444	0.830		0.303	0.479	0.451	0.626
M.SQ	0.142	0.140	0.141	0.056		0.155	0.135	0.137	0.105

The estimate on the elasticity of substitution obtained by means of the ACMS relation is very low. It is in fact the lowest estimate obtained for all samples included in the present study by means of the ACMS relation. And still lower it is when the size-dummies are included. The Kmenta-approximation is of no value in this sample as no coefficients are significantly different from zero in this case.

Section 9

Summary and Conclusions.

As the present study is far from concluded, and consequently the results presented all are preliminary, it is a bit premature to try to draw detailed conclusions concerning the structure of production in Norwegian Manufacturing. The discussion of the results in the previous section mainly aimed at underlining of certain findings that may unweil interesting characteristics of the production structure of different industries. I have not so much tried to make further investigations to clarify if the results are "reasonable". This must be left to a later stage of the study, where we also must try to include findings obtained by others for Norwegian Manufacturing and in general apply all external informations of any relevance of the structure of Norwegian Manufacturing.

It seems to me to be convenient to conclude this paper by a review of the results of the main types of relations applied in the study. I.e. what they may tell us about the scale-properties of production and of the different factor-elasticities, about the substitution possibilities between labour and capital, about the effect of certain characteristics of the establishments expressed by means of the quality-variables, and in general what the results possibly may tell us about the form of the production function. Such a review will be based on "average effects" obtained from Total Manufacturing and the findings from the 27 "independent" samples presented in table 5.1. The other samples applied are as pointed out obtained either by merging or unmerging of some of these 27 samples.

It may also be convenient to indicate at least some conclusions concerning the probable effects of the systematic errors discussed in section 7. The subjective element in these conclusions is naturally very strong, since, as pointed out, the evaluation of the importance of the different types of errors is entirely my own. There may be other types of errors, not discussed in section 7 equally or more important than those discussed. And the direction of the effects of those errors discussed may also be the opposite of what is assumed, but to my opinion this is not very probable.

Firstly we look at the simple value-added Cobb-Douglas relation (i.e. when no qualityvariables are included), to investigate the level of the returns to scale. The results of Total Manufacturing tell us that the level of the scale-elasticity is above one, we have increasing returns to scale on the average in the Manufacturing Industries. As the standard-deviation of the estimate of the scale-parameter is minor we cannot expect large differences for the 27 sub-samples. This is confirmed by looking at the results for the individual groups, presented in section 8. (See also table 9.1) In most cases is the elasticity of scale significantly above one. In only three cases is the point-estimate on this parameter below one, but in no cases is the elasticity of scale significantly below one. The results obtained when introducing quality variables or when applying the Kmenta-approximation are not much different.

Concerning the factor elasticities I consider it to be obvious that, as previously pointed out, the estimates on the capital elasticity obtained by means of direct estimation of the Cobb-Douglas production function (or the Kmenta-approximation) are biased downwards, and that the estimates on the elasticity of labour are biased upwards. When estimating the elasticities by means of the factor-share approach (see Klein |13|) we get quite different, and to my opinion more reasonable results. This is done by estimating the elasticity of labour by means of wages share in value added, and by assuming constant returns to scale we estimate the elasticity of capital as the difference between one and the estimated elasticity of labour.

The estimates on the factor-elasticities of these two methods of estimation are presented in table 9.1. Note that the comparison of these two sets of estimates is not strictly consistent, since we have applied unrestricted estimation when estimateing the factor-elasticities directly from the production function, while we have assumed the elasticity of scale to be one in the other case. Note also that the share of labour in value-added is computed as $\frac{WL}{V}$ i.e. that also imputed wages to proprietors and familymembers are included, as we have assumed a wage-rate, and a number of hours worked a year equal to what are the average numbers for production workers in each sample, and for all manufacturing industries respectively. In light of the previous discussion this may possibly lead to an overstatement of the share of labour in value added.

The results for Total Manufacturing indicate that the elasticity of substitution on the average is below one, both when applying the ACMS-relation and the Kmenta-approxiamtion. In light of the discussion in section 7 it is regrettable that the later relation is almost of no value when trying to investigate the substitution possibilities for labour and capital in the

Table 9.1

Estimates of the factor-elasticities in the Cobb-Douglas function obtained by means of regressions directly on the production function and by means of the factor share-method.

Industry	By regression directly on the production function			By the factor share approach	
Group	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\varepsilon}$	$\hat{\alpha}_1$	$\hat{\alpha}_2$
20.1	0.984	0.078	1.062	0.505	0.495
20.2	0.722	0.233	0.955	0.390	0.610
20.3	0.916	0.151	1.067	0.677	0.323
20.4	0.836	0.183	1.019	0.603	0.397
20.5	0.916	0.049	0.965	0.629	0.371
20.6	0.879	0.257	1.136	0.606	0.394
21	0.973	0.141	1.114	0.465	0.535
23	0.868	0.175	1.043	0.558	0.442
24.1	0.965	0.193	1.158	0.674	0.326
24.2	0.956	0.186	1.142	0.618	0.382
24.3	0.866	0.257	1.123	0.558	0.442
25.1	0.944	0.123	1.067	0.675	0.325
25.2	0.974	0.155	1.129	0.611	0.389
26.1	1.024	0.127	1.151	0.623	0.377
26.2	0.950	0.176	1.126	0.720	0.280
27	0.708	0.264	0.972	0.561	0.439
28	0.821	0.199	1.020	0.629	0.371
31.1	0.511	0.410	0.921	0.388	0.612
31.2	1.024	0.012	1.036	0.558	0.442
31.3	0.766	0.320	1.086	0.392	0.608
33.1	0.865	0.210	1.075	0.656	0.344
33.2	0.834	0.298	1.132	0.546	0.454
34	1.011	0.087	1.098	0.619	0.381
35	0.908	0.155	1.063	0.616	0.384
36	0.978	0.113	1.091	0.635	0.365
37	0.895	0.161	1.056	0.573	0.427
38	1.089	0.035	1.124	0.644	0.356

sub-samples. I believe it cannot at all be doubted that our estimates on the elasticity of substitution obtained by means of the ACMS-relation are for most or even all samples more or less strongly biased towards one. Only when both the coefficient of the $\ln\frac{K}{L}$ - variable and the coefficient of the square term are significantly different from zero, can the results obtained by means of the Kmenta-approximation be considered as fairly reliable, and thus are suited as a control of the results obtained by means of the ACMS-relation. But even then may the results of the Kmenta-aaproximation be insensible, as for sample 20.2 where both coefficients concerned are significantly different from zero, but where we get a negative point-estimate on the elasticity of substitution. To my opinion these curious results are very much due to errors of measurement of the capitalvariable.

Even if it may not be easily acceptable to estimate the share of capital in value added as done in table 9.1, I believe it is worth while to try to estimate the elasticity of substitution in the way proposed by Hildebrand/ Liu | 8| (see section 2) by applying the share-of-capital-estimates obtained.

Concerning the quality-variables, the results presented in section 8 speak for themselves, as we for each sample have selected those quality-variables (if any) that seem to explain a significant part of the variations of produciton. Those variables appearing most often are the regional variables, but this may to a substantial extent be due to misspecifications of the variables, (especially because the production-measures are value-concepts and not quantity-concepts) and perhaps not so much because of "real" differences between the regions. In addition it is mostly the composition-variables d, g_1 and g_2 that seem to explain something.

Concerning the results of the gross production Cobb-Douglas relations, I have not tried to "explain" them i.e. interprete the elasticity of raw material, and the differences of the elasticities of labour and capital in these relations and in the value added Cobb-Douglas relations. This is a matter of further investigation.

The results in general are possibly neither better nor worse than we could have expected. But now, as we have got more appropriate knowledge of what we can expect ot obtain by means of the Cencus of Norwegian Manufacturing Establishments, as concern questions about different characteristics of the structure of production, I believe there are substantial possibilities of improvements. But much is left to be done.

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