An Inverse Relationship between Efficiency and Profitability According to Size of (Upper-)Austrian Firms? Some Further Tentative Results*

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ABSTRACT. This paper examines the relationships between profitability and firm size, and efficiency and firm size, based on firms in Upper Austria. There is considerable evidence suggesting that the average profitability of small enterprises exceeds that of large firms. However, productivity tends to be positively related to firm size. These empirical findings present something of a paradox.

1. Introduction

The advantages and disadvantages of large and/or small enterprises has been discussed over and over again in the industrial economic literature. Nevertheless the empirical results of most studies in industrial economics are far from unequivocal. One reason may be that the relative advantages of specific size classes of enterprises may change with time due to the given state of technology and the organisation as well as the nature of supply and demand. Overall superiority of one class size of firms with respect to efficiency and profitability has not been clearly demonstrated. However, one more general result has been found quite often: a general superiority of large firms could not be substantiated in this field of research.[1]

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In this paper an attempt is made to investigate profitability and efficiency according to the size of firms in the state of Upper Austria. The state of Upper Austria was chosen because we have a data base which covers 95% of all industrial firms in this state. Moreover, the industry structure in Upper Austria is quite representative of the overall industry structure in Austria.

Section 2 formulates six hypotheses concerning the possible superiority of small firms.[2] In Section 3 the empirical results of the analysis of variance and multiple regression are presented that deal with efficiency and profitability of the industrial sector in Upper Austria. Section 4 offers a summary and one preliminary conclusion.

2. Some theoretical considerations about the performance of small versus large firms

In spite of the overwhelming empirical evidence on the superiority of small firms, Aiginger and Tichy (1991) quite rightly argue that there is no comprehensive theory available to explain the high performance of smaller firms. They form six hypotheses with which they try to demonstrate that there may also be some theoretical justification of the performance superiority of small firms. These hypotheses are reported below, but it must be said that they do not come from a coherent theory or from a developed theoretical model. Moreover, some of the hypotheses may only be valid in special circumstances and may not hold generally.

Hypothesis 1.
The higher profitability of smaller firms is reflected in lower wages and social benefits and

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in less regulation (Aiginger and Tichy (1991, p. 88). One reason for this is that large firms are usually located in agglomerations with higher wage brackets. Also in large firms the attraction of more qualified labor may be greater, etc.

Hypothesis 2.
Small firms increase employment as demand shifts to sectors with low optimal sizes, service components determine competitiveness, and demand is more differentiated.

Hypothesis 3.
Smaller firms have to earn a higher average return since their individual risk is larger.

Hypothesis 4.
Smaller firms are owner-managed firms aiming at profit maximization; larger firms are manager-controlled, aiming at maximizing the manager's utility function.

Hypothesis 5.
Smaller firms can react more rapidly to changing demand. The idea is that in smaller firms managers are closer to the market and therefore react more quickly to a change. As their income is even more directly linked to the firm's success (which also holds for the other employees), they show greater flexibility than managers in large firms.

Hypothesis 6.
Technical developments favored larger units in the Sixties, and miniaturization of chips made electronic devices attractive for smaller units. In the Eighties, Aiginger (1988) argues that computer-aided design, computer-aided production, and flexible automation may disproportionately favor smaller units since very small batches are becoming more attractive.

As Aiginger and Tichy (1991) argue, these are some tentative hypotheses which could help to explain the surprising performance of smaller units in the Seventies. They are open to empirical falsification, which will be attempted in the next section with data for Upper Austria.

3. Empricial results for performance of small versus large firms

3.1. *Some descriptive results for Upper Austria*

The most important summary statistics and results for the structure of Upper Austrian firms are presented in Table 1 as averages over the period 1976 to 1987. If we consider column 1, which lists the number of the firms by industrial classification, we see that the metalworking branch is by far the largest single sector. It includes over 38 per cent of all firms, and approximately the same figure holds for employment and value added in this sector as well. It is followed by textiles (17.8 per cent), wood (13.3 per cent), and food production (12.9 per cent). In column 2, which lists average employment, electrical engineering has the highest share with 164 employees per firm. It is followed by chemical production (110). The net production value per firm is also the highest in the electrical industry with 57.6 million ATS, followed by chemical production and metal working (44.9 and 33.8 mill. ATS, respectively).

If we consider the employment size structure of the firms in the industries in column 4, we see that small firms (between 1 and 99 employees per firm) clearly dominate. Over all the different production branches, small firms compose over 60 per cent, and in six cases even higher than 66%. In the wood production industry we have the highest share of small firms with 82.4% and in the electrical industry the lowest with 60.4%. Medium-sized firms (between 100 and 499 employees per firm) reach the highest value with 32% in the textile industry, followed by electrical industry with 30.2%. Large firms (i.e., more than 500 employees per firm) are below 10 per cent in all branches; they reach the highest value of 9.4% in the electrical industry and the lowest with 1% in food production. This picture shows that small firms clearly dominate all branches, followed by medium firms. In terms of their numbers, large firms do not play a significant role. The metalworking branch has the highest employment with roughly 30,000 employed, followed by the textile and chemical industries with 15,000 and 10,000 employed.

TABLE I
Summary statistics of six branches of the Upper Austrian firms, *average over 1976–1987*

Branch	1. Average number of firms	2. Average employment per firm	3. Average net production value per firm in mill. ATS	4. Share of firms size (by employment)			5. Overall employment	6. Overall value added in Mill. ATS
				Small	Medium	Large		
metal industry	289 (38.1%)	101.8	33.8	73.8	21.7	4.4	29.387 (38.6%)	9.768 (40.2%)
electrical industry	39 (5.1%)	163.6	57.6	60.4	30.2	9.4	6.367 (8.4%)	2.264 (9.3%)
food processing industry	98 (12.9%)	79.7	29.4	74.2	24.7	1.0	7.786 (10.2%)	2.881 (11.9%)
textile industry	135 (17.8%)	105.1	23.6	66.3	32.0	1.7	14.197 (18.6%)	3.186 (13.1%)
wood industry	101 (13.3%)	77.8	21.4	82.4	14.7	2.9	7.841 (10.3%)	2.161 (8.9%)
chemical industry	96 (12.7%)	109.5	44.9	74.4	23.4	2.2	10.560 (13.9%)	4.310 (17.8%)
all branches	758 (100%)	100.5	32.4	73.1	23.7	3.3	76.138 (100%)	24.270 (100%)

3.2. *Some empirical tests of the hypotheses asserting for the superiority of small firms*

3.2.1. *Performance criteria measures.*

In this section an attempt will be made to test the hypotheses stated above, which all more or less predict higher efficiency and profitability of smaller units. We will try to test these hypotheses by using four different indicators for efficiency and profitability measures. Table 2 shows the four measures for profitability and efficiency: The gross and net residual quota (see Aiginger, 1982; Schneider, 1991) are used as proxies for profit because we have no direct access to the data about profits. The second criterion is labor efficiency, where we use the traditional measure net output per employee. The third measure is labor cost-efficiency, where labor cost per worker is used, and obviously low cost of labor implies advanced efficiency and competitiveness.

3.2.2. *Empirical results*

These four performance criteria are used to test the six hypotheses using data from industries of six branches of the state of Upper Austria. All observations in Austrian shillings (ATS) are deflated by the GDP-deflator and the data runs on an annual basis from 1976 to 1987; i.e., 12 years are covered and used in order to avoid the problem of spurious results. The data includes almost all industrial firms in Upper Austria, according to the classification of the central statistical office.[3]

In order to check whether a systematic variation between size classes and performance measures exists, an analysis of variance is undertaken of the performance ratios of the firms by employ-

TABLE 2
Performance criteria for comparing the firms according to their size class

Performance criteria	Definition[1]	Dimension
Rentability/profitability:		
Gross residual quota (GRQ)	GRQ = (NPV − LC)/NPV	percent
Net residual quota (NRQ)	NRQ = (NPV − LC − DEP)/NPV	percent
Productivity:		
Net production per employee (NPE)	NPE = NPV/EMP	Mill. S
Labor cost efficiency:		
Total labor cost per employee (LCE)	LCE = LC/EMP	Mill. S

[1] Symbols: DEP = annual depreciation of buildings, machinery and vehicles
EMP = employment
LC = total labor cost
NPV = net production value (= (depreciation) + (indirect taxes − subsidies) + (payments for service inputs) + (profits (or losses))

ment size of the enterprise in Upper Austria over the period 1976 to 1986. The results are shown in Table 3. The variance analysis is done in two ways: In the first case it is weighted by the number of firms in the size class; in the second case the weighting is dropped.

If we first consider the gross (net) residual quota, we see that a statistically significant result shows up in only four (one) out of six cases, i.e., in the case of the unweighted variance analysis for metal, food, textile and wood industries. If we look in detail at these four branches, we can accept our hypothesis of the superiority of small firms only for wood production and must reject it for metal, textile and food production. However, in all cases the medium sized firms (100—499 employees) have the worst performance (lower value) indicating a nonlinear relationship. Considering the net residual quota we can only confirm our hypothesis in the case of the wood industry but in all significant cases the medium-sized firms have the lowest value. This last result indicates again that there may be a nonlinear relationship between the size of a firm and its profitability.

If we turn next to the productivity measure, we see that in two (four) out of six cases we have a statistically significant result for the weighted (unweighted) variance analysis (in the case of metal, electrical, food and chemical industries). But in all significant cases we must clearly reject our hypotheses. The larger the firm, the more productive it is. For example, in the case of metal production, productivity per employed person is 290.500 ATS in the small firms and it rises to 382.500 ATS in large firms. In the electrical industry we have a similar increase from 297.200 ATS in small firms to 360.900 ATS in large firms.

If we go to labor cost efficiency (column 4 in Table 3), we find statistically highly significant differences in all branches. Two results depicted in Table 3 are unique to the labor cost efficiency criterion: In all branches small firms have the lowest cost of labor and large firms have the highest. Furthermore, in all cases labor costs efficiency rises linearly, so that medium-sized firms lie between small and large firms.

To summarize the results of Table 3, we see that small firms are more efficient with respect to labor costs, but less efficient with respect to productivity and in some cases with respect to profitability. The latter result is not unique, since in the metal, food, textile and wood industries small firms are more profitable than medium-sized ones, but less profitable than the large ones (with the exception of the wood industry). Hence we observe to some extent the inverse relationship

TABLE 3
Weighted and unweighted analyses of variance of the performance measures over the three size classes of the firms[1]

Branch firm size class	1. Gross residual quota (%)	2. Net residual quota (%)	3. Net proudction per empl. in 1000 ATS	4. Labor cost per empl. in 1000 ATS
Metal industry				
0—99	27.4	18.5	290.5	191.8
100—499	24.5	17.3	303.5	213.1
>499	29.2	20.9	382.5	254.6
average value	26.8	18.3	298.2	199.9
F-value (weighted)	1.55	0.22	4.08**	23.71**
S-level	0.21	0.80	0.02	0.00
F-value (unweighted)	4.07**	1.06	36.41**	111.9**
S-level	0.02	0.35	0.00	0.00
Electrical industry				
0—99	33.1	23.0	297.2	180.2
100—499	30.8	23.5	301.2	198.0
>499	34.3	28.1	360.9	229.1
average value	32.4	23.7	304.4	190.8
F-value (weighted)	0.39	0.16	1.02	4.1**
S-level	0.68	0.86	0.36	0.00
F-value (unweighted)	0.68	0.73	4.62**	13.8**
S-level	0.51	0.48	0.00	0.00
Food processing industry				
0—99	39.1	25.5	384.7	213.4
100—499	32.1	20.9	373.2	223.2
>499	55.5	52.6	580.7	251.9
average value	37.5	24.6	383.3	216.1
F-value (weighted)	3.54**	1.23	0.33	1.40
S-level	0.03	0.29	0.72	0.25
F-value (unweighted)	8.99**	6.87**	4.82**	4.82**
S-level	0.00	0.00	0.01	0.01
Textile industry				
0—99	26.5	20.5	204.1	129.7
100—499	23.9	15.1	207.3	148.5
>499	28.8	21.3	212.5	148.1
average value	25.6	18.6	205.3	136.8
F-value (weighted)	1.44	5.34**	0.13	25.9**
S-level	0.29	0.00	0.88	0.00
F-value (unweighted)	2.29*	7.65**	0.27	36.9**
S-level	0.10	0.00	0.76	0.00
Wood industry				
0—99	29.1	20.4	258.6	163.7
100—499	20.3	12.2	241.5	185.8
>499	22.9	13.8	269.3	201.6
average value	27.6	19.0	256.4	168.2

Table 3 (Continued)

Branch firm size class	1. Gross residual quota (%)	2. Net residual quota (%)	3. Net proudction per empl. in 1000 ATS	4. Labor cost per empl. in 1000 ATS
F-value (weighted)	2.11	1.55	0.39	4.09**
S-level	0.12	0.22	0.67	0.01
F-value (unweighted)	9.77**	7.27**	1.99	25.5**
S-level	0.00	0.00	0.14	0.00
Chemical industry				
0—99	31.3	20.7	321.0	198.7
100—499	30.7	19.0	383.7	247.0
>499	29.9	23.4	407.5	266.0
average value	31.1	20.3	340.1	212.8
F-value (weighted)	0.03	0.17	8.48**	26.2**
S-level	0.97	0.85	0.00	0.00
F-value (unweighted)	0.09	0.50	19.97**	72.7**
S-level	0.92	0.61	0.00	0.00

[1] Explanations: F-value (weighted) means that a weighted analysis of variance is undertaken; the weight is the number of firms in the respective size class; F-value (unweighted) means that no weight measure is used. (*), *, ** mean significance level of 10%, 5% and 1%, respectively.

referred to in the title of this paper in 3 out of the 6 branches.

Because similar results have already been discussed in Schneider (1991), we make an attempt in this paper to go a step further and to undertake additional investigations in order to shed some light on this quite puzzling result. The first and obvious question is: Are the ceteris paribus conditions fulfilled acceptably? One might question this in several ways. Firstly, if we group one branch of firms into three categories (small, medium and large), do they all produce the same output mix under the same conditions? One important aspect may be the qualification of the labor force. Another is that we might have together quite heterogenous groups of firms in these branches: for example in the electrical industry category we have industries which produce only simple electrical machines and other firms which may produce computer parts or soft- or hardware for computers. To tackle these and other questions and to save space in this paper, we will concentrate in the following on the metal sector (by far the biggest and most important production sector in Upper Austria). As first step, we will investigate whether there are systematic differences when we consider the qualification of the labor force. It is obvious that those firms which have a highly qualified labor force might be more efficient in production than those with a less qualified one. But it might also be the case that, when the firms are grouped in such a way that we better capture the effect, they might also produce different goods and services.

In Table 4, the results of the weighted and unweighted variance analysis with respect to qualification of labor force and the size of the firms are shown.[4] If we again first consider the result of the gross (net) residual quota, we find a statistically significant result for the unweighted analysis of variance in only two (one) of four cases, for firms of the metal branch with very highly skilled and medium-skilled (very highly skilled) working force. Let us first consider the result for firms with a very highly skilled labor force. In this case the result is a clear rejection of our hypotheses: large firms have the highest gross (net) residual quota of 32.60% (25.9%) but medium-sized firms have the lowest value. In the case of medium-skilled firms, we can conform our hy-

TABLE 4
Weighted and unweighted analysis of variance of the performance measures over the three size classes and the five education classes of the firms in the *metal* sector[1]

Qualification of the labor force metal branch	1. Gross residual quota (%)	2. Net residual quota (%)	3. Net production per empl. in 1000 ATS	4. Labor cost per empl. in 1000 ATS
Very highly skilled				
0—99	23.3	14.0	285.8	197.7
100—499	20.0	13.3	304.8	223.6
> 499	32.6	25.9	466.3	286.3
average value	23.1	14.6	300.9	208.3
F-value (weighted)	0.85	0.39	6.25**	13.63**
S-level	0.429	0.68	0.00	0.00
F-value (unweighted)	4.88**	3.91**	51.89**	70.29**
S-level	0.008	0.02	0.00	0.00
Highly skilled				
0—99	27.9	19.8	294.6	196.0
100—499	24.5	18.2	308.8	224.4
> 499	28.5	11.2	351.8	255.8
average value	27.1	19.2	299.2	204.0
F-value (weighted)	0.45	0.13	0.49	7.67**
S-level	0.63	0.88	0.62	0.00
F-value (unweighted)	1.17	1.12	2.83*	28.02**
S-level	0.311	0.326	0.06	0.00
Medium-skilled				
0—99	28.4	19.7	275.8	179.1
100—499	24.5	15.5	299.5	211.6
> 499	24.8	16.8	307.7	226.6
average value	24.0	18.4	284.4	191.1
F-value (weighted)	1.00	0.99	1.67	14.45**
S-level	0.368	0.37	0.189	0.00
F-value (unweighted)	2.03*	1.90	3.92**	37.44**
S-level	0.13	0.15	0.02	0.00
Unskilled				
0—99	32.7	23.1	309.5	189.6
100—499	30.5	23.8	300.8	190.4
> 499	33.9	28.9	361.9	236.5
average value	32.1	23.4	302.2	190.9
F-value (weighted)	0.28	0.01	0.15	0.16
S-level	0.75	0.97	0.86	0.85
F-value (unweighted)	0.54	0.31	1.17	4.62**
S-level	0.58	0.73	0.31	0.01

[1] Explanations: see Table 3.

potheses that small firms have the highest gross residual quota and large firms the lowest (28.4% versus 24.8%, and 24.5% versus 14.4% for the net residual quota). But again, all cases indicate a nonlinear relationship because medium-sized firms have the lowest gross (net) residual quota values.

Looking at the productivity measure, we have a statistically significant result in three cases: for metal firms with very highly skilled, highly skilled and medium-skilled labor forces. In the very highly skilled category we have a similar result as for the overall metal sector: small firms have a significantly lower productivity than large ones (285.800 compared to 466.300 net production value per worker). A result with less variation is obtained for the medium-skilled sector, where large firms have a somewhat higher productivity than small and medium-sized firms.

For the labor cost efficiency measure we find statistically significant differences for all four cases and we find again that the labor cost is lowest in small firms and highest in large firms for all four qualification categories. Again we find the striking result that the larger the firm, the better the productivity is, but the larger the firm the worse is the labor cost efficiency. With respect to the gross (net) residual quota as a profitability measure, the result is mixed. In one case small firms dominate and in one case large firms dominate. But in general we find here, too, the reverse relationship between profitability and efficiency according to firm size, taking into account that medium-sized firms perform worst.

In order to further check these results, we introduce influential factors, so that we can make another attempt to fulfill somewhat better the ceteris paribus conditions. In this last attempt we run a multiple regression; the dependent variables are our four performance and efficiency measures. Besides the differentiation between size of a firm (using a linear and nonlinear term) and education, we include the following additional influential factors:

(1) The share of exports in the gross production value of a firm (in per cent) is incorporated.
(2) The location of the firm in the Upper Austrian region is measured by the ratio of persons employed in the agricultural sector divided by the overall number of employees. With this indicator we want to capture that firms situated in rural regions might have disadvantages.
(3) The influence of the national and international business cycle is measured by the annual rate of the OECD GNP (in real terms).
(4) An interaction variable is constructed between variables 1 and 3 in order to see whether there is an interaction between phases of the business cycle and export structure.
(5) Finally, a time trend is introduced to capture all other factors.

All these additional variables are used to explain the gross and net residual quotas (profitability measures) and the productivity measure. For the labor cost efficiency equation we use only employment and employment squared, export share, and the trend variable. We have the following four regression equations:

$$GRQ_{i,t} = a_0 + a_1FS_{i,t} + a_2FSQ_{i,t} + a_3EXQ_t + + a_4LOC_{i,t} + a_5BCY_t + a_6IVE_t + + a_7TR_t + e_{i,t}$$

$$\text{with } a_1, a_4 < 0; a_2, a_3, a_5 - a_7 > 0; \quad (1)$$

$$NRQ_{i,t} = b_0 + b_0 + b_1FS_{i,t} + b_2FSQ_{i,t} + + b_3EXQ_t + b_4LOC_{i,t} + b_5BCY_t + + b_6IVE_t + b_7TR_t + e_{i,t}$$

$$\text{with } b_1, b_4 < 0; b_2, b_3, b_5 - b_7 > 0; \quad (2)$$

$$\log(NPE_{i,t}) = c_0 + c_1FS_{i,t} + c_2FSQ_{i,t} + + c_3EXQ_t + c_4LOC_{i,t} + + c_5BCY_t + c_6IVE_t + c_7TR_t + e_{i,t}$$

$$\text{with } c_1, c_4 < 0; c_2, c_3, c_5 - c_7 > 0; \quad (3)$$

$$\log(LCE_{i,t}) = d_0 + d_1FS_{i,t} + d_2FSQ_{i,t} + + d_3EXQ_t + d_4TR_t + e_{i,t}$$

$$\text{with } d_1 > 0; d_2, d_3, < 0, d_4 > 0; \quad (4)$$

The symbols are:

BCY = business cycle influence, real annual rate of the OECD-GNP,
EXQ = share of exports in gross production value (percent),
FS = firm size in employed persons per firm,
FSQ = firm size squared in thousands of employed persons per firm,

GRQ = gross residual quota in percent,
IVE = interaction variable, EXQ × BCY,
LCE = labor cost per employee (real values deflated by the GNP price index) in mill. ATS,
LOC = location of the firm (farmers as a percent of all employed persons),
NPE = net production per employee (real values deflated by the GDP price index) in mill. ATS,
NRQ = net residual quota in percent, and
TRE = trend variable, 1976 = 1, 1987 = 12.

It is obvious that, based on our hypotheses, we expect to derive a negative sign for firm size, a positive one for squared firm size, a positive one for the export share, a negative one for the location, and a positive one for the business cycle, for the interaction variable and for the time trend variable. Let us repeat that we have chosen this nonlinear relationship between size and performance because the analysis of variance already showed that quite often medium-sized firms performed less well than small and large ones.

In the following regression analysis, we have in our sample on average 64 firms per year from the metal working sector. In the regression technique we use an OLS-estimation procedure. The results are shown in Tables 5.1 to 5.4 for the four performance measures.

As we found in the analysis of variance that we have quite different results in the different levels of qualification of the working force, we run four

TABLE 5.1
Regression results of the gross residual quota (GRQ) in the metal branch; combined cross sections time series regression analysis; 1976—1987 and between 71 and 56 firms per year[1]

Independent variables	Dependent variables: NRQ of the metal working branch with			
	very highly skilled labor force	highly skilled labor force	medium-skilled labor force	unskilled labor force
constant term	0.206**	0.325**	0.315**	0.303**
	(8.144)	(12.51)	(10.49)	(5.01)
firm size (FS)	−0.392**	−0.412**	−0.137	−0.623**
	(−2.71)	(−3.50)	(−0.921)	(−2.38)
firm size squared (FSQ)	0.579**	0.350**	0.115	0.590(*)
	(3.27)	(3.75)	(0.710)	(1.89)
export share (EXQ)	0.168**	0.026	−0.044	0.103
	(3.26)	(0.277)	(−0.678)	(1.10)
location (LOC)	0.079**	0.030(*)	0.042**	−0.054*
	(3.96)	(1.95)	(3.48)	(−2.57)
business cycle (BCY)	0.030**	0.023*	−0.0005	0.051*
	(3.37)	(2.47)	(−0.055)	(2.26)
interaction variable (IVE)	−0.025	0.011	0.018	−0.014
	(−1.19)	(0.304)	(0.75)	(−0.414)
time trend (TRE)	0.015**	0.018**	0.011**	−0.01**
	(6.09)	(6.49)	(4.16)	(−3.57)
R^2	0.107	0.102	0.065	0.037
F-value	15.13	10.08	5.95	2.91
DW-value	1.313	1.880	1.788	0.852
d.f.	885	622	600	531

[1] Explanations: The figures in parentheses below the estimated coefficients are the t-values. (*), *, ** indicates that the variable has a significant influence at the 90%, 95% and 99% level of confidence (one-tailed tests). "R^2" is the coefficient of determination corrected for degrees of freedom, "DW" is the Durbin-Watson statistic, and "d.f." are the degrees of freedom.

TABLE 5.2
Regression results of the net residual quota (NRQ) in the metal branch; combined cross sections time series regression analysis; 1976—1987 and between 71 and 56 firms per year[1]

Independent variables	Dependent variables: NRQ of the metal working branch with			
	very highly skilled labor force	highly skilled labor force	medium-skilled labor force	unskilled labor force
constant term	0.090**	0.255**	0.242**	0.196**
	(3.04)	(9.20)	(7.66)	(5.60)
firm size (FS)	−0.194	−0.291**	−0.074	−0.12
	(−1.14)	(−2.34)	(−0.47)	(−0.55)
firm size squared (FSQ)	0.375(*)	0.148	0.081	0.202
	(1.80)	(1.50)	(0.48)	(0.72)
export share (EXQ)	0.191**	−0.076	−0.109	0.093**
	(3.15)	(−0.77)	(−1.61)	(3.15)
location (LOC)	0.092**	0.012	0.039**	0.015
	(3.89)	(0.711)	(3.11)	(0.77)
business cycle (BCY)	0.036**	0.012(*)	−0.01	0.024(*)
	(3.45)	(1.99)	(−0.93)	(1.97)
interaction variable (IVE)	−0.032	0.052	0.036	−0.020
	(−1.31)	(1.31)	(1.45)	(−0.63)
time trend (TRE)	0.016**	0.017**	0.009**	0.005
	(5.28)	(5.82)	(3.31)	(1.58)
R^2	0.088	0.074	0.049	0.02
F-value	12.28	7.05	4.37	1.30
DW-value	1.313	1.880	1.788	0.852
d.f.	894	618	598	521

[1] Explanations: see Table 5.1.

separate regressions for each of the three performance measures in order to see whether we have systematic difference according to the qualification level of the working force.

In Table 5.1 (5.2) the results for the gross (net) residual quota as dependent variable are shown. In all four regression equations we have the expected signs for the variables firm size and squared firm size, and for the gross residual quota (as dependent variable) both coefficients are statistically significant with the exception of the regression equation for the metal sector with a medium-skilled labor force. In order to demonstrate the influence of firm size on the gross (net) residual quota, in Figure 1 (2) the influence of the estimated coefficient of firm size on the dependent variable is shown.

This figure also depicts the breakdown of firms by size (in percent) and clearly shows that 96% of the metal firms belong either to the small or medium-sized group. In Figures 1 and 2 the graphs of the gross (net) residual quota of the very highly skilled group shows that the minimum of the parabolic curve occurs at firms at a size of 340 (200) employed persons, and only firms larger than 680 (380) employees have a higher gross (net) residual quota than the group of small firms. Obviously, we have a few large firms which have a higher gross (net) residual quota than the small ones, but the great majority of small firms have a higher gross (net) residual quota than any (most) medium-sized firms. At the highly skilled level the small firms again have a high gross (net) residual quota and the minimum of this parabolic curve lies in the area of large firms with 618 employed persons. Again small firms achieve high performance with respect to gross residual quota, and only firms larger than 1,200 employed persons attain a

TABLE 5.3
Regression results of the net production per employee (NPE) in the metal branch; combined cross sections time series regression analysis; 1976—1987 and between 71 and 56 firms per year[1]

Independent variables	Dependent variables: NPE of the metal working branch with			
	very highly skilled labor force	highly skilled labor force	medium-skilled labor force	unskilled labor force
constant term	5.528**	5.646**	5.635**	5.643**
	(143.3)	(140.4)	(110.44)	(100.0)
firm size (FS)	0.572**	0.224	0.238	−0.346*
	(1.22)	(0.94)	(−1.00)	(2.58)
firm size squared (FSQ)	−0.092	0.036	−0.195	0.591
	(−0.34)	(0.233)	(−0.71)	(1.32)
export share (EXQ)	0.480**	0.143	0.201(*)	0.297**
	(6.09)	(0.991)	(1.83)	(2.24)
location (LOC)	0.009	−0.042(*)	−0.021	−0.077*
	(0.07)	(−1.73)	(−1.00)	(−2.46)
business cycle (BCY)	0.038**	0.042**	−0.001	0.029
	(2.76)	(2.93)	(−0.043)	(1.44)
interaction variable (IVE)	−0.049	−0.007	0.002	−0.032
	(−0.12)	(0.05)	(−0.62)	(−1.52)
time trend (TRE)	0.032**	0.022**	0.022**	0.012**
	(8.30)	(5.20)	(4.80)	(2.18)
R^2	0.23	0.077	0.088	0.048
F-value	37.67	7.47	8.29	3.80
DW-value	1.981	2.400	2.585	2.548
d.f.	893	628	598	531

[1] Explanations: see Table 5.1.

higher gross residual quota; in the case of the net residual quota, none of the large firms reaches the good performance of the small ones. At the medium-skilled level we have a very flat parabolic curve, where we have the minimum of the curve in the group of large (medium) firms with 781 (500) employed persons. However, this curve has to be interpreted with care because the estimated coefficients for FS and FSQ are not statistically significant. Considering the non-skilled case, we clearly see that the minimum is just at border between medium and large firms (489 employed persons for the gross residual quota and 300 for the net residual quota); again only a few large firms have a higher gross residual quota than the small ones.

The coefficients for the share of exports is statistically significant in only one case (for both the gross and net residual quota) and has the expected positive sign in this case; i.e., the higher the share of export, the higher is the gross residual (net) quota, ceteris paribus. The regression variable location measure is statistically significant in all four cases for the gross residual quota (two cases for the net residual quota), but has the "wrong" (positive) sign in three (two) cases; the variable measuring the cyclical influence (real annual rate of the OECD-GNP) is statistically significant in three cases and has the expected positive sign. The interaction variable (share of export multiplied by the business cycle variable) is statistically significant in none of the equations. The trend variable is statistically significant in all equations of the gross residual quota with non-skilled labor force, indicating that there are other (unexplained) influences which have a positive influence over time on the gross (net) residual quota. The coefficient of determination (corrected for degrees of freedom) is quite low, indicating

TABLE 5.4
Regression results of the labor cost per employee (LCE) in the metal branch; combined cross sections time series regression analysis; 1976—1987 and between 71 and 56 firms per year[1]

Independent variables	Dependent variables: GRQ of the metal working branch with			
	very highly skilled labor force	highly skilled labor force	medium-skilled labor force	unskilled labor force
constant term	5.297**	5.231	5.209	5.292**
	(255.9)	(234.4)	(161.5)	(179.8)
firm size (FS)	1.196**	1.000**	1.144**	0.357(*)
	(7.58)	(7.80)	(6.34)	(1.66)
firm size squared (FSQ)	−0.839**	−0.500**	−0.911**	−0.052
	(−4.28)	(−4.84)	(−4.30)	(−0.18)
location (LOC)	−0.091**	−0.069**	−0.050**	−0.124**
	(−4.14)	(−3.95)	(−3.08)	(−5.84)
time trend (TRE)	0.013**	−0.001	0.011**	0.008*
	(4.26)	(−0.37)	(3.09)	(2.30)
R^2	0.16	0.13	0.15	0.086
F-value	44.01	25.0	27.2	12.94
DW-value	1.951	2.232	2.267	2.112
d.f.	920	640	609	550

[1] Explanations: see Table 5.1.

that important influences have not been captured in this analysis, but it has to be considered here that the regression is based upon individual firm data and not — as usual — on aggregated data; hence, it is not astonishing that the R^2 is quite low. With the exception of the regression of the gross residual quota for the unskilled labor force, the Durbin Watson indicates no first order autocorrelation of the residuals.

In Table 5.3 the regression results of the productivity measure (net production value per employee) are shown. What is striking (compared with results in Tables 5.1 and 5.2) is that firm size has a statistically significant influence only in the regression of the productivity measure with the very highly skilled labor force. In all other cases both coefficients the firm size are not statistically significant. In the significant case it has an unexpected positive sign. In this case we have the clear result (compare also Figure 3) that the bigger the firm the higher the productivity performance. Looking at the other independent variables, we see in the regression of the productivity for those firms having a very highly skilled, medium skilled and unskilled labor force, export share is statistically highly significant and has the expected positive sign. In the regression for the productivity of firms with a highly skilled labor force, the location variable has the expected negative sign and is statistically significant. For the regression of the productivity measure for unskilled labor force, both variables (share of export and distance measure) have the expected signs and are statistically significant. All regressions have a very strong positive trend variable, clearly indicating the existence of additional (unexplained) influences which show that over time the productivity in the metal sector in Upper Austria is increasing. The coefficient of determination (corrected for degrees of freedom) is much higher (between 0.21 and 0.39) than in the case for explaining the gross (net) residual quota, but this increase might be the result of the statistically high influence of the trend variable. Also there seems to be no problem with autocorrelation of the first order residuals.

The regression equation for labor cost performance (Table 5.4) shows — for the first time — a very dominating influence of firm size in three out of the four regression equations. In all four regres-

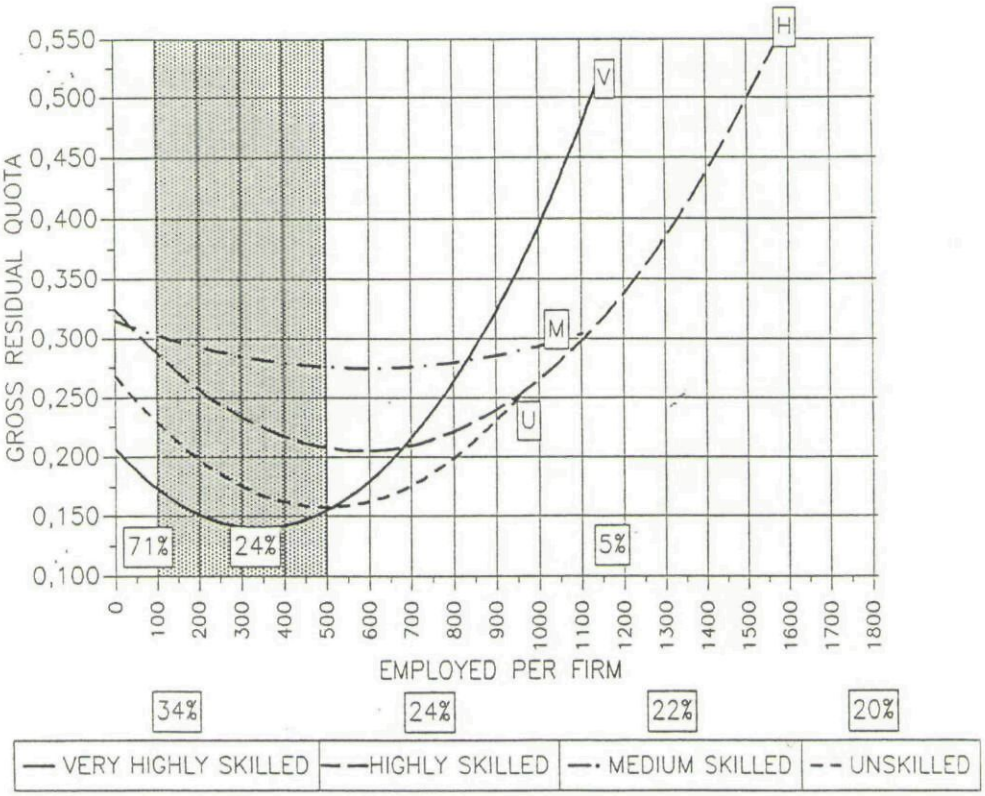

Fig. 1. Gross residual quota metal working.

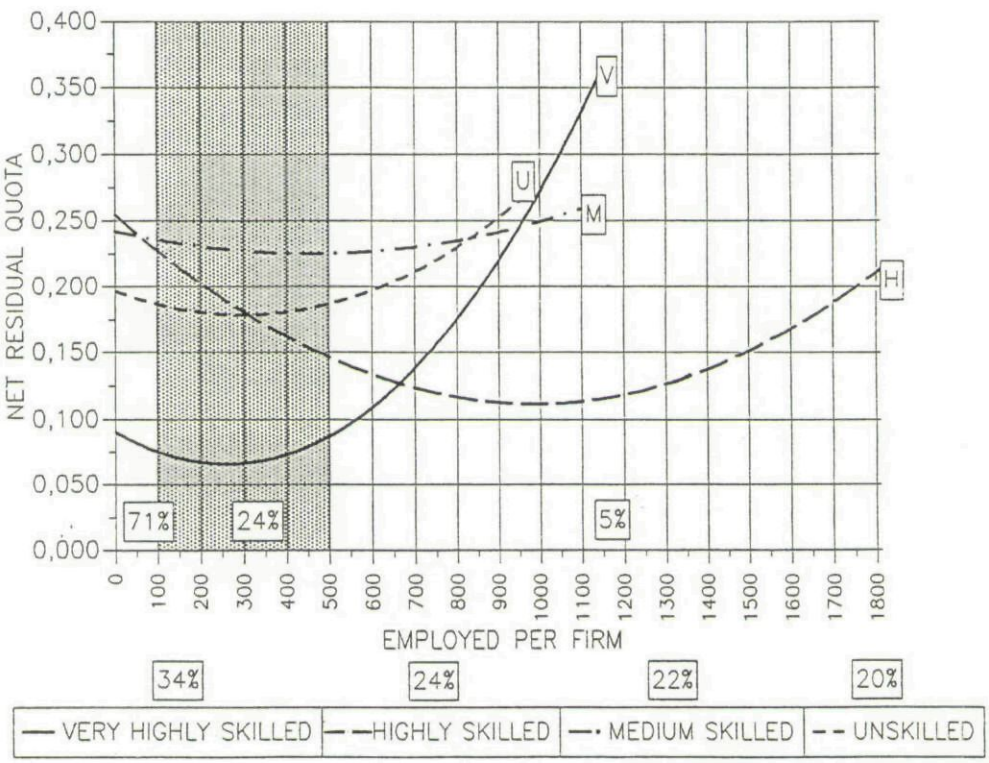

Fig. 2. Net residual quota metal working.

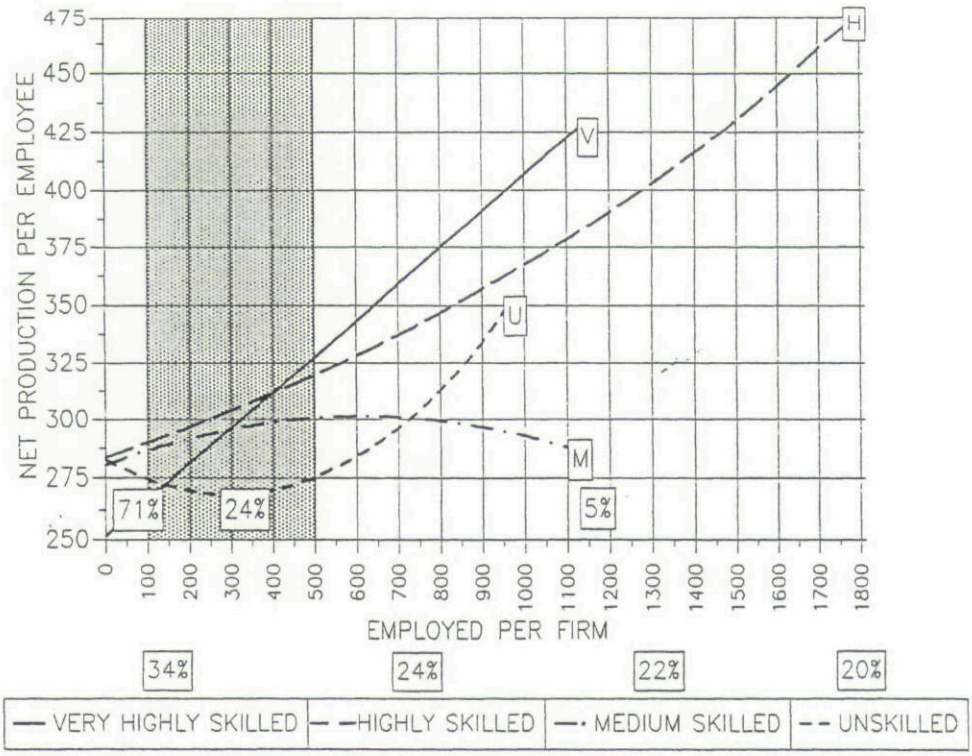

Fig. 3. Net production per employee metal working.

sion equations we have the expected sign and only in the regression equation with the unskilled labor force explaining the cost performance of the metal branch of the unskilled labor force, the squared coefficient is statistically insignificant. The results of this non-linear influence are shown in Figure 4.

For the three cases (cost performance of metal firms with high-skilled, skilled and low-skilled labor force), we see that small firms have the best (i.e., lowest) cost performance ratio, which steadily rises; the maximum of the three parabolic curves lies completely in the area of large firms (for the very highly skilled labor force 720, highly skilled 1002, medium-skilled 655 and unskilled 1000 persons). This result clearly indicates that small firms have much better cost performance than medium ones and large ones. In none of the cases does a large firm have a similarly good cost performance as the group of small firms.

The next independent variable, location measure is statistically significant in all four equations and has the expected sign. Again we find a statistically highly significant and positive trend (in three cases), indicating additional (unexplained) factors, which increase the labor cost per capita per year. The coefficient of determination is low, with values between 0.09 and 0.16. The Durbin-Watson shows no autocorrelation of the first order residuals.

To summarize these results, we realize that if we "explain" our four performance measures with the multiple regressions that we have to somewhat modify our findings compared to the analysis of variance. The influence of firm size is overwhelmingly significant on the dependent variable labor cost per capita. Explaining the gross (net) residual quota we have a statistically highly significant influence in three (one) out of four cases. For the productivity measure, the firm size variable is statistically significant in only one case. These results are somewhat different from the ones in Table 4 (showing the analysis of variance), where we have much more statistically significant cases. This indicates that the attempt is worthwhile to control as well as possible for other influential factors.

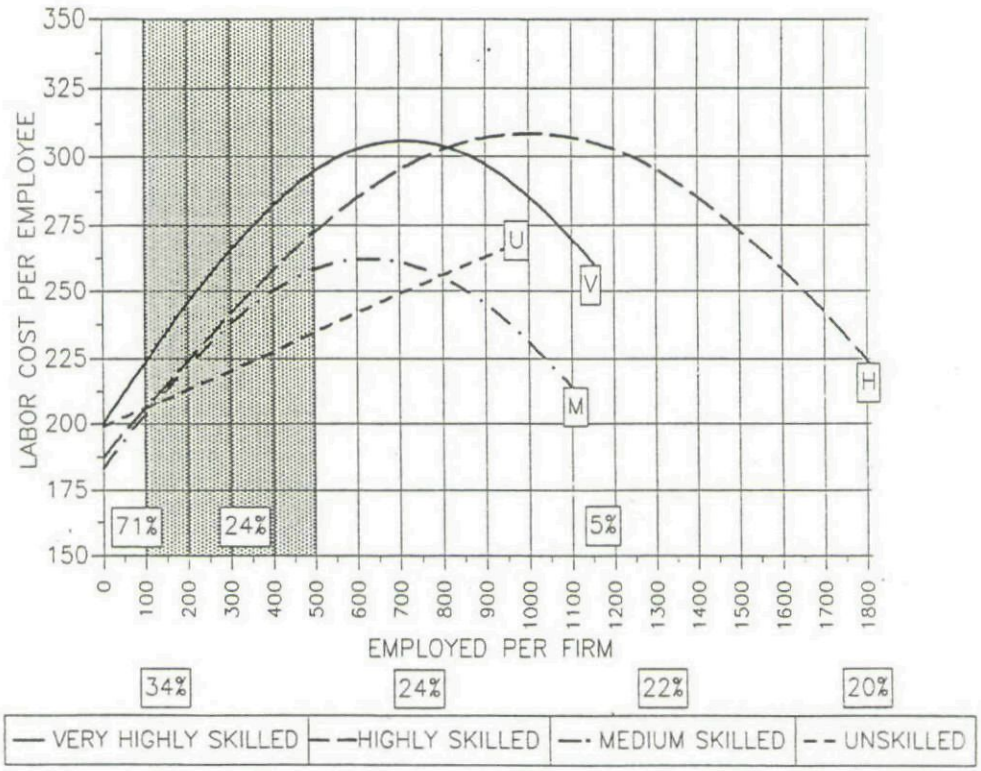

Fig. 4. Labor cost per employee metal working.

TABLE 6
Number of firms (overall employment) according to the branch and skill level of the labor force, averages over 1976—1987

Branch	Skill level of the labor force: Very highly skilled	Highly skilled	Medium-skilled	Unskilled
Metal industry				
Number of firms	103 (73.5)	65 (47.1)	65 (39.5)	56 (17.8)
Overall employm.	9546 (70.6)	5486 (37.8)	9353 (43.3)	5003 (17.7)
Electrical industry				
Number of firms	10 (7.3)	7 (5.1)	5 (3.0)	16 (5.1)
Overall employm.	2606 (19.3)	319 (2.2)	705 (3.6)	2737 (9.7)
Food processing industry				
Number of firms	8 (5.7)	22 (15.9)	20 (12.2)	48 (15.2)
Overall employm.	777 (5.7)	1571 (10.8)	1868 (9.5)	3569 (12.6)
Textile industry				
Number of firms	3 (2.1)	12 (8.7)	25 (15.2)	95 (20.2)
Overall employm.	65 (0.5)	1226 (8.4)	2182 (11.0)	10725 (37.9)

Table 6 (Continued)

Branch	Skill level of the labor force: Very highly skilled	Highly skilled	Medium-skilled	Unskilled
Wood industry				
Number of firms	13 (9.3)	18 (13.0)	26 (15.9)	44 (14.0)
Overall employm.	329 (2.4)	2037 (14.0)	3346 (16.9)	2129 (7.5)
Chemical industry				
Number of firms	3 (2.1)	14 (10.1)	23 (14.0)	56 (17.8)
Overall employm.	201 (1.5)	3887 (26.8)	2300 (11.6)	4171 (14.7)
All branches				
Number of firms	140 (100)	138 (100)	164 (100)	315 (100)
Overall employm.	13524 (100)	14526 (100)	19754 (100)	28334 (100)

As one can argue that these detailed results for the metal branch may be unique, we very briefly show the results for the other production branches in the following four Tables (7.1 to 7.4) and Figures (5 to 8). In order to be very brief, we have chosen a somewhat different procedure which contains two steps: In the first step, we have standardized the four measures with respect to skill level for the six production branches. This has the advantage that we now have only one regression to estimate. In the next step the regressions of the six production branches were estimated again using the four performance measures as dependent variables and using the independent variables firm size, firm size squared, export share, and location variable. The gross (net) residual quota shows the same results as for the metal branch for all other production branches with the exception of chemicals, where we have precisely the reverse picture (for which we have no explanation). For the chemical branch it seems that the medium-sized firms perform best, contrary to the other five cases, where the medium-sized firms perform rather poor. The electrical, wood, textile and food industries clearly show high performance for the gross and net residual quota of small firms and, with the exception of wood, where we have no large firms, we reach similar results as in the metal sector.

The productivity measure (net production per employee) we got here opposite to the disaggregated findings of the metal branch, again a non-linear relationship indicating that small firms have a rather low net production per employee compared to the bulk of medium-sized and large firms. Again, only the chemical sector shows the reverse result; here the medium-sized firms have by far the highest productivity (net production per employee) compared to small and large firms. The fourth performance measure — labor cost per employee —, produces a surprising result which we already got for the findings of the disaggregated metal branch. In six production branches, we clearly see that small firms have the lowest labor costs per employee, which rise significantly for medium-sized firms. For the electrical branch, it falls again for firms with more than 1,500 employees; in the case of metals, it falls for firms with more than 900 employees; for chemicals the highest labor costs per employee are reached in the area of medium-sized firms with 350 employees. The wood branch is similar to the metal branch, and the peak is reached with 700 employed persons. The textile branch is similar to the chemical branch, and here the highest labor cost per employee seems to be case with 220-employee firms.

Summarizing these results, we see that generally we get the same findings for the other production branches as we discussed in some detail for the metal branch. The only exception is the chemical branch, but in principle these findings give us

TABLE 7.1
Regression results for the gross residual quota (GRQ) in the production firms, corrected for the education level and business cycle influences[1]

branch	const.	firm size	firm size squared	export share	location variable	F	R^2	d.f.
food processing industry	0.118 (0.647)	−5.470** (−3.75)	14.05** (4.25)	0.665 (0.72)	0.114 (0.21)	5.27	0.32	41
textile indudtry	0.278 (2.42)	−2.161* (−2.63)	3.280** (2.69)	−0.024 (−0.06)	0.163 (1.23)	5.26	0.30	41
wood industry	−0.019 (−0.035)	−1.972** (−3.20)	1.617** (3.00)	−0.063 (−0.12)	0.178 (0.81)	4.41	0.25	41
chemical industry	−0.070 (−0.52)	1.732(*) (1.80)	−2.557 (−1.33)	−0.905* (−2.45)	0.437* (2.03)	2.41	0.17	41
metal industry	−0.180 (−1.41)	−2.157** (−3.54)	1.939** (4.37)	0.936* (2.04)	0.172 (1.05)	5.90	0.31	41
electrical industry	0.195 (1.26)	−2.771** (−2.71)	2.283* (2.60)	0.363 (1.00)	−0.229 (0.16)	2.62	0.17	41

[1] Explanations: see Table 5.1.

TABLE 7.2
Regression results for the net residual quota (NRQ) in the production firms, corrected for the education level business cycle influences[1]

branch	const.	firm size	firm size squared	export share	location variable	F	R^2	d.f.
food processing industry	−0.015 (−0.08)	−4.436** (−3.11)	12.42** (3.83)	1.426 (1.65)	0.151 (0.76)	4.65	0.29	41
textile industry	0.300** (2.88)	−2.576** (−3.48)	3.607** (3.28)	0.092 (0.25)	0.145 (1.19)	8.25	0.40	41
wood industry	0.052 (0.26)	−2.128** (−3.55)	1.612** (3.08)	0.249 (0.47)	0.032 (0.15)	4.23	0.25	41
chemical industry	−0.025 (−0.18)	0.299 (0.31)	−0.435 (−0.22)	−0.596 (−1.52)	0.347 (1.57)	1.83	0.13	41
metal industry	0.313** (3.37)	−0.884* (−1.99)	0.982** (3.16)	−0.109 (−0.32)	0.218* (2.00)	7.49	0.36	41
electrical industry	0.191 (1.11)	−1.738 (−1.53)	1.848 (1.53)	0.198 (0.50)	−0.264 (−1.53)	1.24	0.09	41

[1] Explanations: see Table 5.1.

TABLE 7.3
Regression results for the net production per employee (NPE) in the production firms, corrected for the education level and business cycle influences[1]

branch	const.	firm size	firm size squared	export share	location variable	F	R^2	d.f.
food processing industry	0.173 (0.84)	−2.946(*) (−1.69)	8.903* (2.20)	1.418 (1.30)	−0.087 (−0.37)	1.71	0.13	51
textile industry	0.152 (0.99)	−0.923 (−0.81)	1.892 (1.14)	0.076 (0.14)	−0.226 (−1.18)	0.59	0.04	51
wood industry	−0.180 (−0.83)	0.545 (0.83)	−0.176 (−0.31)	−0.193 (−0.34)	0.254 (1.10)	0.51	0.04	51
chemical industry	−0.252 (−1.42)	5.792** (4.49)	−8.568** (−3.30)	−0.646 (−1.30)	0.152 (0.56)	8.51	0.41	51
metal industry	−0.152 (−1.44)	−0.530 (−1.01)	1.073* (2.65)	0.913* (2.43)	−0.145 (−1.04)	20.59	0.61	51
electrical industry	0.174 (0.98)	−2.473* (−2.16)	2.783* (2.28)	0.431 (1.05)	−0.353* (2.01)	2.34	0.16	51

[1] Explanations: see Table 5.1.

TABLE 7.4
Regression results for the labor cost per employee (LCE) in the production firms, corrected for the education level and business cycle influences[1]

branch	const.	firm size	firm size squared	export share	location variable	F	R^2	d.f.
food processing industry	−0.083 (−0.31)	3.427(*) (1.65)	−7.550(*) (−1.64)	1.476 (1.13)	−0.327 (−1.21)	3.46	0.24	51
textile industry	0.10 (0.06)	2.466* (2.14)	−2.383 (−1.42)	0.020 (0.04)	−0.418* (−2.20)	9.24	0.42	51
wood industry	−0.377 (−1.51)	4.055** (5.36)	−2.945** (−4.46)	0.417 (0.65)	−0.003 (−0.01)	11.08	0.46	51
chemical industry	−0.414* (−1.98)	9.180** (6.09)	−14.20 (−4.61)	−0.165 (−0.28)	−0.632 (−0.49)	20.94	0.64	51
metal industry	0.057 (0.50)	2.345** (4.40)	−1.306** (−3.37)	0.225 (0.55)	−0.621** (−4.30)	57.29	0.81	51
electrical industry	−0.321 (−1.36)	1.231 (1.09)	−0.636 (−0.53)	0.183 (0.46)	−0.050 (−0.29)	3.42	0.21	51

[1] Explanations: see Table 5.1.

some confidence that the rather disaggregated results for the metal branch might also be obtained for the other branches.

4. Summary and some concluding remarks

In this paper, we make an attempt to shed some light on the performance of Upper Austrian firms by size class. Considering our theoretical hypotheses that small firms have a better performance measure, we find that to some extent we can confirm our hypotheses with respect to profitability. On average, the gross (net) residual quota of small firms is higher than that of medium-sized firms, and only a very few large firms have a higher gross (net) residual quota than small firms. However, we should interpret this result with some care. The influence of firm size on the productivity measure shows a weak influence of the firm size indicating the larger the firm is, the higher the productivity. Explaining the productivity in the metal sector for a high-skilled labor force, we have again the result that the larger the firm, the better the productivity measure is — an empirical result which contradicts our hypotheses. In the case of labor cost per capita, we clearly can confirm our hypotheses that the smaller the firm, the lower the labor cost is. This result is one of the few, which is quite strong, but obviously this is not enough, so that the small firms also then have an overall higher profitability. In Schneider (1991) there are reasons discussed why this may be so, because the Austrian industrial policy clearly favors medium and large firms. In general, these empirical findings are somewhat puzzling. Partly our hypotheses are confirmed and partly refuted. This underscores the need for more empirical investigations to be conducted using better and more convincing theoretical approaches.

At least one preliminary conclusion can be drawn. The hypothesis — although easily asserted and supported by frequent international findings — that small firms are more efficient and show better performance could only be confirmed partially for Upper Austria.

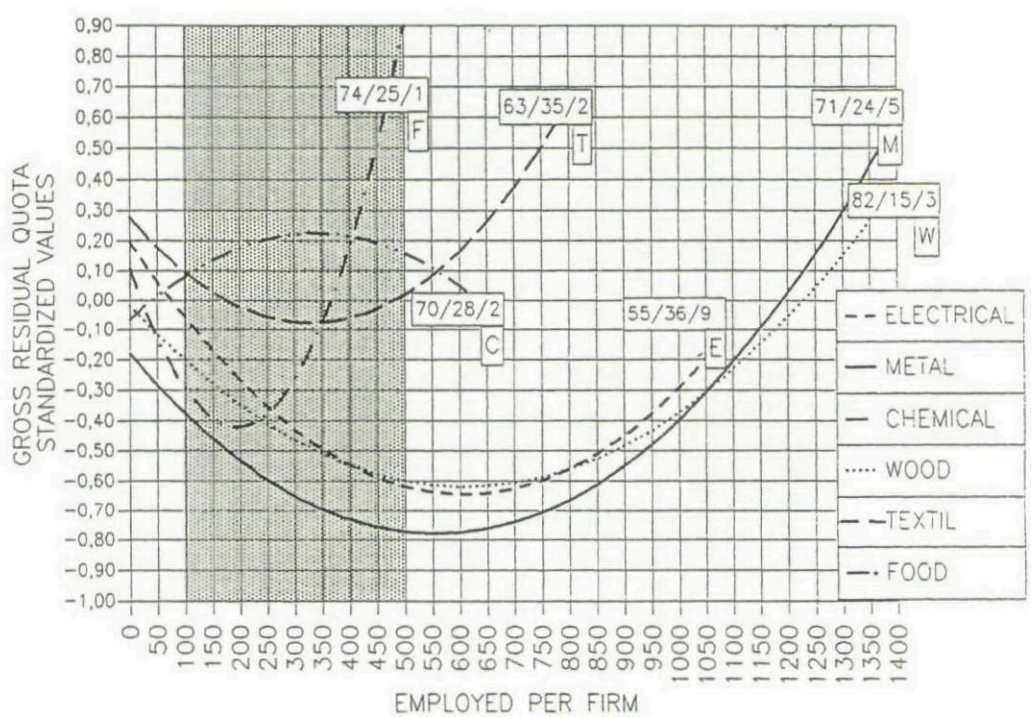

Fig. 5. Gross residual quota standardized values. (Explanations: The numbers of each graph mean, e.g. for the metal sector, 71% of all firms are small ones, 24% are medium-sized ones and 5% are large ones.)

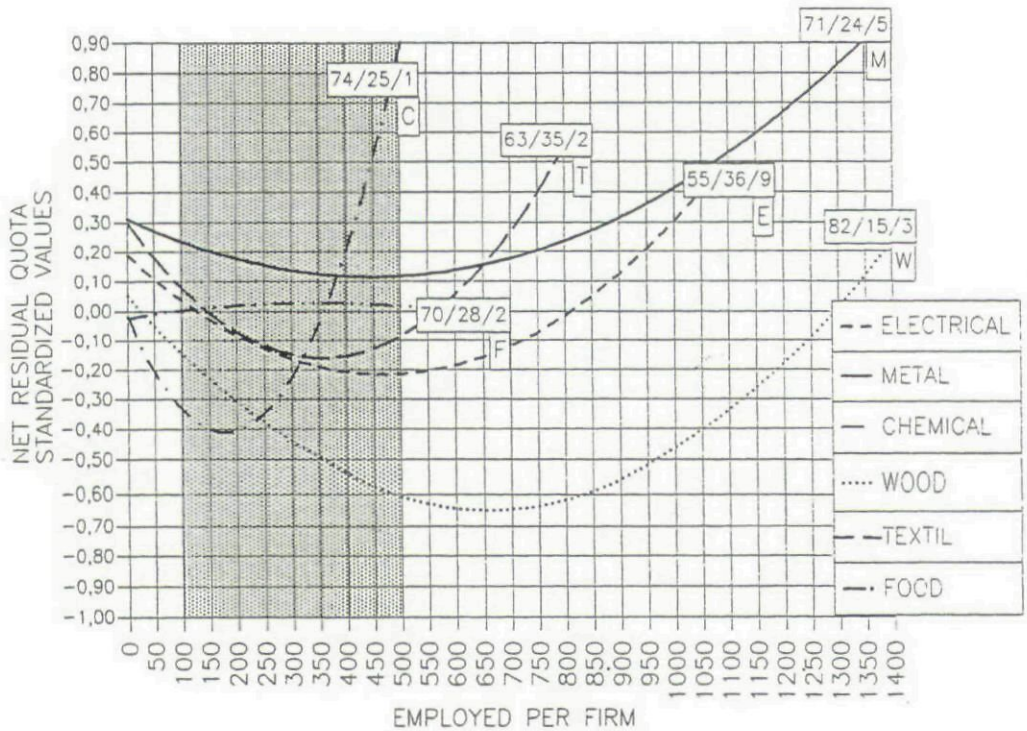

Fig. 6. Net residual quota standardized values. (Explanations: The numbers of each graph mean, e.g. for the metal sector, 71% of all firms are small ones, 24% are medium-sized ones and 5% are large ones.)

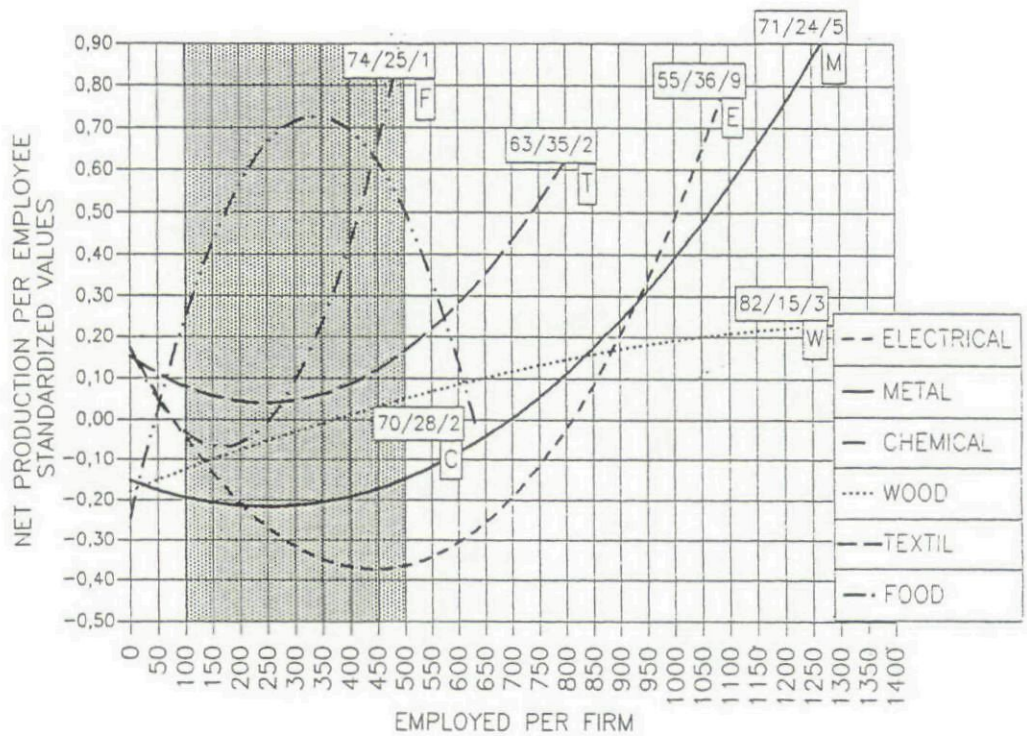

Fig. 7. Net production per employee standardized values. (Explanations: The numbers of each graph mean, e.g. for the metal sector, 71% of all firms are small ones, 24% are medium-sized ones and 5% are large ones.)

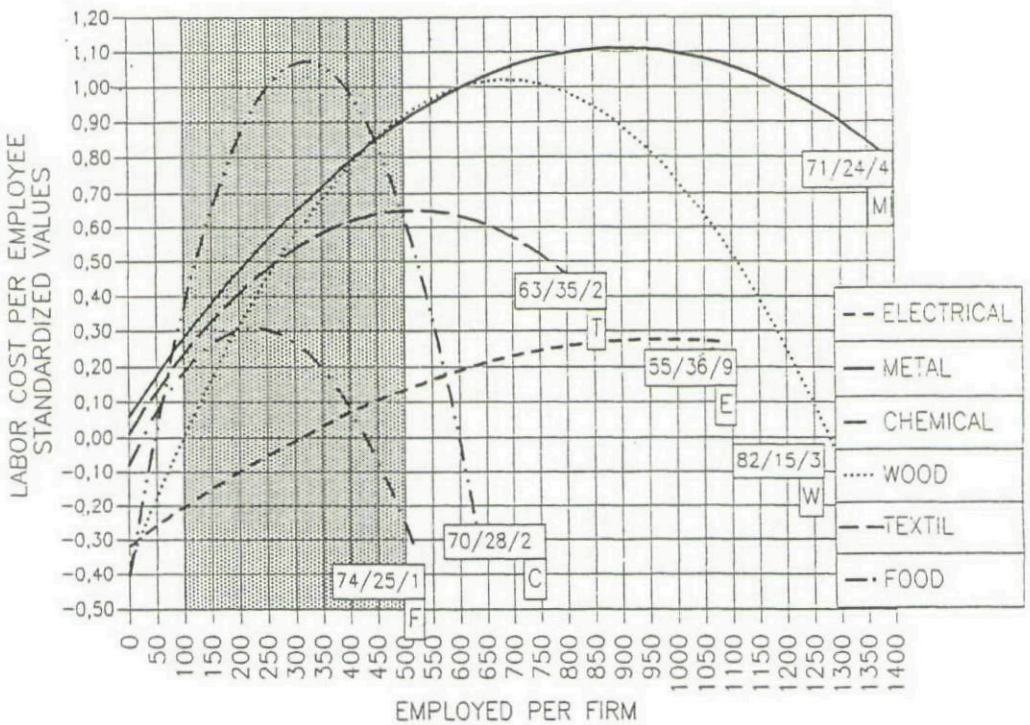

Fig. 8. Labor cost per employee standardized values. (Explanations: The numbers of each graph mean, e.g. for the metal sector, 71% of all firms are small ones, 24% are medium-sized ones and 5% are large ones.)

Notes

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[1] Compare the discussion of this finding in Aiginger and Tichy (1984, 1991) and Schneider (1991).

[2] In Schneider (1991) some remarks on the literature are given.

[3] Not included are (A) state-owned industries, because they did not always follow the goal of profit maximization, and (B) a number of firms which had to be excluded because of unreliable data.

[4] The fact, that we still have enough firms and each cell can be seen in table 6, where we show the number of firms for each category. The qualification ratings are grouped into the following four categories:

(1) Very highly skilled: In this category we have 71,7 per cent of highly skilled workers;
(2) Highly skilled: In this category we have 46.0 per cent of highly-skilled workers;
(3) Medium-skilled: 24,3 percent of highly skilled workers;
(4) Unskilled: 10,8 per cent of highly skilled workers.

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