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SOME INCENTIVES AND CONSTRAINTS OF SCIENTIFIC PERFORMANCE IN DEPARTMENTS OF ECONOMICS

PART I. PREDICTOR-CRITERION RELATIONS

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The main purpose of this paper is to explore why publication records differ among Dutch departments of economics. The results of a large scale performance evaluations have been used for classifying research units in subsamples of high and low performers. After collecting data on organizational characteristics of economics research units, univariate and multivariate statistics have been applied to test hypotheses regarding determinants of scientific productivity in economics.

"The extreme clannishness, not to say xenophobia, of the Econ makes life among them difficult and perhaps even somewhat dangerous for the outsider. This probably accounts for the fact that the Econ have so far not been systematically studied (...) More research on this interesting tribe is badly needed".*

Introduction

In 1985 the Dutch government asked a review commission, the "Verkennings-commissie Economische Wetenschappen" (VEW), to evaluate the performance of university research in economics and to advise on possible improvements. The VEW issued its report in 1986, concluding that strong productivity differences existed between research units in Departments of Economics (which include units of business administration in the Dutch system)[1]. On the one hand, there were units that published 180 (weighted) pages per person per year. On the other hand, there were units that did not publish at all.

Following Graves et al.,[2] this paper makes an attempt to explain why publication records differ among Dutch departments of economics. The VEW findings have been used for classification research units in subsamples of high and low performers. After

*A. Leijonhufvud, *Information and Coordination. Essays in Macroeconomic Theory*, New York, Oxford University Press, 1981, 347-59

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collecting data on the organization of research units, univariate and multivariate statistics have been applied to explore the research questions regarding facilitators (incentives) and inhibitors (constraints) of scientific productivity in economics.

Performance measurement

The VEW has highlighted the need for the development of productivity indices in the university sector. Their own proposal is that performance of research units should be established on the basis of publications by staff based on numbers of pages published in the period 1979-1984 (six years). Journal articles were weighted according to a U.S. ranking based on citations. *Liebowitz* and *Palmer*[3] have assessed the relative impact of economics journals, and provided a ranking of journals based on their relative influences on the writings of academics, either within the economics profession or in the world at large.The measure of journal impact used to create this ranking is the number of citations that authors make to articles appearing in various journals. The authors have controlled for both journal size and age in constructing the measure. The values of their citation index (CI) varied between 0 and 100. On the basis of Liebowitz and Palmer's set of journals the VEW differentiated A-journals ($CI \geq 10 \leq 100$), B-journals ($CI \geq 1 \geq 10$), and C-journals ($CI < 1$). Examples of A-journals ar the *American Economic Review, Econometrica,* and the *Journal of Money, Credit & Banking.* Examples of B-journals are *Administrative Science Quarterly, European Economic Review*, and *Decision Science*. Examples of C-journals are *History of Political Economy, International Journal of Industrial Organization*, and *Interfaces*. Two categories were added: D-journals and E-journals. The scientific standing of these journals has been estimated to be low; so is their contribution to the growth of economic knowledge (VEW, 1986, p. 65-80). The following weighting factors were allocated to these journals: 4 (A-journal), 3 (B), 2 (C), 1 (D), 1/2 (E). Three kinds of publications were distinguished: journal articles [JA (unweighted), and JA (weighted)], book articles [BA (Dutch), and BA (international)] and books [BK (Dutch), and BK (international)].

Figure 1 shows the distribution of Full time equivalent (FTE) productivity per university. (Key: EUR is Erasmus University Rotterdam; UVA is University of Amsterdam; KHT is University of Tilburg; RUG is University of Groningen; VU is Free University Amsterdam). In total 93 research units were evaluated by the VEW. They were associated with departments of economics and with departments of other disciplines such as departments of law, and departments of management and organization. (The source of Fig. 1 is the VEW report, Statistical appendix, Table 19).[1]

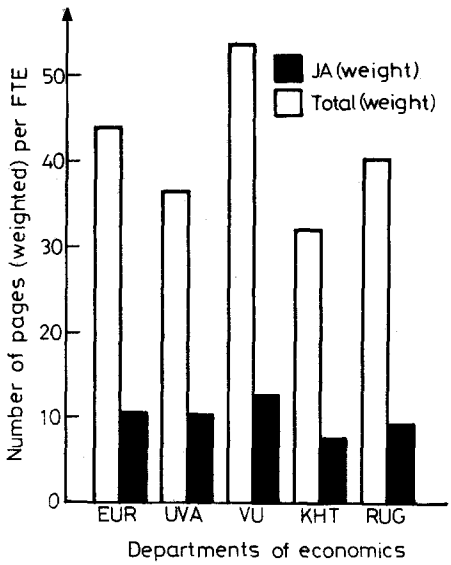

Fig.1. Departmental productivity in Dutch economics

Journals were also classified as to subject. The VEW made use of an amended version of the Journal of Economic Literature (JEL) index of classification codes (Cf.key Fig.2). Each publication has been classified under one subject only, so that double countings were excluded.

It should be mentioned that the JEL index is essentially a classification code for general economics and econometrics. Business administration is included in its entirely in code 5(a). Nevertheless a large portion of the staff of a Dutch department of economics (30-50%) is active in this area.

Figure 2 illustrates the distribution of productivity per field per university. Only universities with a department of economics were requested to participate in the study. Since the evaluation period is 1979-1984, the University of Limburg which was officially established only in 1984, was not requested to participate in this study. (The source of Fig.2 is the VEW report,[1] Statistical appendix, Table 18).

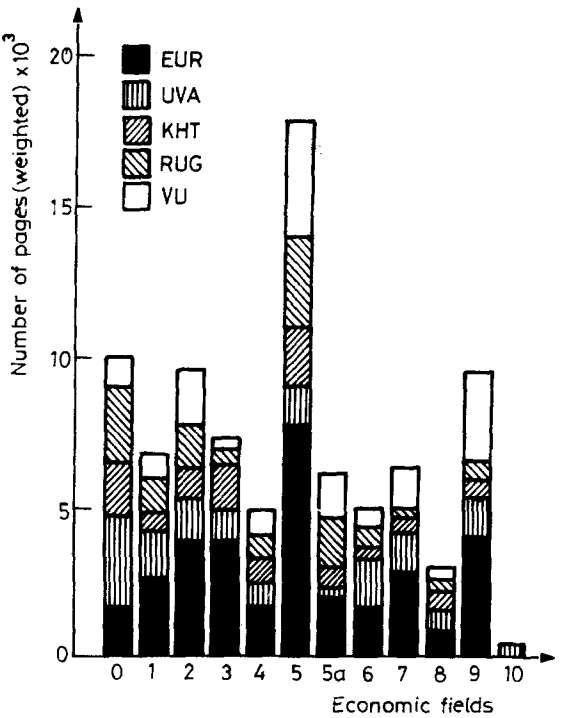

Fig.2. Total productivity in Dutch economics. Key:

0	General economics; Theory; History; Systems.
1	Economic growth; Development; Planning; Fluctuations.
2	Quantitative economic methods and data
3	Domestic monetary and fiscal theory and institutions.
4	International economics.
5	Administration; Business Finance; Marketing; Accounting.
5a	Decision science (distribution and location problems).
6	Industrial organization; Technological change; Industry studies.
7	Agriculture; Natural resources.
8	Manpower; Labor; Population.
9	Welfare programs; Consumer economics; Urban and regional economics.
10	Actuarial sciences.

The differences in the degree to which Dutch economists working in various fields contribute to the international literature (JA weighted; BA int and BK int) is

graphically shown in Fig. 3. Although field 5 (Administration), for example, scores high in an absolute sense (total productivity), its contribution to the international growth of knowledge, according to U.S. standards, appears to be rather low. Its productivity is mainly caused by high output in local journals and books. More internationally oriented fields are economic growth (1), econometrics (2), and decision science (5a). (The source of the figure is the VEW report,[1] Table IV.2).

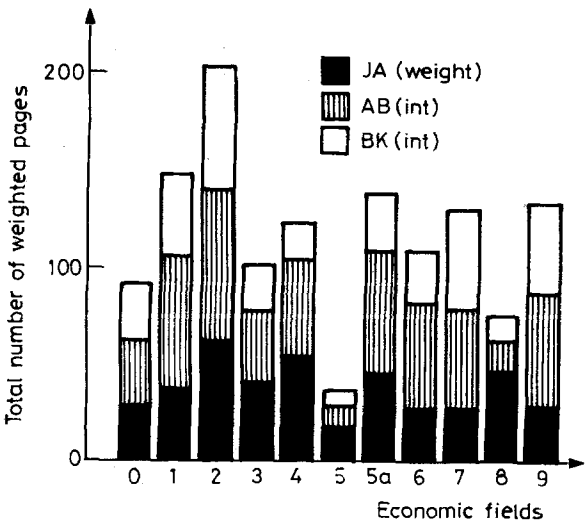

Fig. 3. Contribution to the international literature. Key as in Fig.2

In contrast to the evaluation of Dutch medical research performance[13] in which a combination of 5 indices has been applied, only the results of publication countings (indicating "total productivity" and "contribution to the international literature") have been used for the ranking of the departments and research units in economics. Citations have been counted, but, in general, they proved to be uncorrelated to the productivity criterion. The same is true for the number of editorships. The number of Ph.D. theses per university was rather low (average number per university in the period 1979-1984 was 31; min. 21, max. 47) so that Ph.D. theses were meaningless as a measure of differential productivity. These shortcomings raise some doubt about the validity of the productivity criterion, as have been pointed out by *Cramer*.[4,5] Due to the lack of convergence between partial indicators, the findings of the VEW must, on the one hand, be interpreted with caution. On the other hand, they present the

best available evaluation of the scientific performance of Dutch research units in economics. Consequently, the VEW evaluation has been selected as the basis for our classification units in subsamples of high and low performers.

Sample

A wide variety of economics fields has been selected for inclusion in the study: general economics (JEL code: 0), economic growth (1), quantitative economic methods (2), domestic monetary and fiscal theory (3), international economics (4), administration (5), decision science (5a), industrial organization (6), agriculture (7). manpower (8), and welfare programs (9). Per field a selection was made of one or more high performers and on or more low performers. Given the uncertainty about the validity of the VEW evaluation, the sample was restricted to those units with extreme performance (high or low) scores. Moreover, only units were considered that combined above average performance (in the case of high performers) or below average performance levels (in the case of low performers) on both publication and citation indexes (Table 479-484). Thus, the convergence of performance indicators was introduced as a selection rule which restricted the sample of units. In total 29 units were requested to participate in the study.

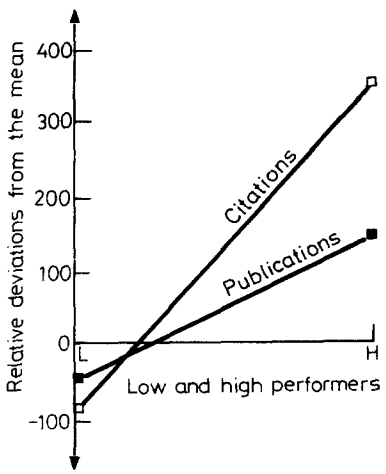

Fig.4. Subsample performance differences

Figure 4 shows the differences between high and low performers in the response sample ($N=16$ units) with regard to scientific productivity (relative deviation of the mean number of publications) and citation impact (relative deviation of the mean number of citations). On average, the impact difference between high and low performers is considerably larger than the productivity difference.

In order to check our classification a number of full professors of economics working in various fields were consulted. These peer reviews were consistent with our classification of units on the basis of the VEW statistics.

Data collection

Data were collected in the period April-July 1987. A mail questionnaire was sent to the selected units, addressed to all staff employees, who (1) were academically educated (thus, excluding administrative and support staff), and (2) were appointed to participate in economics research (thus excluding members with exclusively educational tasks). These criteria produced a population of 152 respondents of whom 86 were working in units with high performance, and 66 were working in units with low performance. In total 25 units (group response 86%) responded to the questionnaire. Only data from 16 units were usable, because 9 units were represented by less than 25% of their researchers. The sample analyzed here consists of 8 high performers (33 subjects; individual response 38%) and 8 low performers (30 subjects; individual response 45%).

Non-response analysis showed that, in the main, two factors accounted for nonresponse on the unit or individual level: lack of time and lack of interest. It should be noted that the questionnaire was sent shortly after the VEW evaluation, and that a large number of economists did not agree with the VEW procedure. *Cramer*,[4] for example, has noted that the quality of the *content* of economics research[6] has not been assessed, and that economics in the Netherlands should be compared with the productivity of similar European countries - such as that of U.K., Belgian or Swedish departments of economics rather than those in the U.S. Despite the apparent shortcomings, the VEW report is conceived as the best available evaluation of economics research effectiveness.[7]

Figure 5 indicates that the distribution of high and low performers over universities (100% = 16 units) is fairly even. The youngest department of economics (University of Limburg) was not requested to participate in the study because it did not yet exist in the evaluation period 1979-1984, and consequently only very recent performance measures were available.

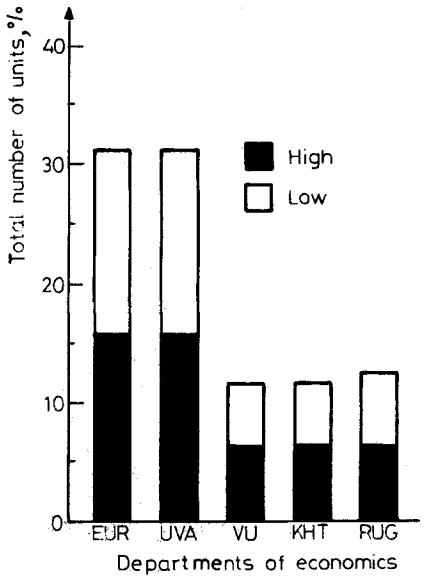

Fig.5. Response distribution universities

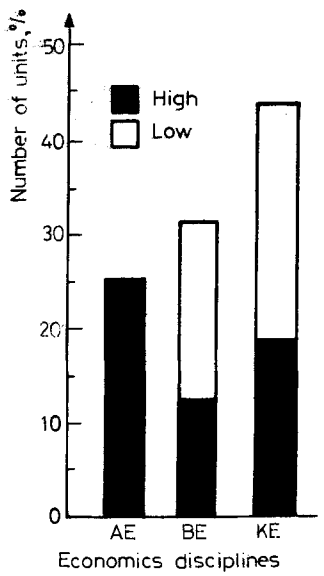

Fig.6. Response distribution disciplines

Figure 6 clarifies the distribution of high and low performers over three major disciplines in the Netherlands: econometrics (KE), business administration (BE) and general economics (AE). Econometrics and business administration are represented by more low than high performers. As a result of non response, general economics is only represented by high performers - which, of course, does not mean that low performers do not exist in that field.

Hypotheses

In selecting predictor variables, we consulted the international literature on research management and scientific productivity (e.g. *Pelz* and *Andrews*,[8] *Allen*[9], *Andrews*,[10] *Keller*,[11] *Bresser* and *Bunbar*,[12] and researchers professors themselves. A panel of experts (N=6) has been requested to indicate the main facilitating and inhibiting factors of research performance in their field. The results of each of these procedures are reported in *Bally* et al.[13] Following discussions with panel members on the content of the variables identified by these procedures, a theoretical model - including the most critical variables - was advanced. The model is composed of predictor-criterion relations. It was expected that competitive advantages are associated with (1) economies of scale, (2) a favorable input mix, (3) economies of scope variables, (4) economies of atmosphere, (5) research management, (6) control dimensions, (7) frequency of scientific communications. As a consequence of the procedure mentioned above, a set of hypotheses was generated. It was hypothesized that research units classified as "high performers" show the following characteristics in comparison to other research units within the same speciality or field (Table 1).

An extensive description of the predictor variables mentioned above is given in Ref. 14. Economies of scale are described in *Stigler*[15] and in standard handbooks of economics.[16] A general description of economies of atmosphere, i.e. the competitive advantages due to a appropriate working climate in the unit, has been given by transaction cost economics,[17] while *Pelz* and *Andrews*[8] focussed on empirical research concerning productive climates in research and development. *Peters* and *Waterman*[18] have suggested that corporate culture contributes significantly to the financial performance of Fortune-500 firms. The impact of management, control, and communication variables on scientific performance is extensively discussed in *Allen*[9] and *Andrews*.[10] The focus here is on the variables mentioned above and on economies of scope.

Table 1
Hypotheses

In comparison with low performers, high performers (...)		
	1. *Scale*	
1.	have critical mass in human resources	HUMAN RESOURCES
2.	have a larger unit size	UNIT SIZE
3.	have more full time research equivalents	FTE UNIT SIZE
4.	have larger research projects	PROJECT SIZE
5.	spend more time on research	TIME RESEARCH
6.	spend less time in education	TIME EDUCATION
7.	have critical mass in capital resources	CAPITAL RESOURCES
8.	spend more money on research	RESEARCH EXPENDITURES
	2. *Input mix*	
9.	have the same age distribution	AGE
10.	have more research experience	HUMAN CAPITAL
11.	have more staff members from other disciplines	INTERDISC MIX
12.	have a lower tenure intensity	TENURE INTENSITY
13.	have higher percentages of secundary and tertiary funding	CASH FLOW MIX
	3. *Scope*	
14.	publish in more JEL fields (25% criterion)	SCOPE (25%)
15.	publish in more JEL fields (10% criterion)	SCOPE (10%)
	4. *Atmosphere*	
16.	have a more innovative climate	INNOVATIVE CLIMATE
17.	have a more stimulating publication climate	PUBLICATION CLIMATE
18.	have a less bureaucratic culture	BUREAUCRATIC CULTURE
	5. *Management*	
19.	have a superior research management	CRAFTSMANSHIP
20.	have superior leadership	LEADERSHIP
	6. *Control*	
21.	are more motivated for research	MOTIVATION
22.	expect more pecuniary incentives from research	REWARD EXPECTATION
	7. *Communication*	
	communicate more often with peers of:	
23.	their own unit	WITHIN UNIT COMMUNICATION
24.	other units in the Netherlands	BETWEEN UNIT COMMUNICATION
25.	other units abroad	INTERNATIONAL COMMUNICATION
26.	units of other disciplines	INTERDISC COMMUNICATION

Economies of scope have been observed in the context of industrial economics[19-20]. The authors argue that economies of scope are realized in team production activity in which joint use of inputs yield a larger output than the sum of the products of the separately used inputs. Knowhow may represent a shared input which can find a variety of end product applications. Whenever the knowledge can serve as a common input into two or more production processes, joint production (utilizing common resources) will produce economies of scope. Thus, if the skills to publish in econometric journals display economies of scale, and these economies are not exhausted, and if the knowhow can also be used in publishing in business administration journal, e.g. decision science. then economies of scope will exist in the production of scientific knowledge. In general, economies of scope can be defined as arising from inputs that are shared or utilized jointly. The shared factor may be imperfectly divisible, or some human or physical capital may be a public input. Economies of scope exist when for all outputs, y_1 and y_2, the cost of joint production is less than the cost (c) of producing each output (y) separately. That is, it is the condition for all y_1 and y_2,

$$c(y_1, y_2) < c(y_1, 0) + c(0, y_2).$$

With economies of scope. joint production of knowledge in two fields is less costly than the combined costs of production of two specialized research units. The present study has defined scope as joined production of knowledge in more than one field but within the same discipline, i.e. related diversification. Multi-production was indicated by publishing in more than one research fields ($N=10$). Note that the fields were classified according to the Journal of Economic Literature (JEL) index. The VEW report contained useful data concerning the multi-production functions of units in terms of their JEL publications. These data, however, had to be transformed since publishing in one field with 1 publication, while the largest output of that unit in another field consist of 100 publications, cannot seriously be defined as joint production in two fields. Consequently, a simple decision rule was applied to assess whether a unit published substantially in another field. The 25% criterion regarded a unit to be active in another field when it published at least 25% of its largest research output (in terms of weighted pages) in one field in that other field. The 10% criterion regarded a unit to be active in another field when it published at least 10% in the other field.

Measurement of predictor variables

In order to measure the input and throughput variables, using standard and new scales, a questionnaire has been designed. Standard scales have been developed by the Institute for Social Research of the University of Michigan,[8] the Massachusetts Institute of Technology,[21] UNESCO,[10] the Institute for Research in Intercultural Cooperation,[22] and the University of Pennsylvania.[23] The scales were translated into Dutch[24] with adapted or new scales being constructed to measure specific aspects of the two disciplines. The first version was tried out in a department of economics before data collection was started. Discussion with member of these departments led to improvements in the design of the questionnaires.

The *Appendix* shows examples of one or two measurement items for each variable. The scales include semantic differentials (item 1) and Likert type 5-point scale (item 13). The numbers of the items (1-21) refer to the variable names mentioned above. The (Dutch-language) instruments used to collect the data are available on request from the authors.

Univariate results

All instrument prove to be fairly reliable with Cronbach's alpha's varying between 0.60 and 0.88.[14] Data were collected at the individual level and aggregated to the unit level. To check the reliability of the aggregated scores, the differences between units in the variance of individual scores (Bartlett F-box) were tested. Except for one item (unrelated to overall performance), the test revealed no significant differences between units in the homogeneity of the answer of individual scientists within high and low performing units. The next section will discuss the relationship between the predictor variables and overall performance.

Predictor-criterion relations

The main univariate test which we used were *t*-tests and correlation analysis. Since the result of the *t*-tests mainly corroborated those of the correlation analysis, only the latter are reported. Table 2 shows the correlation between the predictor variables and overall performance.

Table 2
Pearson correlations of predictor variables and overall performance

Variable	Correlation with performance (Decimal points have been omitted)	Sign.
1. *Scale*		
human resources	41	0.004
unit size	n.s.	
FTE unit size	35	0.02
project size	30	0.03
time research	33	0.02
time education	-32	0.03
capital resources	n.s.	
research expenditures	n.s.	
2. *Input mix*		
age	-34	0.02
human capital:		
(i) research experience during study	34	0.02
(ii) research experience on the job	n.s.	
(iii) research experience abroad	n.s.	
tenure intensity	-33	0.02
interdisc mix	n.s.	
cash flow mix	-30	0.05
3. *Scope*		
according to the 25% criterion	n.s.	
according to the 10% criterion	0.49	0.04
4. *Atmosphere*		
innovative climate	71	0.00(
publication climate	58	0.00(
bureaucratic culture	-71	0.00(
6. *Control**		
motivation	43	0.00:
reward expectation	33	0.02
7. *Communication*		
within unit com	24	0.07
between unit com	47	0.001
international com:		
(i) having international com	39	0.006
(ii) stimulating international com	-47	0.001
interdisciplinary communication	n.s.	

* The management variables (group 5) were uncorrelated to overall performance.

A general point is that the supportive power of the positive but low correlations is a very modest one, sometimes almost negligible. Furthermore, the high number of significant correlations may be influenced by the low number of observations. Consequently, the univariate results are presented with caution. Conclusive evidence can only be demonstrated on the basis of the combination of univariate and multivariate results as compared to other findings concerning the determinants of scientific performance in economics.

Economies of scale

Human resources

The Pearsonian correlations provide strong support for economies of scale with respect to human resources. In comparison with low performers, more high performers believe that the human resources of their unit are sufficient to conduct the research effectively. Consistent with this subjective assessment are the following observations: high performing units are larger in terms of full time research equivalents, and in manpower per project. High performers were, however, not larger in terms of absolute number of staff members (unit size - uncorrected for FTE). The members of high performing units spend more time on research, and less time on education.

Capital resources

The economies of scale hypothesis was not confirmed when capital resources are considered. In contrast to our expectations, no significant relation was found between capital resources or research expenditures and performance. High performers do not have a larger research budget neither do they spend more money on research.

Input mix

Human assets

Regarding the composition of human assets, we have found that the average member of high performing units is younger, but has had more research experience during his masters training. Age was related to learning by doing (on the job research

experience), and international research experience, but not to masters degree research experience. On the job experience, and international research experience were unrelated to performance. The expectation that high performers have a lower tenure intensity has been confirmed. Age and tenure intensity were, not surprisingly, positively correlated ($r=0.50$; $p=0.00$). No relation appeared to exist between interdisciplinary staffing and research performance.

Capital assets

Regarding, the composition of capital assets, the analyses showed a negative correlation between the contribution of the primary cash flow (direct governmental contribution) and research performance. The lower the primary cash flow, the higher the contribution of the secondary and tertiary cash flow. Thus, a higher proportion of the research budget of high performers is acquired in a competitive situation, i.e. paid by the national science foundation (secondary cash flow) or contract research customers (tertiary cash flow).

Economies of scope

Recall that the VEW report contained useful data concerning the multi-production functions of units in terms of their JEL publications. These data, however, were transformed by a simple decision rule which determined whether a unit published in more than one field in a substantial manner. The 25% criterion regarded a unit to be active in another field (B) when is publishes at least 25% of its largest research output (in terms of weighted pages) in one field (A) in B. The 10% criterion regarded a unit to be active in B when it publishes at least 10% of its A-output in B.

The data suggest that economies of scope were captured by departments of economics, since a certain degree of diversification (according to the 10% criterion) appeared to be related to their performance. However, scope was unrelated to performance when the 25% criterion has been used. In comparison to the 10% criterion, the 25% criterion decreases the variance in the economies of scope variable, because the production of units is less likely to be conceived as joint production in more than one field. This finding suggest that thresholds exist concerning the visibility of scope economics. In other words, whether economies of scope are captured by a research unit is dependent of the definition of scope.

Apparently, forther research is required to improve the assessment of the economies of scope variable, and to further test its construct validity in scientific environments.

Economies of atmosphere

The present study provides evidence for economies of atmosphere. There was a stronger pressure to publish in high performing units (publication climate). Furthermore, high performers had a more innovative climate. Finally, it appeared that high performers have a less bureaucratic atmosphere than low performers.

Management

Contrary to the expectations, research management was not related to performance. All univariate tests failed to show that relation. Neither the craftsmanship nor the leadership qualities of the supervisor appeared to be correlated with academic research performance. Does this mean that coordination is a negligible factor? Not necessarily, since it appeared that management was strongly related to the correlates of performance. The following independent variables were positively related to the leadership an the craftsmanship of the unit supervisor: human resources ($r=0.32$; $p= 0.003$), publication climate ($r=0.45$; $p=0.00$); innovative climate ($r=0.56$; $p=0.00$), non-bureaucratic culture ($r=0.44$; $p=0.00$); reward expectation ($r=0.22$; $p=0.01$), within unit communication ($r=0.18$; $p=0.04$), and international communication ($r=0.43$; $p=0.00$). An efficiency function may certainly be attributed to the coordination of the unit, but in an indirect way – i.e. with respect to the boundary conditions for efficient production. This non-directive leadership is consistent with the existence of a non bureaucratic corporate culture. To paraphrase Adam Smith, the supervision of a department of economics has to operate like an "invisible hand" rather than a "visible hand" in order to be productive.

Control

The existence of a strong publication tradition is consistent with the outcome of the control variables. High performers expected more pecuniary rewards (better career opportunities) when they perform well in research than in education. The average economist researcher is not driven by altruistic motivation - a finding that should not be surprising. This result is consistent with *Graves*, *Marchand*, and *Thompson*[2] who found a positive relation between the salaries of full professors in economics and publication performance. While salaries at lower ranks appear to be inversely related to publication performance, this may still be explained by an utilitarian framework: "(...) young academics pay a premium to associate with productive faculties" [2:1137-1139]. With regard to personnel control, it appeared that high performers were more motivated toward research than toward education. These finding are consistent with the previous observations concerning the time spent on research (more) and on education (less) of high performers.

Communication

High performers appear to have more working communications with their colleagues within the unit. Moreover, they communicated more frequently with peers of other research units - in The Netherlands (between unit communication), as well as abroad (having international communication). Having more international communications in fact, the members of high performing units were less stimulated to communicate with international peers (stimulating international communication). This finding may support the idea that having international communications is the effect of high performance (especially of its consequence: international recognition) rather than its cause.

Having communications with colleagues of other disciplines was not related to performance. This is consistent with earlier studies, e.g. Ref. 25. Moreover, it is consistent with the above mentioned result, that there is no relation, neither a positive nor a negative relation, between the interdisciplinary composition of the staff and overall research performance. Finally, and contrary to what might be expected, interdisciplinarity appears to be unrelated to economies of scope.

Multivariate analyses

The present study has both discrete-dichotomous (high versus low performance), and (relatively) continuous criterion measures. The Fisher linear discriminant analysis is analogous to a multiple regression analysis in which the criterion variable, Y, assumes only two values, each indicating membership in one or other of two groups. In other words, discriminant analysis is an appropriate statistical method when the criterion variable is discrete. In this study, however, performance is also indicated by continuous variable, i.e., individual performance index (questionnaire), scientific productivity (VEW report), and citation impact (VEW report). Since these three criterion variables are continuous measures, it is meaningful to apply multiple regression analysis in addition to the discriminant analysis.

Because of the number of variables included in the multivariate analyses is quite high relative to the sample size, the results of our analyses will be tentative. Consequently, the discriminant and regression analyses were not used to discover the best predictive equation but rather to control cruelty for the interaction between the predictor variables when trying to establish differences between high and low performers. Chance capitalization is reduced by running the analyses on the univariately significant predictor variables. The results of the discriminant analysis are presented in the next section. The results of the multiple regression analysis will be discussed in Part II of this paper.

Discriminant analysis

To explain more efficiently the difference between high and low performers, discriminant analysis was conducted with the univariately significant variables. Since the interest here is in the impact of scale, scope, and atmosphere of performance, we will first (1) analyze the data regarding the input variables (scale and input mix), then (2) the data regarding scale, scope, and atmosphere, and finally, (3) the data will be analyzed regarding all variables that have been selected in the discriminant function (including management, control, and communication). The total number of cases in the sample is 16. All variables in the discriminant equations are presented in the order of stepwise selection.

Z_1 (scale and input mix)

First, a stepwise, standardized discriminant analysis on all univariately significant scale and input mix variables has been performed. The following discriminant function resulted for all 16 cases in our sample ($R=0.81$; $R^2=0.66$; $X^2=11.1$; d.f.=3; $p_{(function)}=0.01$):

$$Z_1 = 1.51\ HMCP - 1.71\ AGE + 0.57\ FTE,$$

where HMCP = human capital (research experience during study)
AGE = age
FTE = FTE unit size

correctly classified: 94%
mean discriminant score high performers: 1.10
mean discriminant score low performers: -1.46.

$Z_{2\text{-}3}$ (scale, input mix, scope, and atmosphere)

For the scale, input mix, scope, and atmosphere variables together, two standardized discriminant functions were satisfactory. A function, Z_i, is regarded as optimal when (1) the probability of misclassification is minimized, (2) the function has a larger discriminary power (R^2), (3) $p_{(function)}$ has a higher significance, and (4) the sample contains more cases. In practice, human judgement is required to select a function because there are tradeoffs between these criteria. One of the functions, Z_2 ($R=0.65$; $R^2=0.42$; $X^2=6.49$; $p_{(function)}=0.04$), included the following variables for 16 cases:

$$Z_2 = 0.93\ FTE - 0.59\ OCM1$$

where FTE = FTE unit size
OCM1 = bureaucratic culture

correctly classified: 81%
mean high performers: 0.68
mean low performers: -0.84

This function is, however, outperformed by Z_3 which combines a higher significant function with more accuracy in the classification of 15 cases ($R=0.74$; $R^2=0.55$; $X^2=7.81$; d.f.=2; $p_{(function)}=0.02$)

$$Z_3 = 0.77\,HMCP + 0.99\,SCPE$$

where HMCP = human capital (research experience during study)
SCPE = scope (10%)

correctly classified: 87%
mean high performers: 0.93
mean low performers: -1.08

$Z_{4\text{-}6}$ (all predictor variables)

When we take into account all univariately significant variables, the following 10 variables entered the discriminant function in the order of stepwise selection: FTE unit size, human capital (research experience during study), age, scope (10%), between unit communication, bureaucratic culture, reward expectation, motivation, human resources, and international communication (having). The function was highly significant ($R=0.99$; $R^2=0.98$; $X^2=43.09$; d.f.=8; $p_{(function)}=0.000$; correct classification=93%). The disadvantage of this function is the large number of variables included in this function. Since this study is interested in an efficient prediction of performance, the above mentioned list of variables were conceived as a useful starting point for trying out a number of alternative combinations of variables. Again more than one satisfactory functions have been found. In one of the functions, Z_4, which applied to 15 cases in our sample, scope entered as the first variable in the function. Z_4 ($R=0.82$; $R^2=0.67$; $X^2=10.54$; d.f.=3; $p_{(function)}=0.01$) is a linear combination of the following variables:

$$Z_4 = 1.05\,SCPE - 0.52\,OCM1 + 0.80\,INTC$$

where SCPE = scope (10%)
OCM1 = bureaucratic culture
INTC = international communication

correct classification: 87%
mean high performers: 1.21
mean low performers: -1.42

Another function, Z_5 ($R=0.88$; $R^2=0.77$; $X^2=13.86$; d.f.=3; $p_{(function)}=0.003$), combines classificatory success with a higher level of significance for 15 cases:

$$Z_5 = 1.05\ SCPE - 0.69\ OCM1 + 0.97\ BTWUC$$

where SCPE = scope (10%)
OCM1 = bureaucratic culture
BTWUC = between unit communication

correct classification: 87%
mean high performers: 1.55
mean low performers: -1.81

For reasons that will subsequently be explained, the next function, Z_6 ($R=0.90$; $R^2=0.81$; $X^2=15.09$; $p_{(function)}=0.0045$), may be conceived as the optimal discriminant function emerging for 15 cases in the sample:

$$Z_6 = 0.52\ FTE + 0.93\ SCPE - 0.75\ OCM1 + 0.76\ BTWUC$$

where FTE = FTE unit size
SCPE = scope (10%)
OCM1 = bureaucratic culture
BTWUC = between unit communication

correct classification: 93%
mean high performers: 1.77
mean low performers: -2.07

Comparison of the classificatory success of Z_6 (93%) with Z_1 (94%) shows that adding scope and atmosphere (and other variables) to scale does not really improve the results of the discriminant analysis. However, adding these variables does improve the significance of the function ($p_{(function)}Z_1=0.01$; $p_{(function)}Z_6=0.005$).

Moreover, Z_6 explains the largest percentage of variance in the criterion variable ($R^2=0.81$). Z_6 is an efficient equation with 10 variables (93%).

In general, the results confirm the correlational findings. Moreover, they explained a very high percentage of the variance in the dichotomous criterion variable. The results demonstrate the importance of economies of scale, scope, and atmosphere in departments of economics and business administration. in addition, communication with other units, both in the Netherlands and abroad, appears to be very significant to research performance in economics.

Figure 7 gives a graphical presentation of the 93% match between predicted (correctly classified) and observed performance in the sample of 15 cases. The match is 7/8 (88%) for low performers and 7/7 (100%) for high performers.

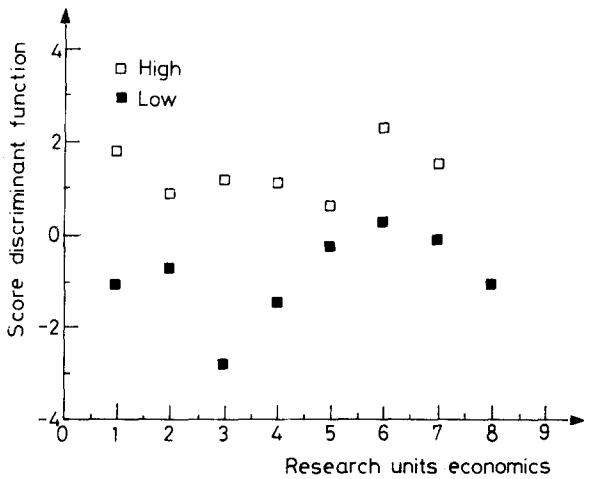

Fig.7. Match between predicted and observed performance

Summary of the multivariate results

Because of the high number of (univariately significant) variables relative to the sample size, discriminant and regression analysis were mainly used as crude control for the interaction effects of the predictor variables. Consequently, the multivariate results should be presented with a degree of reservation. Tentative as they are, however, they confirm the univariate findings, and explain a high percentage of the variance in the overall performance and the single criterion measures. In particular, they support the hypotheses regarding economies of scale, scope, and atmosphere in

scientific organizations. Concerning their differential impact, the results show that scale and input mix variables feature prominently. Some results of the multiple regression analysis of Part II are anticipated in the following.

1. Regarding scale, it was found that high performing units are larger in terms of full time research equivalents. repeatedly, FTE unit size entered a significant discriminant function as the first variable, thus minimizing Wilks' lambda. Project size seems to be important too. Multiple regression analyses showed that it is significantly related to the single performance measures.

2. Regarding input mix, it was found that members of the high performing units, younger as they are, have had more research experience (acquired during their masters degree training). Moreover, research experience proves to be multivariately related to individual performance index, citation impact, and scientific productivity.

3. Regarding scope, it was found that high performers have a multi-product function (in terms of publication in JEL fields according to the 10% criterion). Scope entered significant discriminant functions, but was not included in a regression equation.

4. Regarding atmosphere, it was found that the variable "bureaucratic culture" is inversely related to performance. Repeatedly, bureaucratic culture entered the significant discriminant function – including the optimal function. However, atmosphere was not included in the regression equations. apparently, further research is needed to test the robustness of economies of atmosphere regarding scientific performance.

5. The univariate results are not multivariately confirmed where the control variables are concerned. Regression analysis failed to show a contribution of reward expectation and motivation to the explanation of variance in the single performance measures.

6. Regarding communication, it was found that between unit communication and international communication repeatedly entered significant discriminant functions. Communication with domestic research units is somewhat more important in economics than international communication, since the R^2 increases when international communication is substituted for between unit communication in Z_5. Regression analyses have confirmed the importance of between unit communication. With regard to international communication, it was shown that low performers (in terms of publication and citation) are more encouraged to have international communications, while high performers (in terms of the individual performance index) simply have these contacts. As the saying goes: good wine needs no bush!

Discussion

This paper has attempted to explain why publication records differ among departments of economics. A large-scale evaluation of the performance of university economics in the Netherlands has been used for the classification of units in high and low performers. After formulating additional hypotheses, univariate and multivariate statistics were used to explore the research questions regarding competitive advantages in the scientific enterprise. The results suggest that both economies of scale, economies of scope, and economies of atmosphere are captured in research units. However, when the relative contribution of these economies are inspected, the economies of scale (and the input mix) variables feature prominently. The findings further suggest that economies of scope are somewhat dependent of the definition of scope. In contrast to the recent literature which suggest that atmosphere is a dominant characteristic of excellent organizations, the economies captured by atmosphere here show to be rather marginal. External research communications, finally, prove to be more important than management and control.

Following industrial economics, it may be speculated that low performers in economics operate at a suboptimal scale, i.e they have not reached their minimal optimal scale at which the economies of scale are fully realized by the research unit. Apparently, when the minimum optimal scale of a unit similar to all participants within a scientific discipline, operating on a suboptimal scale is a competitive disadvantage which is only partially compensated by other economies. Since economies of scale variables do not explain the full variance, it may be concluded that scale economics is not a sufficient condition but a necessary one to high scientific performance.

*

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Appendix

Except for 14-15 all items were used in the questionnaire.

1. Economies of scale

1. The research team is too small to conduct the research effectively (1-2-3-4-5).The research team has enough staff members (critical mass) to conduct the research effectively.

2. Indication of the number of staff members in the research unit: (1) 1-4, (3) 10-20, (5) > 20 (rating by the unit's secretary).

3. Indicate the number of full time research equivalents (FTEs) in your research units.

4. Indicate the average number of colleagues with whom you cooperate in your research projects: (1) zero (5) ≥ 10.

5-6. Please indicate in percentages how much of your total work time (=100%) you have spent this year on: research (% time research), teaching (%time teaching), and administration (%time administration).

7. The current budget of the unit is inadequate to allow successful completion of the unit's current research tasks (1-2-3-4-5). The current budget is adequate to allow successful completion of the unit's current research tasks.

8. What were your research expenditures in the last year (=1986) in terms of (i) gross salaries for research assistants, and (ii) other research expenditures (mailing costs, software purchase, travel costs)? Divide your total research expenditures by the number of colleagues with whom you share this money.

2. Input mix

9. How old are you? (1= ≤30 years; 3=41-50 years old; 5= ≥60 years old).

10. How much research experience have you had (a) during your study leading to your masters degree? (b) after your study? (c) abroad? (1=no experience; 3=3-5 years; 5= ≥10 years).

11. What is your original discipline? (aggregation of answers at the unit level shows the (inter)disciplinary composition of the team).

12. Are you employed on a (1) permanent basis (2) temporal basis with tenure perspectives (3) temporary basis with tenure perspectives.

13. How much of your total research expenditures (=100%) originates from (i) primary cash flow (% direct governmental contribution to your department), (ii)

secondary cash flow (% governmental contribution allocated by the national science foundation - in Dutch: NWO - Ecozoek), (iii) tertiary cash flow (% revenues from contract research)?

3. Economies of scope

14.-15. Rating of the number of fields in which the unit conducts research according to the 25% and 10% criterion (source: the VEW report - the number of fields in which a unit publishes has been taken as an index of the diversification of its research activities).

4. Economies of atmosphere

16. Very few new ideas for research or other technical matters are given adequate consideration (1-2-3-4-5). Nearly all new ideas for research or other technical matters are given consideration.

16. There is a feeling that everyone in the unit only works to make a living (1-2-3-4-5). There is an atmosphere of great dedication to work in the unit.

17. Members of this unit are not encouraged to publish their research (1-2-3-4-5). Members of this unit are strongly encouraged to publish their research.

17. In our unit nobody manages to do research (1-2-3-4-5). In our unit everybody manages to do research.

18. Where I work people do not feel comfortable in unknown situations; they attempt to avoid risk taking (1-2-3-4-5). Where I work people feel comfortable in unknown situations; they do not mind to take risks.

18. Where I work, people expert only a limited effort (1-2-3-4-5). Where I work, everybody puts in a maximal effort.

5. Management

19. I am very dissatisfied with my immediate supervisor as regards his knowledge of the fields in which the unit is active (1-2-3-4-5), I am very satisfied with my immediate supervisor as regards his knowledge of the fields in which the unit is active (These questions were answered by non-supervisors only. Unit supervisors were requested to pass over all questions regarding variable 14-15).

20. I am very dissatisfied with my immediate supervisor as regards his leadership qualities (1-2-3-4-5), I am very satisfied with my immediate supervisor as regards his leadership qualities. (Supervisors were requested to pass over this scale).

6. Control

21. I invest more energy in my educational tasks than in my research tasks (1-2-3-4-5). I invest more energy in my research tasks.

22. If you performance with regard to research is fine, what is the probability that you will achieve promotion in your research department? (1) no chance (3) 50% (5) almost certain.

22. If you performance with regard to education is fine, what is the probability that you will achieve promotion in your research department? (1) no chance (3) 50% (5) almost certain.

7. Communication

23. How often do you discuss your work with other members of your own research department? (1) annually or less (3) monthly (5) daily.

24. How often do you discuss your work with other members of other Dutch research departments working in the same field? (1) annually or less (3) monthly (5) daily.

25. How often do you discuss your work with other members of other research departments abroad? (1) annually or less (3) monthly (5) daily.

26. How often do you discuss your work with members of other disciplines? (1) annually or less (3) monthly (5) daily.

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