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FORECASTING STAFFING DECISIONS

Abstract: The purpose of this paper is to present tools to support personnel decisions in the company. The starting point is to measure the results of the work of employees in a given position. Combining the appropriate amount of information on the results of work in the past, a variety of workers and their important personal qualities will enable the construction of an econometric model. This model describes the mechanism of the effects of variation of operations, depending on the various characteristics of the employees. With such a model one can estimate the prediction effectiveness of individual candidates when the position becomes vacant. This may facilitate the selection of a suitable candidate from among many. This candidate has the greatest potential for productivity. The choice of such candidate is weighted with the lowest risk of erroneous personnel decisions.

Keywords: personnel decisions, microeconometrics, forecasting.

1. Introduction

Personnel decisions in a company are in the most important and difficult class. The effects of errors in this field are expensive and often dangerous. Therefore, an important task of science is to support this category of decisions by various tools. It is important that in a job vacancy, the candidate chosen from among many candidates, has the greatest potential for efficiency. Therefore, it is necessary to measure and record the efficiency of the company employees in various positions regarding their personal qualities. The knowledge of the effectiveness of employees will help identify potentially the best candidate for the vacant position in the future. It also allows forecasting the effects of his/her work, which is important to determine the potential productivity.

2. Construction personnel selection tools

The foundation of the construction of personnel selection tools is to measure the effects of employees in the vacant position¹. Knowing the efficiency measures of the

¹ It is possible to find analogous solutions related to effective choice of employee in publications: [Wiśniewski 2002, pp. 72–74, 2009, p. 155 ff.].

i -th worker ($i = 1, \dots, n$) it is important to gather information about a worker's performance over time. Personal qualities should be registered and measured in the same period. Measurement characteristics of the employee are made with a number belonging to the nominal and relative scale. Having statistical information about the efficiency of the i -th worker (y), and about his/her personal qualities (x_{ij} , $i = 1, \dots, n$, $j = 1, \dots, k$), an econometric model of the form can be used:

$$y_i = f(x_{i1}, \dots, x_{ij}, \dots, x_{ik}, \eta_i), \quad (1)$$

At the same time, i is the number of statistical observations (worker), and j is the number of personal characteristics.

Consider the case of MAX company. In that enterprise, statistical information about the effects of the work of traders and some of their personal qualities has been collected. Statistical data on net sales revenue (y) obtained by a group of 34 people is included in Table 1, which also includes figures for seven personal characteristics of each of the traders.

Table 1. Annual net sales revenue of the traders in the MAX company from 2009 to 2011 (in thousand zł)

No of trader (i)	y_i	x_{i1}	x_{i2}	x_{i3}	x_{i4}	x_{i5}	x_{i6}	x_{i7}
1	2	3	4	5	6	7	8	9
1	872	1	0	3	0	0	24	0
2	880	0	0	3	0	0	25	0
3	900	0	0	2	0	0	23	0
4	910	0	0	4	0	2	25	0
5	912	0	0	3	0	1	27	1
6	930	1	1	5	0	1	26	1
7	933	0	0	5	0	1	28	1
8	940	0	0	5	1	3	27	0
9	945	1	1	3	0	0	29	0
10	950	1	0	4	0	0	30	0
11	952	1	0	7	0	1	30	0
12	955	0	0	6	0	1	29	0
13	960	0	1	5	0	1	31	1
14	966	0	0	8	0	1	32	0
15	967	0	0	6	0	2	33	0
16	968	1	0	8	1	1	34	0
17	970	0	0	8	1	2	33	0
18	985	0	1	7	0	1	35	1
19	990	0	0	9	0	1	36	1
20	992	1	0	8	0	2	36	0
21	998	1	0	9	0	2	34	1
22	1000	0	0	9	0	3	36	1
23	1020	0	1	7	0	1	37	1

Table 1, cont.

1	2	3	4	5	6	7	8	9
24	1025	0	0	8	1	2	38	0
25	1030	0	0	9	1	2	39	1
26	1060	1	0	10	0	3	40	1
27	1100	1	1	10	1	3	40	0
28	1160	0	1	11	1	4	41	0
29	1204	0	0	12	0	4	40	0
30	1260	0	1	11	1	2	39	1
31	1304	1	0	10	1	1	38	1
32	1406	1	0	12	0	3	39	1
33	1511	0	1	13	1	4	40	1
34	1620	0	1	15	1	5	43	1
Σ		12	10					

Source: company MAX data.

Consider, therefore, the following general model structure²:

$$y_i = f(x_{i1}, x_{i2}, x_{i3}, x_{i4}, x_{i5}, x_{i6}, x_{i7}, \eta_i), \quad (2)$$

where³: y_i – net sales revenue earned annually by the i -th trader (thousand zł),

x_{i1} – dummy variable representing the sex of the trader, adopting a value of 1 for women and 0 for men

x_{i2} – dummy variable, indicating the fact of competitive sports by the trader, adopting a value of 1, when he practiced sports professionally, and 0 if otherwise,

x_{i3} – length of service in the profession of trader, expressed as number of years,

x_{i4} – dummy variable, indicating an education in economics, adopting a value of 1 if the dealer has a degree in economics and a 0 if the dealer does not,

x_{i5} – the number of dependents of the traders,

x_{i6} – trader's age, expressed as the number of completed years of life,

x_{i7} – dummy variable, indicating the possession of higher education, adopting a value of 1 if the dealer has a university degree and 0 if the dealer does not.

² Most of the traders are dimensioned personal characteristics using dummy variables, as Table 1 indicates.

³ Suppose that the results of the study concern the sale of sporting equipment by sales companies. Therefore, the relevance may be that the merchant played sport in the past. Competitive sports may be important not only for the sale of sporting equipment – this type of activity gives the person the will to fight, tenacity of purpose, which promotes all kinds of activities.

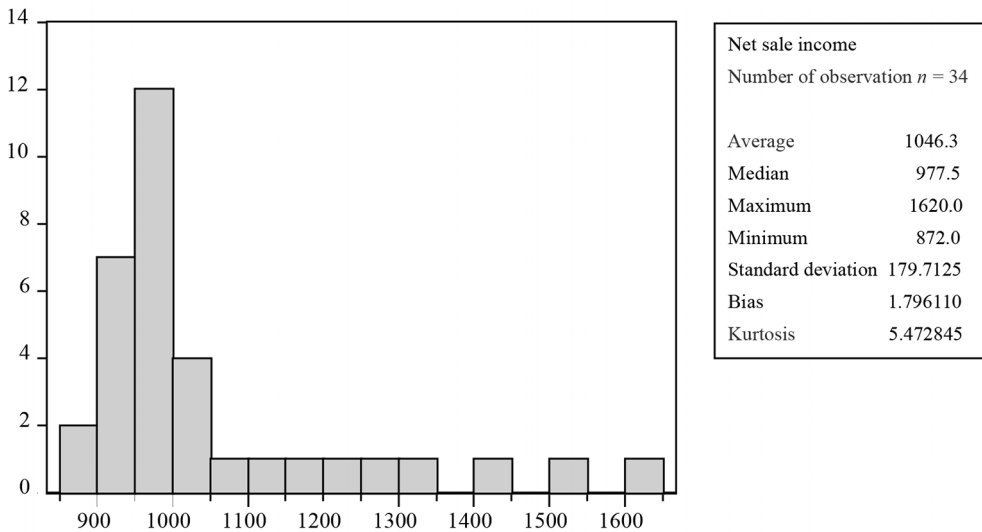


Figure 1. Structure of net sales of the trading department in amounts received per year (in thousand zł)

Source: Table 1.

Figure 1 above shows the right-handed skewness distribution efficiency of MAX traders in the company⁴. It is a typical economic structure. This means that it is much more difficult to achieve a very high amount of sales revenue, well above their average, than the revenues of the dominant, or the median.

3. Empirical econometric models of sales efficiency

Two forms of analytical models describing the efficiency of traders are considered:

a) exponential model

$$y_i = \prod_{j=0}^7 \alpha_j^{x_{ij}} e^{\eta_i}, \quad (3)$$

b) linear model

$$y_i = \sum_{j=0}^7 \alpha_j x_{ij} + \eta_i, \quad (4)$$

where: Π – a product of,

Σ – a sum,

α_j – structural parameters of the equation ($j = 0, 1, \dots, 7$),

e – base of natural logarithms,

η – a random component.

⁴ More about schedules of production capacity of work see [Cieślak 1965, section 5.2, p. 136 ff.].

The empirical equations describing the sales efficiency due to their personal characteristics are as follows⁵:

a) exponential equations

$$\hat{y}_i = 887.3 * 1.067^{x_{i2}} * 1.053^{x_{i3}} * 0.993^{x_{i6}}, \quad (5)$$

(54.304) (2.320) (5.211) (1.315)

$$S_u = 0.0070461, \quad V = 1.015\%, \quad R^2 = 0.807.$$

$$\hat{y}_i = 756.6 * 1.059^{x_{i2}} * 1.040^{x_{i3}}, \quad (6)$$

(212.259) (2.059) (9.971)

$$S_u = 0.071286, \quad V = 1.027\%, \quad R^2 = 0.796.$$

b) linear equation⁶

$$\hat{y}_i = 961.2 + 83.18x_{i2} + 65.0x_{i3} - 12.77x_{i6}, \quad (7)$$

(6.096) (2.354) (5.241) (1.775)

$$\gamma_6 = 0.086,$$

$$S_u = 88.88 \text{ Th. zł}, \quad V = 8.49\%, \quad R^2 = 0.778.$$

Equations (5)–(7) indicate that the most important differentiating efficiency variables in the MAX enterprise are x_{i2} – dummy variable, indicating the fact of competitive sports by the trader, adopting a value of 1, when he/she practiced sports professionally, and 0 for otherwise, and x_{i3} – length of service in the profession of trader, expressed in number of years. They appear to be statistically significant for each of the empirical equations below the significance level $\gamma = 0.05$. A slightly weaker sales feature, differentiating their individual efficiency is age, which turns out to be important especially in the linear equation where $\gamma_6 = 0.086 < 0.1$. It can be seen that the traders with the experience of competitive sports are more productive than others. In addition, the performance favors the experience gained at work by the merchant. In parallel with the age, there is a fall in labor productivity. The total linear model with varying parameters and x_{i6} and x_{i3} is $83.18 - 12.77 = 70.41$ thousand zł. This means that in the balance of “work experience” less “age” trader – there is an increase in the efficiency of an annual average of over 70 thousand zł.

The efficiency of the trader depends on many groups of factors, including his/her personal qualities. These personal characteristics may cause variability in the efficiency of various degrees, typically from 30% to 70%. Empirical equations (5)–(7)

⁵ Parameters have been estimated using the classical least squares method by using the fourth package reviews. Empirical equations presented versions created after the removal of variables statistically insignificant at the significance level below $\gamma = 0.10$. At the reviews there are structural parameters of t-statistics. Empirical equations attached to the standard errors of residuals (S_u), random coefficients of variation (V) and coefficients of determination (R^2).

⁶ γ_6 value in equation (7) is the level of significance for the variable x_{i6} .

explain on average about 80% of the variation in labor productivity of sales. This means that the personal characteristics are prominent among the conditions of their work efficiency. In this case, special attention should be paid to personal qualities of the potential employee.

It has also been found that most of the personal characteristics do not differentiate between sales efficiency. These include gender, the type and level of education and number of dependents. It is worth mentioning that in each case the efficiency of the study, different beam characteristics may appear statistically significant and a different set of variables statistically insignificant.

4. Forecasts efficiency of candidates for traders

Having at least one acceptable empirical equation describing the performance of the job based on an appropriate statistical test, allows us to estimate the efficiency of forecasts of candidates who have applied for the vacant position. Empirical equations (5)–(7) can therefore be used as predictors of job performance of candidates. So we have the following predictors:

$$y_{Tp}^{(l)} = 887,3 * 1,067^{x_{i2}} * 1,053^{x_{i3}} * 0,993^{x_{i6}}, \quad (8)$$

$$y_{Tp}^{(l)} = 756,6 * 1,059^{x_{i2}} * 1,040^{x_{i3}}, \quad (9)$$

$$y_{Tp}^{(l)} = 961,2 + 83,18x_{i2} + 65,0x_{i3} - 12,77x_{i6}. \quad (10)$$

In these equations, $y_{Tp}^{(l)}$ is the estimate of labor productivity in the period T candidate number l ($l = 1, \dots, L$), where L is the number of candidates for the vacant post.

Equations (8)–(10) allow determining the potential effectiveness of the work of any of the candidates who have applied for the competition, revealing their important personal characteristics. Consider, therefore, the individual estimates of labor productivity for each of the ten candidates for the vacant post of salesman in the company MAX. The dimensional characteristics of the individual candidates and their labor efficiency⁷ are presented in Table 2.

The estimated forecasts of the efficiency of candidates for the trader position are provided in Table 2. From the point of view of each of the empirical equations the candidate considered to be the best for the job turns out to be a man aged 33, with the rank of senior trader for 9 years, saved under the number 6. The candidate has

⁷ Figures in bold and italics in the columns of features are statistically significant in the development of sales productivity. The lines in bold type and italics denote the selected candidate with the highest potential for the advertising. Questions in the questionnaire about the characteristics of both highlight how difficult or irrelevant is the candidates' possible manipulation of their own personal data.

Table 2. The characteristics of the candidates for the traders in the company MAX and an estimate of their effectiveness ($y_{Tp}^{(l)}$)

No of candidate (l)	$y_{1Tp}^{(l)}$	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	$y_{2Tp}^{(l)}$	$y_{3Tp}^{(l)}$	Position ranking
1	708,6	0	0	0	1	1	30	0	756,6	578,2	10
2	850,4	0	1	2	0	0	28	1	866,5	816,9	5
3	780,1	1	0	1	0	2	24	0	787,0	719,8	9
4	999,1	0	1	5	1	2	27	1	975,2	1024,7	2
5	832,5	0	0	3	0	0	29	0	851,4	786,0	6
6	1098,6	0	0	9	1	1	33	1	1078,3	1124,9	1
7	807,9	1	1	1	0	2	28	0	833,1	751,9	7
8	876,3	1	1	2	0	4	24	1	866,5	868,0	3
9	851,4	0	0	3	1	2	26	1	851,4	824,3	4
10	784,1	0	1	1	0	1	32	0	833,1	700,9	8

Source: own calculations.

a university degree in economics, and one person to maintain. The candidate does not practice sport professionally. The projections estimate that the candidate may earn revenues from sales within the range 1078.3–1124.9 thousand zł per year. The successful candidate no 6 can expect an average annual income of $\bar{y}_{6Tp} = 1100,6$ thousand zł. The second in hierarchy appears to be pretender 4. The average efficiency of the potential candidate remains at the level $\bar{y}_{4Tp} = 999,7$ thousand zł. The difference between the candidates: no 6 and no 4 is 100.9 thousand zł in favor of the no 6 candidate.

It should be noted that only the forecast performance of candidate no 6 is above the average of sales effectiveness in the company, because $\bar{y}_{6Tp} = 1100,6 > \bar{y} = 1046,3$. The possibility of employment of that applicant (if the forecast estimate is accurate), will not lower the average sales effectiveness in the company. The forecast of the second ranked candidate no 4 slightly lowers the average efficiency of the company. However, the estimate forecast is higher than the median, ie $> Me = 977,5$. The acceptance of that candidate, the prediction accuracy of the performance, would also mean a bad choice. The third candidate in the ranking no 8 has already a forecast of a lower efficiency of both the arithmetic average of the company, as well as less than the median. The recruitment of the potential candidates other than the sixth and fourth can degrade the efficiency of the total sales team. The potential effectiveness of each of the eight candidates (except the sixth and fourth) is lower than the performance of the vast majority of workers in the company of traders. So if the conditions of employment with candidates no 6 or no 4 are not agreed – it seems necessary to carry out a re-recruitment for the vacant post in the sales department.

5. Conclusions

The construction and use of an econometric model of labor require having adequate statistical information from the past. It is worth collecting statistical data on individual job performance for a variety of jobs and the personal characteristics of the employees. This will allow – with the possession of an appropriate statistical sample – the use and operation of an adequate empirical econometric model in decisions regarding employment for the vacant position.

Having an econometric model can support employers in making employment decisions rationally. However, note that such a model is stochastic in nature. This means that it does not guarantee error-free and risk-free decisions. It can be concluded that the greater efficiency of the job depends on the personal characteristics of the employee, the more effective decisions can be based on an empirical econometric model. Reducing the role of personal characteristics in shaping productivity tools limits the usefulness of the model presented in the decisions of employment.

Even the best analytical tool must be used judiciously, taking into account the different circumstances that cannot always be predicted. The use of any method of any type of decision support is effective if carried out with due care and caution.

Literature

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PROGNOZOWANIE W DECYZJACH KADROWYCH

Streszczenie: Celem niniejszej pracy jest prezentacja narzędzi wspomagających decyzje kadrowe w przedsiębiorstwie. Punktem wyjścia jest pomiar efektów pracy osób zatrudnionych na określonym stanowisku. Zgromadzenie odpowiedniej liczby informacji o rezultatach pracy rozmaitych pracowników w przeszłości oraz o ich istotnych cechach osobistych umożliwi skonstruowanie modelu ekonometrycznego. Model taki opisuje mechanizm zmienności efektów pracy, w zależności od rozmaitych charakterystyk zatrudnionych. Posiadając taki model, można oszacować prognozy efektywności poszczególnych kandydatów do pracy, gdy stanowisko stało się wakujące. Ułatwić to może wybór odpowiedniego kandydata spośród wielu. Kandydat ten charakteryzuje się największym potencjałem wydajności. Wybór tegoż kandydata obarczony jest najmniejszym ryzykiem wadliwej decyzji kadrowej.

Słowa kluczowe: decyzje kadrowe, mikroekonometria, prognozowanie.