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MODELS OF COMPETITORS' PREFERENCES INFLUENCE UPON THE NUMBER OF SEAFARERS ON BOARD AND ASHORE

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An attempt is made to model, with the help of the theory of subjective analysis, a distribution of the number of seafarers on board and ashore at a certain time. According to a few-year statistical data of the "Marlow Navigation" crewing company, having a total number of recruited seafarers approximately 11000, there is an approximate distribution ratio for a stable economic period: on board is twice as much as ashore. By the foreseen data of the same company, due to the financial-economic crisis, it is expected vice versa proportion: ashore is twice as much as aboard.
Key words: preferences functions, subjective entropy, seafarer choice, crewing company.

Introduction. Ship-owners hire seafarers recruited for them by crewing companies. Rotation of the seafarers goes on and neither the ship-owners nor the members of their ships' crews do know exactly when and where they change their colleagues. Moreover the financial situation on the world market sometimes changes dramatically and all of the players have their own preferences. Thus, for the ship-owners and crewing companies, the number of seafarers on board and ashore has a probabilistic value.

Urgency of researches. The problem also increases due to uncertainty because agreements not always can be come to, unexpected events may happen, there is a competition factor etc. Therefore the problem of taking into account subjective preferences is urgent.

Subjective analysis allows considering the factors. The problem setting in general view is related to problems of decision making, financial situation prediction, modeling of psychological processes, expected results of a conducted economic policy etc.

Analysis of the latest researches and publications. Subjective analysis methods were developed in works [1-3]. In the works it is postulated an optimizing principle. In the works [2, 4, 5], there are examples of modeling of subjective preferences influence upon: the number of passengers of an air company; ship's power plant work indexes.

Models of the divider of the processes need more attention, mathematical researches.

The task setting. The object of this article is to consider a new model for the intensity of transitions from a state to another state of a potential seafarer.

The main content (material). At the condition that there are three major groups of players in the field of seagoing transportation industry, we can imagine it diagrammatically, see figure 1.

At each of the three levels there is competition between members and members of a level interact with members of other levels. The interaction between levels is antagonistic. Therefore there can be conflicts of antagonism between levels and conflicts of competition on each level.

Preferences influence upon the intensity of the transition process.

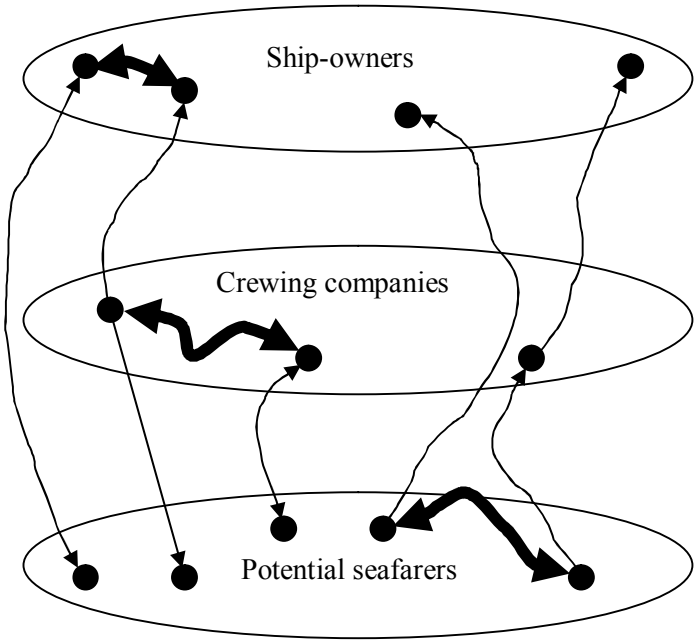


Figure 1 – Competition and interaction between groups and individuals

The problem formulation. Formulating the problem in this setting we will consider some simplifications. The work [1, p. 119, (3.38)] reads: a subject forms his own preferences at the set of achievable for his goals alternatives with the help of a functional taken in a rather general view:

$$\Phi_{\pi} = \alpha H_{\pi} + \beta\varepsilon + \gamma \mathrm{N} \qquad (1)$$

where H_{π} – the subjective entropy; $\varepsilon = \varepsilon(\pi, U, \ldots)$ – a function of subjective effectiveness; N – normalizing condition; α, β, γ – structural parameters, they can be considered in different situations as Lagrange coefficients, weight coefficients or endogenical parameters which represent certain psychic properties.

Choosing the functional (1) in the view of [1, p. 124, (3.55)]:

$$\Phi_{\pi}^{-} = -\sum_{i=1}^{N} \pi^{-}(\sigma_i) \ln \pi^{-}(\sigma_i) - \beta \sum_{i=1}^{N} \pi^{-}(\sigma_i) L(\sigma_i) + \gamma \sum_{i=1}^{N} \pi^{-}(\sigma_i), \qquad (2)$$

where $\pi^{-}(\sigma_i)$ – a function of negative preferences of a subject concerning achievable for him alternatives σ_i; $L(\sigma_i)$ – a function of losses («harmfulness»); or [1, p. 125, (3.57)] in the view:

$$\Phi_{\pi}^{+} = -\sum_{i=1}^{N} \pi^{+}(\sigma_i) \ln \pi^{+}(\sigma_i) + \beta \sum_{i=1}^{N} \pi^{+}(\sigma_i) U(\sigma_i) + \gamma \sum_{i=1}^{N} \pi^{+}(\sigma_i), \qquad (3)$$

where $\pi^{+}(\sigma_i)$ – a function of subjective positive preferences; $U(\sigma_i)$ – a function of usefulness («utility») which has positive sense; from indispensible conditions for extremes for the cases (2, 3):

$$\frac{\partial \Phi_{\pi}^{-}}{\partial \pi^{-}(\sigma_i)} = 0, \qquad \frac{\partial \Phi_{\pi}^{+}}{\partial \pi^{+}(\sigma_i)} = 0, \qquad \left(\forall i \in \overline{1, N}\right),$$

we get:

$$-\ln \pi^{-}(\sigma_i) - 1 - \beta_L L(\sigma_i) + \gamma_L = 0, \qquad -\ln \pi^{+}(\sigma_i) - 1 + \beta_U U(\sigma_i) + \gamma_U = 0, \qquad (4)$$

coefficients β and γ here β_L, γ_L – for (2), negative σ_i; and β_U, γ_U – for (3), positive.

From (4):

$$\pi^{-}(\sigma_i) = e^{-1+\gamma_L} e^{-\beta_L L(\sigma_i)}, \qquad \pi^{+}(\sigma_i) = e^{-1+\gamma_U} e^{\beta_U U(\sigma_i)}, \qquad (5)$$

or simplifying (5), with constants:

$$\pi^{-}(\sigma_i) = C_L e^{-\beta_L L(\sigma_i)}, \qquad \pi^{+}(\sigma_i) = C_U e^{\beta_U U(\sigma_i)}. \qquad (6)$$

Constants of C_L, C_U, for (6):

$$C_L = \left(\sum_{j=1}^{N} e^{-\beta_L L(\sigma_i)} \right)^{-1}, \qquad C_U = \left(\sum_{j=1}^{N} e^{\beta_U U(\sigma_i)} \right)^{-1}. \qquad (7)$$

Then using (7) в (6), we got:

$$\pi^{-}(\sigma_i) = \frac{e^{-\beta_L L(\sigma_i)}}{\sum_{j=1}^{N} e^{-\beta_L L(\sigma_i)}}, \qquad \pi^{+}(\sigma_i) = \frac{e^{\beta_U U(\sigma_i)}}{\sum_{j=1}^{N} e^{\beta_U U(\sigma_i)}}. \qquad (8)$$

The simplest model for a potential seafarer transitions is represented by the graph shown on the figure 2.

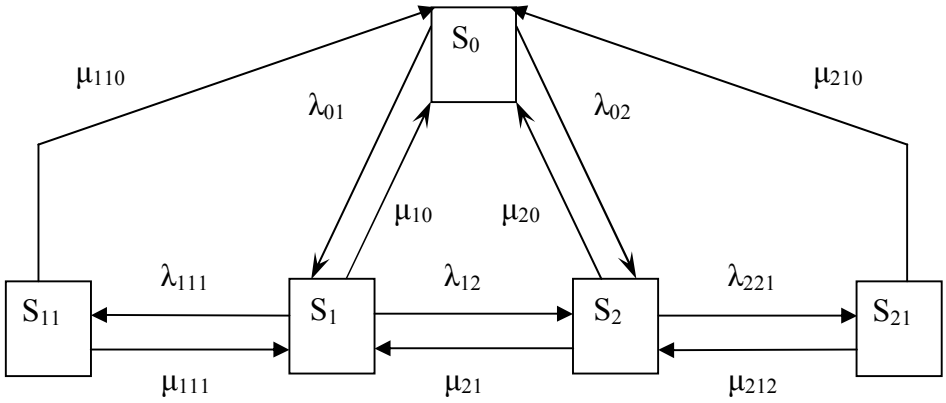


Figure 2 – Graph of a potential seafarer states

S_0, S_1, S_2, S_{11}, S_{21}, – are states of an individual: "not a seafarer", "a seafarer recruited by the first crewing company", "a seafarer recruited by the second crewing company", "a seafarer recruited by the first crewing company is on board the ship of the first ship-owner", "a seafarer recruited by the second crewing company is on board the ship of the second ship-owner" respectively. λ-s and μ-s are intensities of transitions from a state to another state. Probabilities of states – P_0, P_1, P_2, P_3, P_4 respectively.

The number of seafarers is divided proportionally to the corresponding probability. According to the variant, fig. 2, the system of the differential equations (by Erlang):

$$\left.\begin{aligned}
\frac{dp_0(t)}{dt} &= -(\lambda_{01}+\lambda_{02})\cdot p_0(t)+\mu_{10}\cdot p_1(t)+\mu_{20}\cdot p_2(t)+\mu_{110}\cdot p_3(t)+\mu_{210}\cdot p_4(t)\\
\frac{dp_1(t)}{dt} &= \lambda_{01}\cdot p_0(t)-(\mu_{10}+\lambda_{12}+\lambda_{111})\cdot p_1(t)+\mu_{21}\cdot p_2(t)+\mu_{111}\cdot p_3(t)\\
\frac{dp_2(t)}{dt} &= \lambda_{02}\cdot p_0(t)+\lambda_{12}\cdot p_1(t)-(\mu_{20}+\mu_{21}+\lambda_{221})\cdot p_2(t)+\mu_{212}\cdot p_4(t)\\
\frac{dp_3(t)}{dt} &= \lambda_{111}\cdot p_1(t)-(\mu_{110}+\mu_{111})\cdot p_3(t)\\
\frac{dp_4(t)}{dt} &= \lambda_{221}\cdot p_2(t)-(\mu_{210}+\mu_{212})\cdot p_4(t)
\end{aligned}\right\} \quad (9)$$

Due to crisis or other uncertainty, subjective preferences change intensities λ-s and μ-s. One of the possible ways of that can be modeled by:

$$\lambda_{01}(c,\tau)=\begin{cases}\left(\frac{1}{2}\cdot\lambda\cdot\frac{\pi_1(c,\tau)}{\pi_2(c,\tau)}\right) & if\ \ \pi_1(c,\tau)<\pi_2(c,\tau)\\ \left(\lambda-\frac{1}{2}\cdot\lambda\cdot\frac{\pi_2(c,\tau)}{\pi_1(c,\tau)+\pi_2(c,\tau)}\right) & otherwise\end{cases}, \quad \lambda=\lambda_{01}+\lambda_{02}. \quad (10)$$

where c and τ – price and time interval (let us say salary and voyage duration in the case). Resources $(L(\sigma_i), U(\sigma_i))$ (8) depend on c and τ. Thus preferences functions for the 1st and 2nd ship-owners are $\pi_1(c,\tau)$ and $\pi_2(c,\tau)$:

$$\pi_1(c,\tau)=\frac{e^{-\beta\cdot R_1(c,\tau)}}{e^{-\beta\cdot R_1(c,\tau)}+e^{-\beta\cdot R_2(c,\tau)}}, \qquad \pi_2(c,\tau)=\frac{e^{-\beta\cdot R_2(c,\tau)}}{e^{-\beta\cdot R_1(c,\tau)}+e^{-\beta\cdot R_2(c,\tau)}}. \qquad (11)$$

where $R_1(c,\tau)$ and $R_2(c,\tau)$ – resources for the 1st and 2nd shipping companies dependently on price c and time interval τ.

Researches results. Results of modeling by formulas (8-11) are shown on figures 3-7. Calculations were performed for values c = 100 … $8\cdot10^3$ and τ = 10 … 100.

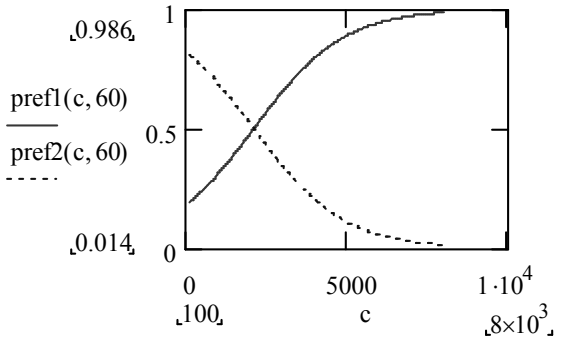


Fig. 3. Preferences functions for τ = 60

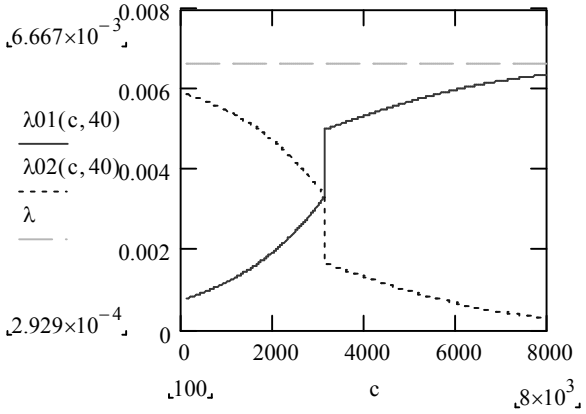
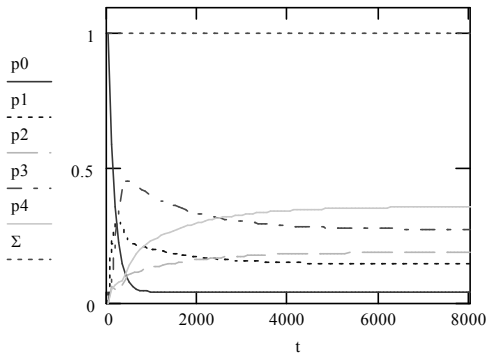
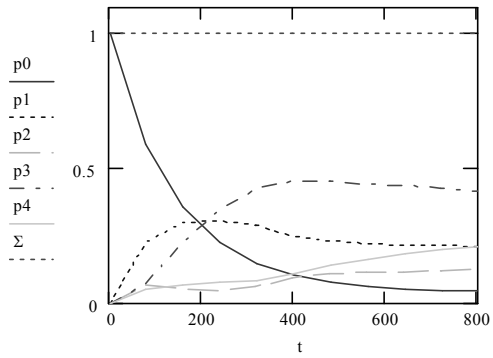


Fig. 4. Intensities of transitions for τ = 40

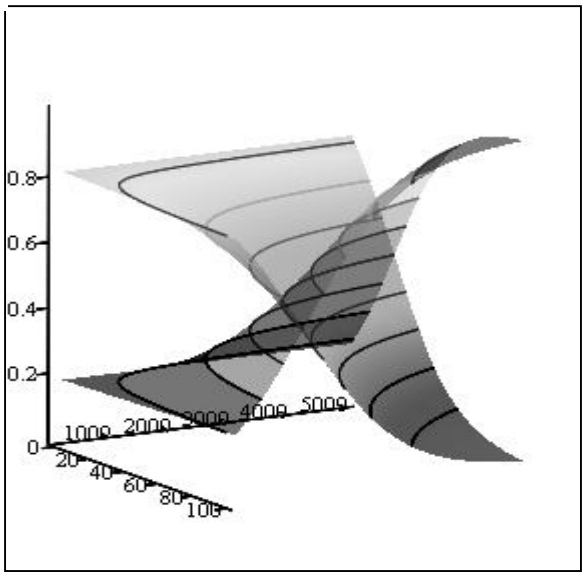


a)



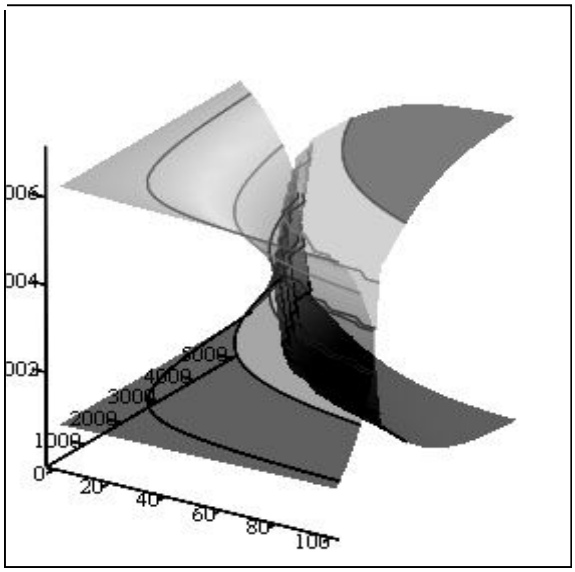
b)

Figure 5 – Dependences of probabilities
a) and b) for different time intervals



pref1 , pref2

Figure 6 – Preferences functions



λ01, λ02

Figure 7 – Intensities of transitions

Diagrams for dependences of probabilities (fig. 5 a) and b)) are plotted for a case when c and τ are the time dependent values.

Conclusions. Accordingly to simplifications and assumptions made at the problem formulation it was acquired that the number of seafarers on board is twice as much as those ashore for both shipping companies. That coincides with the "Marlow Navigation" crewing company statistical data for the economic stability period.

Models for the divider system (10) can be composed by the algorithm proposed in the papers [2, 4, 5].

LITERATURE

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Касьянов В.О., Гончаренко А.В. МОДЕЛІ ВПЛИВУ ПЕРЕВАГ КОНКУРЕНТІВ НА КІЛЬКІСТЬ МОРЯКІВ НА БОРТУ ТА НА БЕРЕЗІ

Здійснено спробу змоделювати, за допомогою теорії суб'єктивного аналізу, розподіл кількості моряків на тих, хто у певний момент часу знаходиться у морі, та тих, хто очікує відправки у рейс. За декількарічними статистичними даними крюїнгової компанії "Marlow Navigation", при загальній кількості рекрутованих ними моряків (приблизно в одинадцять тисяч осіб), для стабільного економічного періоду характерним є розподіл тієї кількості у співвідношенні приблизно: у морі вдвічі більший контингент, аніж на березі, тих, хто очікує відправки в рейс. За прогнозними даними тієї ж компанії, унаслідок наявної фінансово-економічної кризи, очікується прямо протилежна пропорція: на березі вдвічі більше моряків, аніж на борту суден.

Ключові слова: функції переваг, суб'єктивна ентропія, вибір моряка, крюїнгова компанія.

Касьянов В.А., Гончаренко А.В. МОДЕЛИ ВЛИЯНИЯ ПРЕДПОЧТЕНИЙ КОНКУРЕНТОВ НА КОЛИЧЕСТВО МОРЯКОВ НА БОРТУ И НА БЕРЕГУ

Осуществлена попытка промоделировать, с помощью теории субъективного анализа, распределение количества моряков на тех, кто в определенный момент времени находится в море, и на тех, кто ожидает отправки в рейс. По нескольколетним статистическим данным крюинговой компании "Marlow Navigation", при общей численности рекрутированных ими моряков (приблизительно в одиннадцать тысяч человек), для стабильного экономического периода характерным является распределение этого количества в соотношении приблизительно: в море вдвое больший контингент, чем на берегу, тех, кто ожидает отправки в рейс. По прогнозным данным той же компании, вследствие имеющегося финансово-экономического кризиса, ожидается прямо противоположная пропорция: на берегу вдвое больше моряков, чем на борту судов.

Ключевые слова: функции предпочтений, субъективная энтропия, выбор моряка, крюинговая компания.