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Prof. Dr. Sabri ORMAN Özel Sayısı s.394-403

AN EXPLORATORY NOTE ON THE EFFICIENT UNIVERSITY MANAGEMENT

Ahmet Kara[1] **ORCID ID: 0000-0002-0162-8137**

ABSTRACT

This note extends some of the points developed in Kara (2018, 2019) so as to explore new avenues for an efficient university management. The particular avenues we will explore center around certain processes that we think are fundamental, namely the processes of accumulation, concentration and deepening of knowledge, experience, skills/capabilities and expertise that facilitate or give rise to scientific output. One can suggest policies that could influence those processes and help the university to achieve its objectives. Such policies could be derived through properly formulated and solved optimization problems involving objective functions and constraints of the university. The objective functions to be formulated should properly take into account the possible paths in the world of science and realistically reflect the university's short and long term target and preferences. We will make some suggestions for constructing objective functions incorporating the objectives of the university.

Key Words: Knowledge-based processes of accumulation, concentration and deepening. Efficiency. University management.

ETKİN ÜNİVERSİTE YÖNETİMİ ÜZERİNE AÇIMLAYICI BİR NOT

ÖZET

Bu kısa makale (not), Kara (2018,2019) kapsamında geliştirilen bazı fikirlerden hareketle, etkin üniversite yönetimi ile ilgili yeni bir açılım getirmeyi denemektedir. Söz konusu açılım, bilgi, tecrübe, yeterlik ve yetkinliklerle ilgili birikme, yoğunlaşma ve derinleşme süreçlerine odaklanmakta; bu süreçleri etkileyerek, üniversiteyi amaçlarına taşıyacak bazı politikalara işaret etmektedir. Bu politikalar, üniversitenin amaç fonksiyonları ve kısıtlarına dayalı, doğru formüle edilmiş optimizasyon problemlerinin çözümlerinden türetilebilirler. Formüle edilecek amaç fonksiyonlarının, üniversitenin kısa ve uzun dönem hedef ve tercihlerini, dünya bilimindeki doğrultuları da dikkate alarak, gerçekçi bir tarzda yansıtmaları gerekir. Makalede, üniversitenin amaçlarını temsil edecek amaç fonksiyonlarının kurgusu ile ilgili bazı önerilerde de bulunulmaktadır.

Anahtar Kelimeler: Bilgi-temelli birikme, yoğunlaşma ve derinleşme süreçleri. Etkinlik. Üniversite yönetimi.

[1] Prof. Dr. Istanbul Commerce University, Department of Economics. 2a0c1a1c@gmail.com.

1. Introduction

Problems and prospects of universities in modern times have almost always constituted multidimensional and multidirectional spectrums of topics that have captured the attention of many scholars. Works in these spectrums have explored a wide array of university-related phenomena ranging from the strategic university management to the research efficiency of higher education institutions. Among these works are Abramo, Cicero & D'Angelo (2012), Abramo, D'Angelo & Di Costa (2014), Barlas & Diker (2000), Barlas, Diker & Polat (1997), Dzisah (2007), Ehrenberg (2020), Hage, Mote & Jordan (2013), Hayrinen-Alestalo & Peltola (2006), Ivanov, Markusova & Mindeli (2016), Kara (2007, 2013, 2015), Kosslyn, Nelson & Kerrey (2018), Lach & Schankerman (2008), Metcalfe (2010), Munoz (2016), Owen-Smith (2018), Parilli & Elola (2012), Ramos-Vielba & Fernandez-Esquinas (2012), Shin (2009), Simai (2003), Spencer (2001), Walton, Tornatzky & Eveland (1986).

A detailed literature review of the topics associated with universities is beyond the scope of this note. We should, nevertheless, indicate that though the literature is fascinatingly rich in its coverage, there are many areas that need further exploration and improvement. Among these areas is the issue of efficient allocation of resources within the university systems. In view of the complexity of this particular area, hybrid combinations of methods with new ideas may potentially yield non-negligible contributions to the literature. In this note, we will take a step towards such a contribution by extending some of the points developed in Kara (2018, 2019) so as to explore new avenues for an efficient university management.

The next section will construct a simple exemplary model that could serve as a basis for the simulations of key variables associated with resource allocation problems within a university. The model could open the doors to various extensions, some of which will be indicated in the text. Based on the line of inquiry pointed out in the note, policy options could be developed for the purpose of improving the university performances. Final remarks will be presented in the concluding section.

2. A simple model

Suppose that a representative university employs three factors of production to produce "teaching-related", "research-related" and "project-related" services. The three factors of production in question will be represented by the three well-known concepts of capital, namely human capital, physical capital and social capital, the definitions of which are presented in many works in the literature such as in Kara

(2018). For the purpose of analytical convenience, the concept of human capital will, in our analysis, serve as a central point of reference, the role of which will be facilitated by the concepts of physical capital and social capital.

Consider a market for human capital where individuals, firms and educational (and other) institutions (including universities themselves) act as market participants with possibly interlinked expectations. A typical university may well be both on the demand as well as on the supply side of the market. We will make some simplifying assumptions and posit the following demand and supply functions for human capital. Suppose that the quantity demanded for human capital at time t (HK^D_t,) is a function of the level of human capital at time t-1 (HK_{t-1},), the price of human capital at time t (PHK_t), the price of physical capital at time t (PPK_t), the price of social capital at time t (PSK_t), the return on human capital at time t ((RHK_t), the level of teaching performance at time t (x_t), the level of research performance at time t (y_t), the level of project performance at time t (z_t) and the human capital subsidy at time t (S_t),

i.e., $HK^D_t = f(HK_{t-1}, PHK_t, PPK_t, PSK_t, RHK_t, x_t, y_t, z_t, S_t)$, (1)

which is a hybrid demand function for human capital. All variables take on positive real values. Here HK_t, HK_{t-1} (together with other forms of capital), x_t, y_t, and z_t could be measured by properly constructed indices. RHK_t could be conceived as a composite price representing the average return that results from the employment of human capital in various productive activities. We will assume that HK^D_t depends positively on RHK_t, x_t, y_t, z_t, and S_t, and negatively on HK_{t-1} and PHK_t. Intertemporal needs and expectations could conceivably influence the particular relation between HK^D_t and HK_{t-1}. The dependence of HK^D_t on PPK_t and PSK_t is likely to be contingent upon the relations of substitutability and complementarity between human capital and other two forms of capital.

Similarly, suppose that the quantity supplied for human capital at time t (HK^S_t) depends on the level of human capital at time t-1, the level of overall university performance at time t ($OPERF_t$) and the price of human capital at time t (PHK_t),

i.e., $HK^S_t = g(HK_{t-1}, OPERF_t, PHK_t)$, (2)

which is a hybrid supply function for human capital. Quantity supplied takes on positive real values and depends positively on PHK_t. The dependence of HK^S_t on HK_{t-1} and $OPERF_t$ may well be related to a variety of factors such as intertemporal needs and expectations, which we will not explore here in detail. For the sake of simplicity, we will assume that HK^S_t depends negatively on HK_{t-1} and positively on $OPERF_t$.

Suppose that the demand and supply functions for human capital have the following forms:

$$HK^D_t = \alpha_0 + \alpha_1 HK_{t-1} + \alpha_2 PHK_t + \alpha_3 PPK_t + \alpha_4 PSK_t + \alpha_5 RHK_t + \alpha_6 x_t + \alpha 7\ y_t + \alpha 8\ z_t + \alpha 9\ St + u_{Dt}\ , \quad (3)$$

and

$$HK^S_t = \beta_0 + \beta_1 HKt\text{-}1 + \beta_2 OPERF_t + \beta_3 PHKt + u_{St}, \quad (4)$$

where u_{Dt} and u_{St} are normally-distributed stochastic terms with zero means and constant variances σ_{uD} and σ_{uS} respectively.

We propose a proper dynamic for the trajectory of human capital over time so as to make human capital's movements proportional to the excess demand for human capital,

$$\text{i.e., } HK_t - HK_{t-1} = k\,(HK^D_t - HK^S_t), \quad (5)$$

where k is the coefficient of adjustment. This is simply a dynamic adjustment equation for human capital. Substituting the expressions for HK^D_t and HK^S_t specified above, setting the initial values of PHK_t, PPK_t, PSK_t, RHK_t, x_t, y_t, z_t, S_t and $OPERF_t$ to their averages PHK_t^{avr}, PPK_t^{avr}, PSK_t^{avr}, RHK_t^{avr}, x_t^{avr}, y_t^{avr}, z_t^{avr}, S_t^{avr} and $OPERF_t^{avr}$ and rearranging the terms in the equation, we get,

$$HK_t + (-1\text{-}k(\alpha_1 - \beta_1))\, HK_{t-1} = k(\alpha_0 - \beta_0 + (\alpha_2 - \beta_3)\ PHK_t^{avr} + \alpha_3 PPK_t^{avr} + \alpha_4 PSK_t^{avr} + \alpha_5 RHK_t^{avr} + \alpha_6 x_t^{avr} + \alpha 7\ y_t^{avr} + \alpha 8\ z_t^{avr} + \alpha 9\ S_t^{avr} - \beta_2 OPERF_t^{avr} + u_{1t} - v_{1t}. \quad 6)$$

This is a stochastic difference equation that could serve, together with the supplementary structures developed below, as a basis for the simulations of some of the key variables of the system.

Having developed a simple human capital-based framework, we can now proceed to inquire about and formulate ways in which the university management could influence certain fundamental processes so as to achieve some desired ends. The processes we will consider are termed, in Kara (2019), the processes of "accumulation", "concentration" and "deepening" of knowledge, experience, skills/capabilities and expertise that facilitate or give rise to scientific output. Though, in this note, we will define/describe these processes in terms of human capital, similar descriptions could also be put forward in terms of physical capital and social capital. Composite descriptions combining all three forms of capital are possible as well. The level of accumulation will be defined as the human capital stock representing all the

accumulated knowledge, skills and competences, which could be measured by a properly constructed index. The rates of concentration describe the proportions with which the human capital stock is allocated among different uses such as teaching, research or project-related activities. Within each category of use, there could be sub-concentration rates assigning weights to constituting subcategories such as different areas/subcategories of research or specialization. The rate of deepening will be represented by the marginal productivity of human capital, demonstrating the extent of additional contributions human capital could make to the total scientific production or the total performance of the university.

The level of accumulation and the rates of concentration and deepening of human capital, in conjunction with the levels of physical and social capital, will determine the teaching, research and project performance levels, a weighted average or a nonlinear function of which might represent the overall performance of the university. For the sake of simplicity, let the performance functions associated with the teaching, research and project-related activities take the following simple linear forms.

$$x_t = \theta_1 HK_t + \theta_2 PK_t + \theta_3 SK_t + \theta_4 w_{1t} + \theta_5 w_{2t} + u_{xt}\,, \tag{7}$$

$$y_t = \lambda_1 HK_t + \lambda_2 PK_t + \lambda_3 SK_t + \lambda_4 w_{1t} + \lambda\gamma_5 w_{2t} + u_{yt}\,, \tag{8}$$

$$z_t = \gamma_1 HK_t + \gamma_2 PK_t + \gamma_3 SK_t + \gamma_4 w_{1t} + \gamma_5 w_{2t} + u_{\lambda zt}\,, \tag{9}$$

where PK_t and SK_t are the levels of physical capital and social capital. w_1 represents the rate of concentration of human capital associated with research. w_2 is the rate of deepening of human capital. u_{xt}, u_{yt} and $u_{\lambda zt}$ are normally distributed stochastic terms with properly specified mean and variances.

Overall performance of the university could be a linear or nonlinear function of a number of factors/components including the teaching, research and project performances. Such a function could serve as an objective function of the university. Since linear functions lend themselves to easily understandable, simple practical interpretations and applications, we will, first, posit a linear overall performance function of the following form and elaborate on the nonlinear forms later.

$$OVERP_t = \Phi_1 x_t + \Phi_2 y_t + \Phi_3 z_t, \tag{10}$$

where Φ_1, Φ_2 and Φ_3 could be interpreted as the weights associated with the teaching, research and project performances in the overall objective function of the university. These weights could be determined by the governing organs or the management of the university. The relative values of these weights would reflect overall orientation of the university. For instance a higher Φ_1 relative Φ_2 and Φ_3 would indicate a

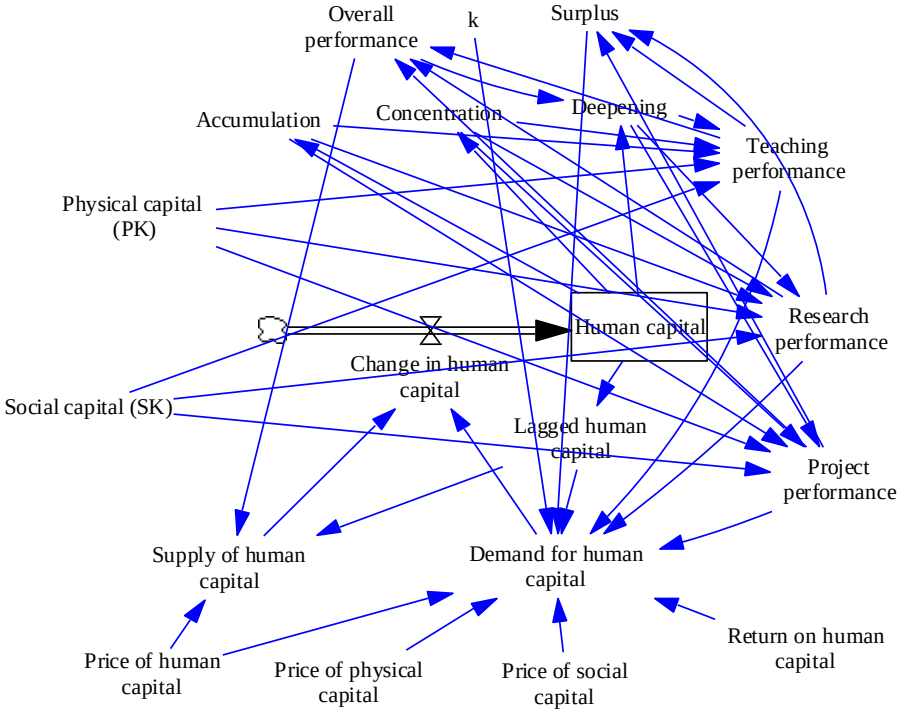
preference for a teaching-oriented university while a higher Φ_2 would signify a preference for a research-oriented university. Alternatively, the university may want to strike a balance between these orientations or choose a priority structure that assigns a relatively higher priority to one of them subject to minimally necessary levels for others. On the other hand, nonlinear objective functions are possible as well. They may provide a greater degree of flexibility, and as such, they may more sensitively represent the complexities of real-life decision processes. Nonlinear objective functions may, in some cases, better capture the possible paths in the world of science and better reflect the university's short and long term target and preferences.

Once the priorities and requirements reflecting the objectives and constraints of the university are determined, the management should go ahead and solve the optimal resource allocation problem subject to the constraints in question. The problem is a difficult one with many interconnected dimensions. In this note, I will only suggest an optimal way in which surpluses that could be generated from the teaching, research and project-related activities could be distributed so as to influence the processes of accumulation, concentration and deepening which would facilitate the achievement of the overall objectives.

Each component of the surplus generated from the teaching, research and project-related activities could be calculated by taking the difference between the revenues and costs of each activity. Total surplus will be the sum of the teaching, research and project-related surpluses. A portion of the total surplus could be reserved for the purpose of subsidizing human capital, physical capital and social capital investments. Let us assume that k percent of the reserved surplus is used for the purpose of human capital improvements, which will stimulate the demand for human capital. 1-k percent of the reserved surplus will be used to provide a unit price-based subsidy for physical capital and social capital. We will skip the mathematics of incorporating the subsidies into the analytical framework above. This could be done easily and in a number of ways.

The subsidies in question could provide an impetus to the human capital improvements over time, which would lead to changes in the levels of accumulation and rates of concentration and deepening, which would in turn lead to changes in the teaching, research and project performances and consequently in the overall performance. The simulation diagram for the entire process is presented below:

Figure 1: Simulation Diagram[2]



Using this simulation set-up, we can simulate the effects of the policy parameter k on the processes of accumulation, concentration and deepening for human capital which can influence the micro performance components as well as the overall performance of the system. Additionally, we can find the optimal value of the parameter k that maximizes the overall performance of the university. This could be done through optimization modules built in simulation software. Needless to say, the solution to the optimization problem could depend on the nature and the form of the objective function and the policy instrument(s) as well as on the intricate relations between them.

Finding the optimal value of a resource allocation parameter such as k is an instrumentally important component of the efficient management of the university. There are of course other economic as well as power-related components of the

[2] Vensim is used to construct the diagram.

system, which are central to the efficient university management, such as employment and micro analytics of authority-distribution. These could be modeled by extending the framework here so as to jointly include complexly interwoven resource allocation and power distribution mechanisms within the university system.

3. Concluding Remarks

In this note, we have extended some of the points presented in Kara (2018, 2019) so as to present a human capital-based framework for simulating the policy-influenced trajectories of the processes of accumulation, concentration and deepening of human capital. We have suggested a way of finding, in this framework, the (optimal) value of the policy parameter k that maximizes the overall objective or performance function.

Two extensions of this note might be worthy of future inquiry. First, the university may have multiple teaching, research and project-related preferences that need not always be commensurable. Analyzing the complications such as kinks and discontinuities that might arise in decision contexts with such preferences might be useful to explore.[3] Second, this note presented a supply-and-demand set-up only for human capital. Extending the model so as to include supply-and-demand set-ups for all three categories of capital and undertaking simulations of accumulation, concentration and deepening processes in such an extended framework might yield additional insights for the effectiveness of performance-enhancing policies.

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[3] For the issue of multiple preferences in economic theory, see Kara (1996, 2009).

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