SUSTAINABILITY OF EMPLOYEE PRODUCTIVITY AS A PRESUMPTION OF SUSTAINABLE BUSINESS

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ABSTRACT

The concept of the sustainable development popularized the reflection on resources allocation, but considering of sustainability of employee productivity is still in its infancy. Using the game theory model, we will analyze the influences and mechanisms that affect the individual as the unit of the sustainability of the company. In this paper, we will provide a new approach to an individual productivity and determine the boundaries of the employee's workload using the game theory model. The model will sketch and determine the framework of long term and sustainable productivity of an individual, as the basis for the sustainable economic growth of the company. The final goal is to point out to the importance of respecting sustainability of productivity on the individual level. Provided framework could be used for both practical and theoretical application.

I. INTRODUCTION

„How can you buy or sell the sky – the warmth of the land? The idea is strange to us. Yet we do not own the freshness of the air or the sparkle of the water. How can you buy them from us?

* * *

This we know: the earth does not belong to man, man belongs to the earth. All things are connected like the blood that unites us all. „ from the letter sent by Chief Seattle of the Duwamish Tribe in Washington to President Pierce in 1855 .

Considerations and researches of sustainable development often start with this cite, and continue in the spirit of the conservation and the revision of human attitude toward environment. We want to approach to this subject from another, not so represented, socioeconomic perspective, the perspective of human's attitude toward a human, that is, by himself. Even the Chief Seattle cite places the human, a human in the focus. The focus is on the human's autonomy, his ability to manage the surroundings and his right to make the decisions. Yet, in modern (or post modern) times, it becomes questionable. Just like the Chief asked to whom it belongs the land two centuries ago, today we can rightfully ask: to whom does belong the human? If a human owns himself, can he sell himself? If so, under which conditions? How much of his time and abilities should he sell and when should he stop? And is it sustainable? Those, almost philosophical questions will find quantitative answers in this papers, considering the individual as an economic factor in businesses.

Sustainable development concept popularized the considerations on resource management, but deliberations on sustainability of employee productivity is still at an early stage. The companies want to maximize their profit, often without giving a thought on sustainability of the elements that participate in profit generation. In this papers, even though with the humanistic intentions, we will observe the employee from the functionalist perspective as a company's resource. Therefore, we will take away employee's human characteristics and define him as the economic unit of the company, measured in productivity. In other words, the request placed before the company is to treat the employee as any other scarce resource. Surprisingly, this approach will result in requirement for equilibrium and long term sustainable employee's load.

This is not another paper with the goal to show the importance of the investment in employees or just how to maximize the benefit from the worker. In this paper we will use sustainable development approach to consider the companies attitude towards the employee, using the analogy of how considering the companies relations toward the environment is encouraged to be considered. The human deserves the same attention. He deserves the determination of the exploitation boundaries. The aim of this paper is to provide a different insight using a mathematical model of individual's sustainable productivity, which will provide framework for insight in socioeconomic influences.

In this paper we will determine the productivity boundary for an individual, such that it will provide maximization of overall utility of economic and social aspect. Since different individuals have unique set of abilities, which form different productivity curves, boundaries should also be individual, given the specific situation. We will prove that it is possible to shift the boundary by shifting the productivity curve due to investment in employee's training and education. Moreover, model will show that increase in productivity provides a new equilibrium in economic aspect. Solution extends to a new equilibrium in social aspect. The model will show that due to higher qualifications, employee's abilities extend to a non work related tasks.

Malthus catastrophe was one of the first sustainability models, and also an anthropocen-

tric model, which observed sustainability of human population given the limited resources. In spite of the model's inaccurate prognosis, two centuries later the problem hasn't been solved. Moreover, a human capital was added to the resource set. Contemporaries of sustainable development emphases on sustainability of natural resources and ecology. In new studies on productivity, emphasis is on the motivation and education. For the long term effects, which will be considered in this papers, education will be powerful tool of productivity incensement.

Many researches gave a thought on productivity taking economic, sociologic and psychological approach. Considering that the reward for the work is money, many researches considered the impact of money amount on work and performance. The conclusions point out that motivation by higher payoff is temporary, even sometimes too big amounts lead to a higher stress level which decreases productivity. In order to enhance the employee's performance, the success under social pressure considered. Further on, researches considered the difference in intrinsic and extrinsic motivation, in which intrinsic motivation took the forefront. Also, the factors as job relevance and recognition affect the long term performance. Most of those researches are focused on how to gain the maximum productivity from the individual or how to motivate people to work more, faster and better. Usually, only short term solutions are offered and they tend to lose in their effects over the time. In this papers the question on long term stability and boundaries will be set in order to define when to stop in exploitation of employee's time and capacities. In other words, what is the equilibrium that enables reliable, sustainable and long term productivity? Respectively, how to achieve a higher level of productivity which will not be determined by extrinsic motivators or short term stimulants. To achieve that, it is necessary to dismantle productivity on basic factors which game theory model provides.

The question is how the employer solves the optimization of worker's load while maximizing his utility from the labor unit. The employer wants to maximize the load for the employee. In the same time, he should keep in mind that this load should be set according to individual worker abilities. If employer would solve the optimization problem without considering boundaries, he would face a benefit declining or even a negative payoff due to overload and worker's work ability loss. Hence, there is a limitation condition for every worker, which is his productivity. Second limitation condition is the number of labor units, and the importance of setting up the regulatory framework (which is defines law in most of the countries), will be confirmed. The employer is not the only party interested in employee's time and abilities: there are also employees social obligations.

The first assumption that employee's productivity is limited. When overloaded, productivity reaches a tipping point after which workers abilities crush down to a minimum[1]. The second assumption is that the overload point can be shifted to a higher level by using the socioeconomic factor to achieve higher level of productivity.

By investing in employee by professional training or lifelong learning, the company can raise the worker's level of productivity. The worker will be capable for the acceptance of higher number of work tasks or equal number heavier tasks, in other words, his productivity will be higher.

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[1] For example, this could be a situation when an overloaded or stressed out worker takes a sick leave. At the sick days, worker's productivity is equal to zero, causing the lack of generating profit for the company at the time and additional costs of hiring another employee while paying the sick leave.

The company's investment in human capital, respectively employee's education will be considered firstly from economic and indirectly from sociologic dimension of sustainable development. Psychosocial elements that have short-term influence on performance will not be considered. We would never dare to claim that those elements are irrelevant, but it is necessary to ignore the variables with temporary effects if we want to establish the long-term equilibrium.

In these papers, game theory model will be offered to determine the boundaries of workload for the employee. In this game theory model, social and economic dimension elements will be considered in order to enable the shift of equilibrium load to a higher level.

Exactly the equilibrium solution enables the achieving sustainability of socioeconomic development of the company, starting from the individual level. The model will sketch and determine the framework for the long-term and sustainable productivity of an individual, and necessary boundaries of workload. Final goal is to point out the importance of respect of productivity on the individual level.

Deductive approach will be used. Below, the theoretical framework will be provided, by secondary data and desk research, linking the sociological and economic dimension of sustainable development with the productivity. Follows the explanation of the model principles as methodology used in this papers. The model will be presented, following with the conclusions.

II. CONCEPTUAL FRAMEWORK

The human always used the environment to satisfy his needs, but also adjusted it to them. However, with the sudden population increase during the 20th century, enlarged industrialization and urbanization, the environment couldn't absorb the human's harmful impacts according to Theis and Thompkin (2012). According to the same authors, the amount of environment exploitation was much larger than its capacity of renewal.

At the very beginning of the development of sustainable development concept, the human's and industrial negative influence on the environment was in the focus of the prevention, as well as the aim to determine the compromise between economic growth and environment protection.

Authors cite the Brundtland report in 1987, the environment and development commission refined the sustainable development „as meeting the needs of the present without compromising the ability of future generations to meet their own needs".

In the last two decades many different definitions of sustainable development were offered, and widespread is the one containing tree dimensions of the sustainable development: economic, ecologic and sociologic. „From this model, all three aspects must be considered in parallel in order to establish a balance between the replenishing rates of a system and the impact of activity that occurs within that system" according to Theis and Thompkin. Schmuck and Schultz (2002) provided the explanation for the three dimensions of sustainable development. The economic dimension covers the capital flow, trade, knowledge, abilities, competences, and individual's attributes important for the realization of the economic activities. Ecological dimension includes the recognition of the differences and interdependence of the ecosystems, protection of the natural goods and the negative influence of the society to the environment. Sociological dimension refers to interaction between the institutions, companies and individuals, human values, welfare and ethical questions.

According to the Mahdavan et al (2013) collection of essays, summary of the newest thoughts on sustainability is presented in Table 1.

TABLE 1 - THE OVERVIEW OF THOUGHTS ON SUSTAINABILITY

Author	Essay	Thoughts on sustainability
Simon Levin	Cooperation and sustainability	„It appeals to me as the fairest criterion for what we should demand of our environment, and my prescription for improving how sustainability must be addressed is that it needs to become more interdisciplinary, building partnerships across disciplines that at best have been independent of each other, and at worst have been at odds."
Robyn Beavers	Approaching the Future with Optimism	„I consider sustainability to be a description of any entity that can live, grow, and prosper in a closedloop system. The "entity" can be an economic process, an organization of people, a commercial or residential building, a vehicle, a consumer product, or a community."
Robert Atkinson	Innovation Economics: The Race for Global Advantage	„Sustainable development means to me a rapid and continuous growth in the standards of living of peoples around the world, particularly citizens of developing nations."
Meg Crawford	Unlocking the Energy of Business to Effect Change	„We need to generate more long-term thinking, which would underpin our ability to encourage decision makers – such as individuals, companies, and policy makers – to use resources and talent in ways that are sustainable rather than tied to short-term gains."
Matthew Taylor	Mind the Gap: A Different Take on Sustainability	„Sustainability means each of us having a better understanding of our behavioral dispositions and marshaling that knowledge in order to lead better, more fulling lives. As someone who leads an organization dedicated to achieving social progress and human fulfillment, sustainability and a consideration for past, present, and future generations have to be bound into every decision."
Kevin Finneran	Don't Sustain; Advance	„Sustaining implies preserving and maintaining, whereas development demands change. Therefore, the concept of sustainable development has an inherent tension that's difficult to reconcile."
Karabi Acharya	Changemakers for Sustainability	„Too often, I feel sustainability is "owed" by "environmentalists," which can feel exclusive. We talk so much about the ecosystems involved. But at its heart, sustainability is about people; people caring enough to act. We need to talk more about the people skills needed."
Mirjam Schöning	What Social Entrepreneurs Taught Me About Sustainability	„Sustainability means ensuring long-term survival by taking social, environmental, financial, economic, and political factors into account. Organizations and individuals should take a longer-range, full-lifecycle view when they make decisions about using natural resources and protecting the environment. Good stewardship is good business."

Source: Practicing sustainability (2013), authors' systematization

The individual plays a major role in the sustainable development concept conduction. With his choices and moral values system, affects the society and environment. According to Bartkevicius et al. (2008), if one wants to achieve in conducting the concept, has to create socially responsible society. The individual, as the basic unit of the society should be educated for the sustainable development in order to become moral, righteous, honest, unselfish and to respect the society and environment. Implementing education should result with understanding of the system of moral responsibility of human towards human, of human towards a society and of human towards the environment. According to the same authors, to achieve that, a focus should be set on relatively neglected social dimension of the sustainable development.

Bockermann at al. (2005) in modeling sustainability defined minimal conditions for sustainable development, as follows: **economic growth, domestic consumption levels, i.e. the standard of living, labor productivity, average working hours, total resource consumption (by key categories), and resource productivity**. In order to deliver a sustainable economy, a mix of economic, social, environmental and labor policy measures are required. The findings regarding social and economic perspective of sustainable development, as labor productivity and average working hours, support the socioeconomic approach of this paper.

Ayers (2008) observes sustainability economics from a resource economics point of view. In his papers, he points out a need for the integration of resource and environmental economics, emphasizing on human capital as a substitute for natural resources. The similar, resource perspective offers Haurie (2005) using game theory framework in order to assess the future generations gain as a discounted sum of future consumption. Approaching the labor issue from the resource perspective enables rational analysis of productivity, which is suitable approach for game theory modeling.

Spangenberg (1998, 2002) defined the environmental space and the prism of sustainability, naming the sustainability indicators. At the micro level, systems of indicators for households, companies and local communities have been developed. 'Environmental Space' offers a framework which is essentially based on social and environmental science-based policy targets.
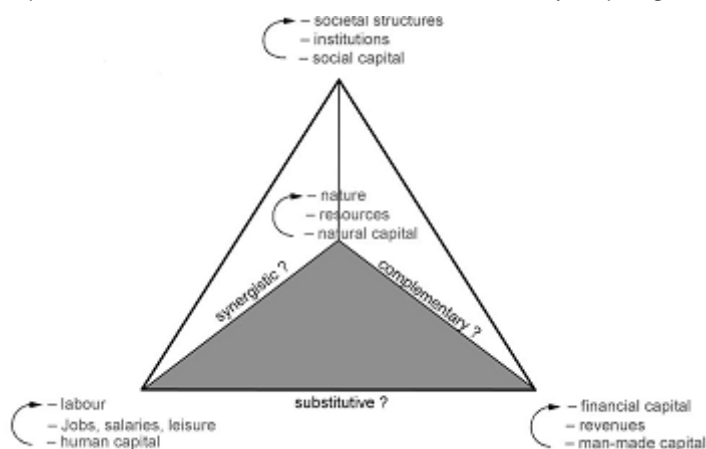

FIGURE 1: ENVIRONMENTAL SPACE

Source: Spangenberg 1998

Omann and Spangenberg (2002) assessed social sustainability. They noticed the lack of knowledge in this area. They were the first ones who offered the social criteria. According to Spangenberg (2002) „social sustainability focuses on the personal assets like education, skills, experience, consumption, income and employment". The authors cite UNDPCSD (1995, Hans Boeckler foundation 2001) where is made the conclusion that focuses of social sustainability should be quality of life, the possibility to sustain oneself, and all dependants on the basis of one salary. The social criteria they determined are:

1. Self-determined life style,

2. Satisfaction of basic needs,

3. A reliable and sufficient social security system,

4. Equal opportunities to participate in democratic society and

5. Enabling of social innovation and structuring of work types.

This qualitative description of socioeconomic approach in sustainable development places emphasis on individual. This is important prop for modeling the sustainability of employee productivity.

Noe, Ford (1992) claim that further research of employee development should be considered based on Schein's conclusion that „calls for suitable employee development programme were based on the recognition that organizations were becoming increasingly dependent on their human resources".

According to Bujas (1952), the labor automation organized to achieve the maximum of the production is not a rational solution and in long-term could do more harm than benefits. The same author claims that it is rational to allocate the workers according to their abilities, using the professional orientation, selection and appropriate professional education system using the professional lectures and trainings. The enlargement of the production is the main goal of professional enabling, because the quantity and quality of production depend on the worker's abilities.

After the knowledge that education and training is important for employee development and productivity, many researchers considered this topic. Barrett, O'Connell and Philip (1999.) discovered that although general training has positive effect on productivity, they found no such correlation for specific trainings. Using the ROI, Bartel (2000) found that the return of the investment in employee training is higher than it was perceived. Škare et al. (2013 – to be published) also made a conclusion that the rate of return from education is higher than it was perceived for the individual, but also for the government. Dearden, Reed and Reenen (2000) had similar conclusion after conducting a panel research in a British industries. Sahinidis, Bouris (2008) found that there is a significant correlation between the employee perceived training effectiveness and their commitment, job satisfaction and motivation, therefore indirectly exists impact on productivity. Many authors considered correlation between age and labor productivity, which Skribekk summarized in his papers (2003). Main conclusion is that due to higher experience employees can solve more demanding tasks which is correspondent to highest wage. The performance in routine tasks descends. Hellerstein and Neumark (1995.) noticed a general problem in age – productivity or a long term productivity investigations using a cross- sectional data, because those data does not take in count that trainings and seniority leads to occupational shifts and promotions for good employees while inefficient workers lose their jobs or are demoted. This conclusion confirms that the shifts in productivity can occur.

Heyman and Ariely (2004) suggested that there are two markets where a person exchanges his work for benefits, monetary and social market. They found that people sometimes expend more effort in exchange for no payment than they expend when they receive low payment. This is an important insight that could be applied on a workers in this papers, in a sense that they will trade their work for both monetary and social benefits depending on the wage, social gain (free time is one of them) and the trade of those two. Those findings are coherent with the request for economic and social development of an employee.

Providing a sustainable approach in defining an organization, Soyka (2012) offers the idea that employees want to have autonomy, and challenging working conditions. Moreover, author considers that company should help it's key employees to develop greater insight in challenges and to promote expansive and creative thinking about responses.

According to Weidinger et al (2014), due to constant change, uncertainty and insecurity, it is neccessary to apply true leadership, open innovation, entrepreneurial spirit to derive long-lasting success. The concept of corporate social responsability becomes the concept of sustainable entrepreneurship. „This new strategic positioning of businesses in society aims at increasing social and business added value at the same time (shared value)." The proposed balance between economic and social perspective is coherent with previous overwiev and the presumptions.

III. METHODOLOGY

Malthus (1798) was one of the first scientists who gave a thought on survival of the human population, their development and different impacts with reference to previously determined principles by Hume[2] and Smith[3]. Already then Malthus actually considered sociological dimension of the sustainable development, considering the role of the institutions on the preservation of the human existence. However, his most famous legacy is the „Malthus catastrophe", a model according to which the growth rate of human population is unsustainable given the existing low growth rate of food production. Malthus anticipated the overlapping point after which there will be no food for the population. Even though his predications turned out to be inaccurate, up to this day[4]it remains one of the most vividly models of the scarcity of resources. Almost two centuries later, Hardin (1968) relied on those premises in his papers on the need for the limitation of the population in scarce public good resources condition.

There is a similarity in a way that individuals treat the public good and the way the employers treat their employees. The public goods problem game considered Janssen and Ahn (2003), Fehr and Schmidt (1999), Rand et al. (2009), and in this papers we will refer to model The problem of commons, Gibbons (1992).

The model can be applied on the most forms of exploitation. It is extensive form of the „prisoner dilemma" model, conducted to a collective decision making. On one meadow of limited size, a few farmers takes their goats to graze. Only a limited number of goats can graze on the meadow. Each farmer has to decide on the number of the goats that he will have, such that

[2] In discussion on human nature, Hume (1739) claims that people pay attention and feel responsibility only towards private incentives, and simultaneously overexploit public goods. This attitude toward commons is often used as an analogy to sketch the attitude toward scarce goods.
[3] According to Smith (1776), the individuals who want to maximize their benefits are guided by "the invisible hand," that leads them to contribute concurrently to the society benefits in general.
[4] This idea is often used by Neo - Malthusians

meadow sustainability and life of all goats would not be harmed. Inspired by this static model of complete information, the boundaries of employee's productivity will be described.

A. The model

The players are all persons that want to acquire the share in time and the abilities of the employer[5]. We assume that the player is passive in this game[6]. The employer and employee's social contacts simultaneously choose a number of tasks to "burden" the employee. All players know how much tasks are available to choose. Hence, the rules of static game of complete information will be applied. The employer wants to arrogate maximal possible amount of employee's abilities and time shares, but keeping in mind that others in employees surroundings want to do the same. If he wants to achieve that, employer should maximize the employee's utility from economic perspective. Respectively, employee's social contacts should maximize social utility by their choice.

Let the productivity be the number of uniform tasks which require certain expertise level, and which employer can successfully accomplish with the given work time units[7].
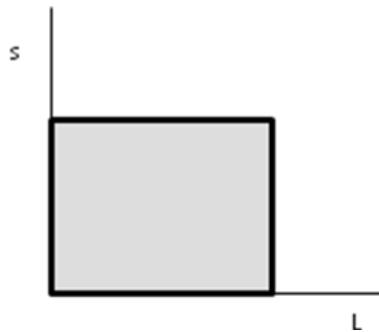

FIGURE 2. THE EMPLOYEE'S PRODUCTIVITY

Source: authors

The employer wants to choose the maximum load for the worker, but in the terms of sustainability. In fact, the employer does not want to load the worker for one day, in this game he wants to determine the best load amount that will give optimal results on the long run.

Let the task be equal to work time units necessary for the accomplishment multiplied by the level of the skills. The productivity of an employee is the sum of the tasks, with the given skill level[8]

$$A = a_1 + ... + a_i + ...a_n ,$$

(1)

with the cost of the task of c. The value/ benefit of the task for the employer and the company is

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[5] The employee's productivity extends to his complete time that he manages with the given level of skills, s. One part of his time the employee spends on his job, a part of his time he spends sleeping, and the rest of the time he initiates in other non- profit commitments with family, friends, volunteering, spare time and so on. The way in which those elements are combined should satisfy the social criteria (Spandenberg, Omann, 2002).

[6] The employee is not a player. The employee, in fact his time and his skills are the exploitation object by the employer and the other engaged in the employee's life. The employee if passive, just like a meadow.

[7] The space of employee's time units and skills can be thought of like the area of a geometric figure, for instance a square or rectangle that can be filled in with the assignments.

[8] In this part of the model, we will assume that the employee's skill level is given.

π(A). Given the every task subtracts a certain level of employee's time and skills, there is a finite number of the tasks that can be assigned to an employee. Therefore is true that is $\pi(A) > 0$ if $A < A_{\max}$, respectively $\pi(A) = 0$ if $A > A_{\max}$. Hence, if the workload is less than maximal, the employer will benefit from the accomplishing of the assignments. If the employer overloads[9] the employee with the tasks, his benefit from them will be equal to zero.

With regard that first few tasks have much more free space for execution, adding up one more task, will not significantly harm existing tasks. But, if there is a lot of tasks, namely too much, adding up one more assignment affects the execution of all the tasks. So, the function of the task value shows the diminishing returns and it is true

$$A < A_{\max}, \pi'(A) < 0, \pi''(A) < 0 \tag{2}$$

In a certain moment, the employer decides on the assignment number, given the assumption that assignments are divisible.
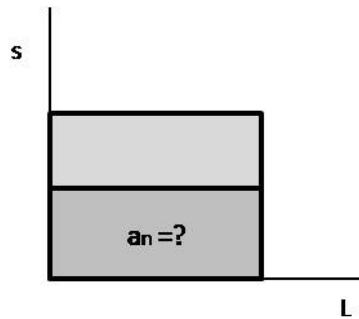

FIGURE 3: CHOOSING AMOUNT OF WORKLOAD

Source: authors

Observing the individual as a whole, the employer wants to choose the maximal feasible number of tasks, so the space of his possible strategies is set by $a_i = [0, \infty\rangle$, hence the set of feasible strategies is $a_i = [0, A_{\max}\rangle$. Beside the productivity boundary that employer intuits, he knows that employee could have commitments which are not related to work (family, hobby, education, volunteering, friends and so on). The employer wants to pick such a_i, which will tend to maximize the benefit of the tasks given the number of other tasks derived from the non-work commitments. The payoff to the employer from choosing a_i, with the given number of the other employee commitments[10] $[a_1, ... a_{i-1}, a_{i+1}, ... a_n]$, is equal to: $a_i \pi(a_1, ..., a_n) - a_i$.

[9] Within overload with the work assignments, the tiredness, stress, or collapse can occur, which make the employee incapable (temporally) for work.

[10] The expression could also be written as a_{-i}

If the space $(a_1^*, ..., a_n^*)$ is Nash equilibrium, than the employer, i, maximizes his payoff by choosing a_i^*, while choice of a_{-i}^* optimizes the employees non work related commitments. Therefore the essential requirement[11] of the optimization is conducted to

$$\pi(a_i + a_{-i}^*) + a_i \pi'(a_i + a_{-i}^*) - c = 0 \qquad (3)$$

$$\pi(A^*) + \frac{1}{n} A^* \pi'(A^*) - c = 0$$

From this follows[12]: $\qquad (4)$

The value of an additional task is

$$\pi(a_i + a_{-i}^*), \qquad (5)$$

with the given cost c. In the same time a damage to the existing tasks is made and it amounts

$$\pi'(a_i + a_{-i}^*) \text{ by task, or}$$

$$a_i \pi'(a_i + a_{-i}^*) \qquad (6)$$

in total.

According to model, it can be concluded that there exists a tendency to exploit the worker, just like the exploration of the public good in the original model which is obvious in $A^* \pi'(G^*)$.

If the certain work place or the company demands the execution of higher amount of tasks than the employee can obtain, the collapse will occur through the workers overload and decrease of the benefits. Yet, productivity is given by the labor units and skills. Considering it is obviously unsustainable to enlarge the task number given the limited time[13], it is necessary to refocus to the skills.

IV. RESULTS

Modeling new equilibrium solution due to employer productivity change

This model implies the representation from the different point of view. Individual worker productivity A is defined as a sum of all tasks that an individual can work off entirely with the given skill level and time period. The task function is

$$a = f(L) = s\sqrt{L}, \qquad (7)$$

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[11] The first order condition reflects the tendency of the employer who already set the task demand at a_1 task, to add one task more

[12] Substituting Nash Equilibrium, and dividing by n

[13] Moreover, most developed countries have laws that protect employees by restricting a number of working hours on weekly or monthly basis.

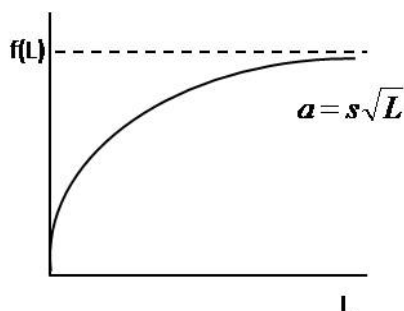and as it is obvious from the graph, it show the diminishing returns.

FIGURE 4. THE TASK FUNCTION

Source: authors

Insofar as the employer wants to load the worker by the higher task number depending only on the available time[14], he will face diminishing returns. The dashed line represents the carrying capacity of an employee. Crossing that line, the employer will face the collapse of the employees productivity, which has a consequence of expenses being higher than possible revenues.
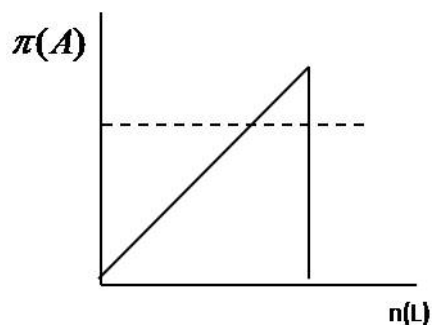

FIGURE 5. EMPLOYER'S PAYOFF FUNCTION

Source: authors

The maximal number of sustainable feasible assignments[15] also denotes the upper boundary of the domain of the function of the sustainable profit gain by the individual, respectively it is the amount after which the function reaches the tipping point. At the time, profit gained by the labor unit reaches its maximum, after which decreases rapidly. Hence, the enlargement in the tasks numbers at the individual level will not provide neither the company's, neither individual's prosperity. Moreover, such burden on the individual set by the company would be not just unsustainable, but also not rational.

At this point, the employer has the choice between hiring more workers for the required job, or

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[14] It can also be a choice of too big number of the assignments or choosing too difficult assignments that require more effort and time.

[15] It can be seen at the scheme that there is a possibility of crossing the boundary, but it is also obvious that it is in short term and unsustainable.

increasing the level of knowledge and skills of the existing employee. The decision should be in the spirit of the sustainability of company's development and consider the sociological and economical dimension, like lifelong education, satisfaction of worker's needs, unemployment decrease, expertise's and responsible job management. The most of the demands will be satisfied if we follow the second option, of increasing the skills level of employee.

The employees who perform the routine tasks in longer period, in time they improve in velocity of task performance, where the learning (whether in procedures or motor skills) happens trough the repetitions where the employee is his own teacher[16]. In this case, where the same sort of tasks is being performed, skill development will occur but not the increase in knowledge[17].
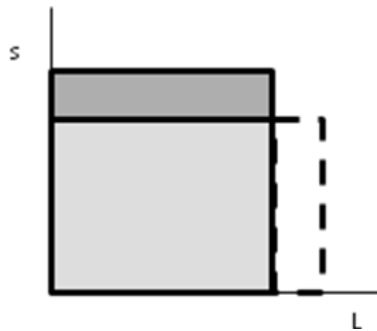

FIGURE 6. PRODUCTIVITY INCREASE

Source: authors

Observing the space of feasible tasks by the individual, it can be noticed that there are two ways in which the increase could occur: by adding up the units of time or by the increscent in the expertise level. Given that we have already proved that increscent in labor units is not the sustainable form of development[18], the employer remains with the option of employee's expertise increase. The difference achieved by the increase in expertise is shown in the darker rectangle in the scheme, and it means that the higher level of expertise will be applied in all future tasks and time units. Hence, investing in worker, the company permanently increases his productivity level. The employee will be capable to obtain more tasks, respectively, his marginal productivity will be higher. That means that contextual change occurred that caused the shift of the carrying capacity, respectively shift of tipping point to a higher level. According to that, new space of feasible assignments is:

$$A_s = A + \Delta A = \sum_{i=1}^{n} a_i + \sum_{i=1}^{n} \Delta a_1 = \sum_{i=1}^{n} s\sqrt{L_i} + \sum_{i=1}^{n} \Delta s\sqrt{L_i} = \sum_{i=1}^{n} \sqrt{L_i}(s + \Delta s)$$. (8)

The same change can be more vividly described in a graph.

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[16] It is the age – productivity effect..

[17] The exception is if the worker by his creative activity or the trial and error comes to an innovation. Then again, if it is innovation it cannot be a routine work anymore.

[18] It is displayed by the dashed line on the scheme.

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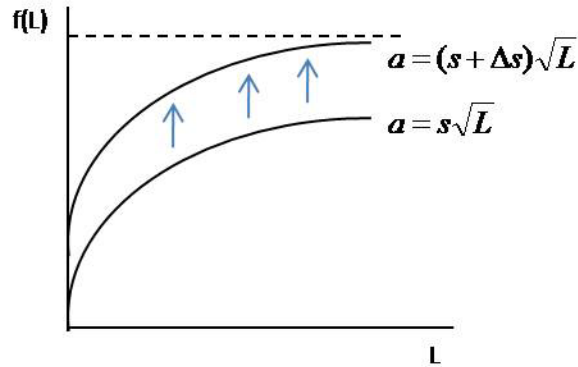$$a = (s + \Delta s)\sqrt{L}$$

$$a = s\sqrt{L}$$

FIGURE 7. THE SHIFT IN THE TASK FUNCTION

Source: authors

In order to achieve better understanding of the contextual change, in the next two schemes we will observe what happens if we assume that the increase in skills occurred in a certain moment in time.

First scheme shows a significant increase in productivity comparing the period before and after of expertise incensement time t.
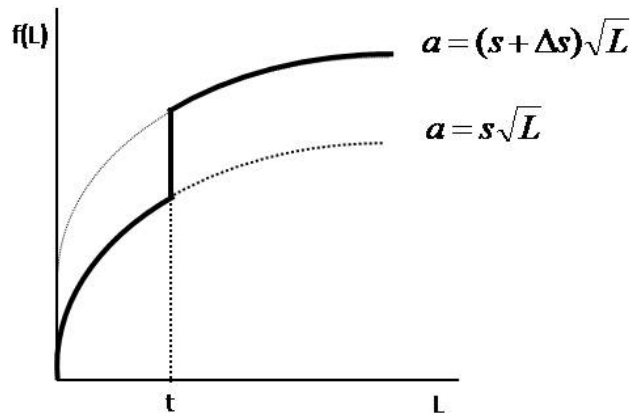

$$a = (s + \Delta s)\sqrt{L}$$

$$a = s\sqrt{L}$$

FIGURE 8. THE SHIFT IN THE TASK FUNCTION AT A CERTAIN POINT

Source: authors

The change manifests also in the function of the gain from every feasible assignment.

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[14] It can also be a choice of too big number of the assignments or choosing too difficult assignments that require more effort and time.
[15] It can be seen at the scheme that there is a possibility of crossing the boundary, but it is also obvious that it is in short term and unsustainable.
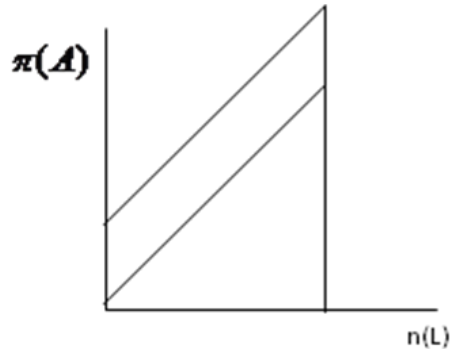
FIGURE 9. THE SHIFT IN THE EMPLOYER'S PAYOFF FUNCTION

Source: authors

If A_s is the new space of individuals productivity, then it is true

$$\pi(A_s^*) + \frac{1}{n} A_s^* \pi'(A_s^*) - c_s = 0 \quad , \tag{9}$$

where $\pi(A_s^*) > \pi(A^*)$, $\pi'(A_s^*) \leq \pi'(A^*)$, and $c_s \geq c$.

The contextual change that caused the shift in the tipping point, can be explained by comparison of the situations before and after. From the previous expression, follows that the value of an additional task after education/ training is $\pi(a_{\hat{s}} + a_{-i}^*)$, which is bigger than $\pi(a_i + a_{-i}^*)$, because $a_{\hat{s}} > a_i$. Within, the damage made to the existing tasks done with lower level of skills, compared to the previous damage of additional task is smaller, and it amounts $\pi'(a_{\hat{s}} + a_{-i}^*)$ for the task, respectively

$$a_{\hat{s}} \pi'(a_{\hat{s}} + a_{-i}^*) \tag{10}$$

in total.

After the establishing the change and explaining it, it is necessary to determine the equilibrium for the situation.

The employer chooses the new task amount a, which will maximize the benefit from the task given the employee's other tasks and commitments. The payoff to the employer from $a_{\hat{s}} = a_i + \Delta s$, with the given set of other employee's commitments and with the special deno-

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tation of higher level of qualifications $[(a_1 + \Delta s),...(a_{i-1} + \Delta s) \ (a_{i+1} + \Delta s),...(a_n + \Delta s)]$, is equal to:

$$a_{si}\pi(a_1,...,a_n)\Delta s - c_s a_{si}$$

(11)

The difference between the „after" and „before" payoff to the company is

$$\Delta s^2 + c - c_s,$$

(12)

what makes obvious the conclusion that the company gained profit by increasing its own payoff function by investing in employees.

If space of choices $(a_{s1}^*,...,a_{sn}^*)$ is Nash equilibrium, then, then choosing the assignments number i the employer maximizes his payoff by choosing exactly a_{si}^*, while the choice of other commitments a_{-si}^* optimizes the employees commitments not related to the work assignments[19]. Hence, necessary optimization condition is

$$\pi(a_{si} + a_{-si}^*) + a_{si}\pi'(a_{si} + a_{-si}^*) - c_s = 0,$$

(13)

and the solution is similar to the previous (4) one and it can be denoted as

$$\pi(A_s^*) + \frac{1}{n}A_s^*\pi'(A_s^*) - c_s = 0.$$

(14)

Also,

$$\pi(a_{si}^*) = c_s - a_i\pi'(a_{si}^*)\Delta s,$$

(15)

is valid, which shows that the cost of adding one new assignment must not be larger than the expense of unit of labor after gaining expertise, respectively this indirectly defines the equilib-

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[19] Given the higher competences are obvious in the work tasks, and extend to the spare time task, that could imply that the individual spends his total time more efficient that affects life satisfaction in general (which is consistent with the previously mentioned social criteria).

rium expense of investment in training. Moreover, the expression points out the cost of education invested in worker's competence as the investment, that returns in the form of revenue, but it can be lowered by adding up more assignments than the equilibrium amount. From this follows that the only sustainable enlargement in tasks in relations to the equilibrium amount from the previous period can be only $\Delta s L_i$, where the task amount grow due to increase in skills and not affecting the amount of time units of labor. This solution provides framework of the sustainable productivity of an individual with defining the necessary restrictions of the employee's overload. Exactly the respect for the long-term sustainability of socioeconomic development of an individual within the company, enables the employer achieving the socioeconomic development of the company, given the conditions fixed.

V. DISCUSSION

Even though it is intuitively clear that workers have their own boundaries and that their productivity is not unlimited, the very boundary is common matter of dispute of employees and employers. From the company's perspective, it is important to maximize the profit. From the employees perspective, the labor demand should be such that enable quality work but also the quality of the spare time and satisfaction of the social criteria given by the Bockermann et al. In order to combine these two demands, first is necessary to determine the quantity and quality of the work assignments in such way that they maximize the long-term worker's productivity. By maximizing sustainable productivity, overspill occurs extending the positive effects on social benefits. While maximizing the productivity, social benefits are also maximized. The boundary is defined such it provides higher life standard and quality time expenditure, higher labor productivity and economic growth of the company.

In modern times, more than ever, appears the need for establishing detail defined boundaries, in order to create the space of liberty for an individual. Given the boundary is set such that satisfies both side conditions, it is more likely that it will be respected by the companies.

Given the assumption that the worker's productivity is limited and the assumption that the level of productivity of the worker is variable, a game theory model has been constructed. In the first part of the model it has been proven that the worker's productivity is limited and that employee should obtain the boundary because it is tightly bonded to the company's profit. Without the respect for the boundaries, expenses for the employer occur. In the extension of the model, the influence of professional training on the increase in productivity was presented. Given it is proven that it is possible to increase productivity by professional education, by the other authors and additionally once again confirmed with this paper, we suggest this way as sustainable influence on productivity, respectively the company's profit.

The model pointed out that the increase in skills extends to entire individual's time, therefore it can be concluded that the additional expertise does not provide only higher work quality, but also a higher quality of spare time use. The model also points out that demand for the higher task amount than the equilibrium one is exploitation, an unsustainable and expensive way of business. Also, it turned out that cost of adding one new assignment must not be larger than the expense of unit of labor after gaining expertise, respectively this indirectly defines the equilibrium expense of investment in training. Application of this conclusion can be both theoretical and practical. In theory approach, the model provides systematization in the area of individual productivity from a sustainable socioeconomic development point of view and a base for further research. The conclusions can contribute the area of internal marketing and human resources.

Furthermore, practical application of the model can be used by the labor policy makers. Findings can help the employers in decision making on employment and workload for the employees.

This paper provides a different approach to the productivity, a sustainable development approach, using game theory to construct a simple model. Defined boundaries are justified by the social and economic criteria and indicators of the sustainable development. The equilibrium solution, the boundary enables the achievement of the sustainability of sociologic and economic development of the company, starting with the individual level.

The solutions set provides the framework for the long term and sustainable employee productivity by defining the necessary restrictions of the employee's overload. The importance of sustainability enforcements starts with the implementation on the individual level. The conclusion is that if the company encourages the sustainable socioeconomic development of the employees in the company, it might also initiate the socioeconomic development of the company. But, that topic remains open for further researches.

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