PRICE: 7,5 RON

Vol. XII., Nr. 92.

2009
DECEMBER SPECIAL ISSUE

Economist's Forum

RMKT

RMKT 2009

Editor: Hungarian Economist's Society of Romania

Scientific journal of the Hungarian Economist's Society of Romania and the Hungarian line of study of the Babeş–Bolyai University (Faculty of Economics and Business Administration)

ISSN 1582-1986
CNCSIS 755-2007 (C)

Contents

ECONOMIST'S FORUM

RMKT

Contents

An MRP-based integer programming model for capacity planning

LEVENTE SZÁSZ[1, 2]

Abstract

Capacity planning decisions represent an important topic in the operations management literature, as they greatly influence the performances of the firm and determine if the firm is able to satisfy market demand in each period. In order to be able to deal with uncertainties and fluctuations of market demand and other elements of the internal and external environment, capacity planning decisions are broken down into several levels of aggregation. This paper builds a general integer programming model for capacity planning at the master production scheduling (MPS) level. Input data and parameters for the model can be gathered from a typical MRP/MRP II-based information system. Using the integer programming model we can determine the optimal level of production capacities, at which operating costs are minimal. The last chapter of the article presents a case study, where we use the integer programming model built to investigate what cost reductions are possible by optimizing capacity levels at a small-sized firm from the textile industry.

Keywords: capacity planning, MRP/MRP II system, production planning and control, integer programming, master production schedule.

1. Introduction

Capacity planning and control decisions are one of the most fundamental decisions in operations management as they provide the capability of a company to satisfy current and future market demand. Additionally, capacity planning decisions provide a rigid framework and constraint for other operations and production decisions. In a continuously changing, dynamic environment firms face many uncertainties, like variable customer demand, and the management of these firms has to find a way to effectively deal with these uncertainty factors. In capacity planning the main factor that influences a firm's operational efficiency is fluctuating market demand. A firm can deal with demand uncertainties basically in two different ways on aggregate level (Vörös 2007): actively attempt to change demand patterns to fit capacity availability (1), or reactively adjust production capacities to deal with the fluctuations in demand

[1] „Invest in people!" PhD scholarship in „Project financed from European Social Fund through the Sectoral Operational Program Human Resources Development 2007–2013"

[2] Ph. D. candidate, Babeş–Bolyai University, Faculty of Economics and Business Administration.

(2). In this paper we will investigate the second option to deal with changes in demand. The second, reactive option includes two different capacity strategies: the firm can predict future demand fluctuations and set production capacity to a constant level, which still makes possible to fulfill market demand in each period, or it can attempt to follow the fluctuation of market demand by adjusting capacity levels in each period. In this article we try to build an integer programming model which follows the latter strategy and changes production capacity levels accordingly to market demand fluctuations.

In order to achieve this, in the second chapter we will demonstrate that capacity planning decisions play a crucial role in a firm's operations strategy and can have a major impact on a firm's overall production efficiency. In the third chapter we also briefly review these important capacity decisions are broken down into multiple hierarchical levels in order to find the best capacity configuration possible. The fourth chapter investigates the connection between production planning and control (PPC) information systems and the capacity planning process, highlighting those elements of a PPC system which can offer a high quality input data for capacity planning on the master production scheduling (MPS) level. Based on these input data, in the fifth chapter, we build a general linear programming model with integer variables for capacity planning on the MPS level. The sixth chapter contains a case study which uses the model built in the previous chapter to demonstrate in a real case that by determining the optimal capacity level the firm can improve the efficiency of its production system and the firm's overall performance.

2. The strategic role of capacity planning decisions

Capacity planning is an important part of operations strategy as it plays a critical role in the success of an organization. In operations management capacity planning problems are one of the most critical ones, since all other operations planning problems are managed within the framework of the capabilities set by the capacity plan. Production capacity decisions for new, expanding, and existing facilities have a direct impact on a firm's competitive position and resulting profitability (Hammersfahr et al. 1993). There are several reasons, which make capacity decisions one of the most fundamental decisions of strategic operations management (Stevenson 1996):

- Capacity decisions have a major impact on a firm's ability to meet future demand for products and services;
- There is a significant relationship between capacity and operating costs. Costs of over- and undersized capacity should always be taken into consideration in strategic planning.

• The strategic importance of capacity decisions also lies in the initial cost involved. Required production capacity is usually a major determinant of investment costs.

•The importance of capacity decisions stems from the often required long-term commitment of resources and the fact that, once they are implemented, it may be difficult or impossible to modify those decisions without incurring major costs.

Referring to the important role of capacity planning and controlling problems, other authors argue that the decisions operations managers take in devising their capacity plans will affect several different aspects of performance (Slack et al. 2007):

• Costs will be affected by the balance between capacity and demand. Capacity levels in excess of demand could mean under-utilization of capacity and therefore high unit costs.

• Revenues will also be affected by the balance between capacity and demand, but in the opposite way. Capacity levels equal to or higher than demand at any point in time will ensure that all demand is satisfied and no revenue is lost.

• Working capital will be affected if an operation decides to build up finished goods inventory prior to demand. This might allow demand to be satisfied, but the organization will have to fund the inventory until it can be sold.

• Quality of goods or services might be affected by a capacity plan, which involved large fluctuations in capacity levels, by hiring temporary staff for example. The new staff and the disruption to the operation's routine working could increase the probability of errors being made.

• Speed of response to customer demand could be enhanced, either by the build-up of inventories (allowing customers to be satisfied directly from the inventory rather than having to wait for items to be manufactured) or by the deliberate provision of surplus capacity to avoid queuing.

• Dependability of supply will also be affected by how close demand levels are to capacity. The closer demand gets to operation's capacity ceiling, the less able it is to cope with any unexpected disruptions and the less dependable its deliveries of goods and services could be.

• Flexibility, especially volume flexibility, will be enhanced by surplus capacity. If demand and capacity are in balance, the operation will not be able to respond to any unexpected increase in demand.

3. Main objective and structure of capacity planning decisions

Capacity planning is a very complex decisional process and, as we have seen, can have a major impact on a firm's competitive position. As the most important goal of capacity planning is to meet future customer demand, running a production system with sufficiently large capacities seems to be a priority. However, having too much capacity leads to underutilization of capacities and wasted capital costs, which weaken the competitive position of a firm. On the other hand, having less capacity than required in a certain period of time leads to unfulfilled market demand, which can damage the firm's public image and incurs the costs of lost sales. Therefore, over-utilization of capacities has also a negative impact on the firm's competitive position.

Thus, capacity planning involves delicate decisions, which balance between the two extremities illustrated above. Uncertainties regarding future market demand increase the difficulty of this problem. However, finding the optimal solution of capacity-sizing problems and expanding/reducing capacities at the right moment of time can significantly contribute to the efficiency of a production system.

In order to find an optimal, balanced solution, capacity planning decisions are usually made at multiple hierarchical levels in an organization, which involve different planning horizons. Usually, we can identify two major levels of capacity decisions, which are part of either the long-term, or the short-term capacity planning process (Krajewski et al. 2007, Wortman et al. 1996). Bahl (Bahl 1991) describes managerial decisions in capacity planning as a hierarchy of decisions, where capacity planning involves long-term decisions with a planning horizon of 3-10 years, while capacity adjustments and balancing involve medium-range decisions with a planning horizon of 1-3 years. In today's rapidly changing markets these numbers may seem somewhat rough and large, when flexibility and quick responsiveness to environmental changes is considered to be a key factor to market success. Still, the hierarchisation of these decisions shows the complexity of capacity planning process, involving different planning horizons. Long- term capacity planning decisions are also referred to as rough-cut capacity check (RCCC) or simply capacity planning, while short-term capacity planning is also referred to as capacity requirements planning (CRP) or detailed capacity planning (DCP) (Gupta et al. 2006, Wortman et al. 1996). The first category represents the planning process which decides how much of each capacity resource to install, while the second category allocates available capacity among different products or jobs (Balachandran et al. 1997). Actually, RCCC is a capacity availability check applied at the master production schedule level for longer-term planning purposes, while DCP is a capacity availability check applied to planned order releases for shorter-term planning purposes (Ding et al. 2007).

Another approach to these concepts suggests that the entire planning process is started from the highest level of product aggregation and it is continued until the lowest possible level of detail is reached. The typical hierarchy of plans involves different approaches to capacity planning at every level:

Table 1. Typical hierarchy of capacity planning decisions

	Aggregation level	Type of capacity planning
1.	Aggregate planning	Resource Requirements Planning (RRP)
2.	Master Production Scheduling (MPS)	Rough-Cut Capacity Planning (RCCP)
3.	Material Requirements Planning (MRP)	Capacity Requirements Planning (CRP)
4.	Shop floor control	Input-output analysis

Source: Diaz - Laguna 1996

According to the same authors, subdividing the capacity planning problem into hierarchical levels according to different degrees of aggregation has the advantage of increasing the tractability of the corresponding subproblems. In addition, these subproblems usually map to different responsibility levels of the organizational structures of most companies.

This paper focuses mainly on long-term capacity planning (Rough-cut capacity planning) and on the timing of capacity expansions/reductions, but in the case-study presented we include also some short-term considerations regarding capacity adjustments into the capacity planning model. Looking at the aggregation level we focus basically on the Master Production Scheduling level by performing a rough-cut capacity check. However, by including in our model the possibility to use overtime, we reach down in the hierarchy until the Material Requirements Planning level, and identify some adjustment possibilities on the level of different product types.

4. The role of information systems in capacity planning decisions

For an efficient capacity planning process there is a need for accurate information regarding (Naghi et al. 2009):

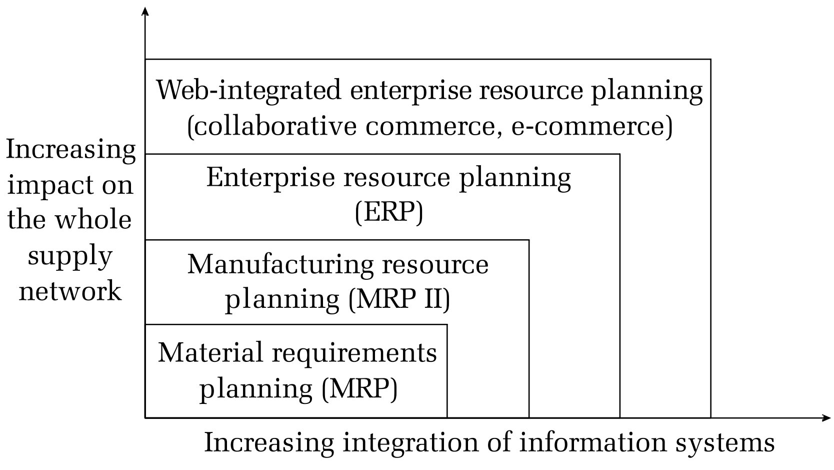
1. Quantities of expected future demand for different product types;
2. Duration and type of manufacturing processes needed (or „machine times") in order to produce the product types demanded;

3. Current capacities available regarding every type of manufacturing processes (or number of different machine types available);

4. Manufacturing costs on process level (monthly cost of maintaining and operating different types of machines, cost of labor force, cost of overtime etc.).

These information are needed to develop a capacity plan which enables the production of different product types - in the demanded quantity and at the lowest possible cost. This requires a capacity plan, which minimizes the cost of over- and underutilization of production capacities, but does not incur the cost of lost sales.

Information systems for production planning and control usually posses a database, which contains a major part of the information, needed as input for an efficient capacity planning process. As information solutions evolved starting from Materials Requirement Planning (MRP) systems, through Manufacturing Resource Planning (MRP II) systems, reaching the Enterprise Resource Planning (ERP) system's complexity, capacity planning techniques were tried to be included as part of these systems, with greater or lesser success. Original MRP systems aimed at efficient scheduling of production requirements so that raw materials, components and subassemblies can be provided in the right amount and at the right time (Ram et al. 2006). ERP systems today are the latest and the most significant development of the original MRP philosophy. The historical development of ERP systems can be followed on figure 1.



Source: Slack et al. 2007

Figure 1. The evolution of MRP-based production planning and control systems

Many authors state (Du - Wolfe 2000, Gould 1998), that one major problem of MRP-based information systems is that they mainly ignore capacity constraints, assuming infinite resources (machine capacity and labor). Capacity Requirements Planning (CRP) and its complementary systems at different levels of aggregation were added to MRP II systems and they tried to correct this situation by identifying under-utilization and overload conditions at a machine or manufacturing unit. Some authors report that even CRP systems in an MRP II environment provide only information regarding a capacity problem, but not a viable solution to the planner (Wuttipornpun - Yenradee 2004).

In this paper we develop a simple capacity planning system based on the 4 types of information, listed at the beginning of this chapter. Looking at an MRP/MRP II based information system as a set of algorithms and objects, the needed information is provided by the following parts (units, objects, data tables) of the system:

1. Fully functional MRP II systems include a unit, which supports the *sales and marketing function* of the company. This unit next to order entry and billing is also responsible for projecting, forecasting product demand based on historical data (Duchessi et al. 1989). Using powerful statistical tools they can provide vital input information for capacity planning regarding the expected demand of different product types. Having the expected demand we can build the future master production schedule (MPS), which is a prerequisite to perform the rough-cut capacity check (Diaz - Laguna 1996).
2. Machine types and machine times needed to produce the demanded types of products is included in the *operations list*. This describes the duration and sequence of tasks to be performed to produce a finished good or a fabricated component.
3. As MRP systems evolved to MRP II systems, a *larger database* was also created which included data not only referring to the type and quantity of materials needed in production, but also regarding the number of machines, types of capacities and labor force needed (Stegerean 2002). This information provides us the actual capacity constraints, which have to be taken into consideration during the capacity planning process.
4. The evolutionary process of MRP systems, illustrated on figure 1., also meant, that MRP II systems took over the role to tie the basic MRP system to the company's *financial system* and other core processes (Krajewski et al. 2007). This enables us to calculate the exact costs to maintain a unit of capacity (a machine), including the cost of capital, the cost of labor force and other incidental expenses.

5. An integer programming model for capacity planning

Using the information listed above we can formulate a general linear programming model, which rationalizes capacity utilization. We build this model based on a paper presented by the author and two co-authors on an international conference (Naghi et al. 2009), and we also add some minor modifications. The following model aims to minimize the total operating cost of the production capacity used, while satisfying market demand (lost sales are not allowed).

For a general linear programming model we first need to determine the values of the two parameters listed below:

- *ct* – the average number of days of order cycle times
- *th* – the average number of days after which the company can make decisions regarding capacity dimensioning.

With the help of these to parameters, we can find out how many orders occur over one capacity planning horizon (*T*), which is the average number of days in a capacity planning horizon (*th*) divided by the order cycle time (*ct*):

$$T = th / tc$$

For example in the case study presented in this paper we use the following time periods:

- Average order cycle time is one week – after receiving the placed order from the customer the company has one week to produce the demanded quantity
- Capacity planning time horizon is one month – the company can make capacity resizing decisions on a monthly basis

Having this information, the objective function of the linear programming model can be formulated as follows:

$$\min z = \sum_{t=1}^{T} \left(\sum_{i=1}^{n} x_i \cdot c_i + \sum_{i=1}^{n} x_i \cdot to_i^t \cdot co_i \right) ,$$

where the elements of the objective function denote the following quantities:

z – objective function value that has to be minimized; *z* represents the total cost needed to operate the production capacities (machines) per month (both in regular time and overtime);
t – current index of order cycle time
T – number of order cycle times in one capacity planning time-horizon
i – index number denoting the current machine type
n – number of machine types used by the company

x_i – represents the vector of the decision variables (X), which contains the current number available of every i[th] type production equipment needed in a month ($i = \overline{1, n}$):

$$X = [\, x_1, x_2, \ldots, x_n \,];$$

c_i – stands for the operating cost of the i[th] machine type in regular time during one order cycle time. Here we include all of the expenses which would not become due in case of the machine was not used.

If the i[th] machine type is rented or leased by the company over the planning horizon c_i can be calculated as follows:

$c_i =$ rent or lease payment per week +
cost of labor force needed to operate the machine per week +
average incidental costs per week (maintenance costs, repairing costs etc.).

In case the i[th] machine type is not rented or leased, we assume that it was purchased by the company to be used for a certain period of time (useful lifetime of the machine). In this case the price of the machine can be converted into equivalent payments in every order cycle time, using an annuity formula, dispersing the investment costs over the lifetime of the machine. We can determine these payments by using the annuity formula, given below (Brealey - Myers 2005):

$$PV = C \cdot \left(\frac{1}{r} - \frac{1}{r \cdot (1 + r)^t} \right), \text{ where}$$

PV – present value of the annuity (C yearly payments), in our case the amount of the initial investment (the price of the machine)

C – yearly payments

r – average cost of capital used by the company for evaluating investment options

t – useful lifetime of the machine

Expressing the value of C from the formula above and dividing it by the number of order cycle times in a year (denoted by cty), we get the amount of weekly payment (c_i) equivalent with the initial purchase price of the machine:

$$c_i = \frac{1}{cty} \cdot \frac{PV}{\left(\frac{1}{r} - \frac{1}{r \cdot (1 + r)^t} \right)} .$$

The remaining elements of the objective function denote the following quantities:

to_i^t – average number of hours worked in overtime by the i[th] machine type in period t. Overtime decisions during the capacity planning horizon can be represented by the following TO matrix ($t = \overline{1, T}$ $i = \overline{1, n}$):

$$TO = \begin{bmatrix} to_1^1 & \dots & to_n^1 \\ \vdots & \ddots & \vdots \\ to_1^T & \dots & to_n^T \end{bmatrix}$$

co_i – cost of operating the i[th] machine type in overtime per hour, including only the cost of labor and incidental expenses, excluding rent or lease payment.

We want to minimize the objective function, subject to the following constraints:

5.1. Monthly demand constraint

$$\sum_{j=1}^{m} D_j^t \cdot h_{ji} \le x_i \cdot (tr_i + to_i^t) \quad i = \overline{1, n}; \ t = \overline{1, T}$$

m – number of product types manufactured by the company

D_j^t – quantity demanded of the j[th] product type in period t. The forecasting module of the production planning and control system should provide the projection of demand for the following capacity planning period for each product type, which can be written in the following matrix (D) form ($t = \overline{1, T}$ $j = \overline{1, m}$):

$$D = \begin{bmatrix} D_1^1 & \dots & D_m^1 \\ \vdots & \ddots & \vdots \\ D_1^T & \dots & D_m^T \end{bmatrix}$$

h_{ji} – manufacturing hours needed on the i[th] machine to produce the j[th] product type ($j = \overline{1, m}$ $i = \overline{1, n}$)

$$H = \begin{bmatrix} h_{11} & \dots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{m1} & \dots & h_{mn} \end{bmatrix}$$

Every row of the matrix above represents the operations list for different product types, indicating how much operation time a certain product requires on different machines.

tr_i – total regular operating time available for machine i in a week, which remains constant during one capacity planning horizon ($i = \overline{1, n}$)

$$TR = [tr_1, tr_2, ..., tr_n]$$

Regular operating time per week can be calculated as:

tr_i = (number of working days in one order cycle period) ×
× (available working hours for machine i per day).

The demand constraint expresses that there has to be enough capacity during every period to fulfill the demand by producing in regular time and in overtime.

5.2. Overtime constraint

$$to_i^t \leq tr_i \cdot otl\,(\%) \quad i = \overline{1, n}\,;\; t = \overline{1, T}\,, \;\; where$$

$otl(\%)$ – the maximum limit of overtime per period, expressed as a percentage of regular operating time per period. The value of this maximum limit can be determined according to the regulations of the current legal system regarding labor force or can be found in a contractual framework with the workers or syndicate.

5.3. Non-negativity constraints

$$x_i \geq 0 \quad i = \overline{1, n}$$

$$to_i^t \geq 0 \quad i = \overline{1, n} \quad t = \overline{1, T}$$

The value of every decision variable should be greater than or equal to zero.

5.4. Integer constraint

$$x_i \; integer \qquad i = \overline{1, n}$$

The value of the x_i decision variable, representing the number of type i machines should have an integer value. By introducing this latter constraint we transform the linear programming problem into an integer programming model.

Summarizing the integer programming model built in this chapter we get:

Decision variables:

$X = [x_1, x_2, ..., x_n]$ – number of machines of different types

to_i^t - overtime decisions (hours) for each machine type and each period of the capacity planning horizon ($t = \overline{1, 4}$ $i = \overline{1, n}$):

$$TO = \begin{bmatrix} to_1^1 & \dots & to_n^1 \\ \vdots & \ddots & \vdots \\ to_1^T & \dots & to_n^T \end{bmatrix}$$

Parameters:

c_i – one period's operating cost for machine i in regular time

co_i – one period's operating cost for machine i in overtime

D_j^t – projected demand for product j in period t

h_{ji} – manufacturing time for product j on machine i

tr_i – total regular operating time available for machine i per period

$otl(\%)$ – maximum limit of overtime per period, expressed as a percentage of regular time available

t – current number of period within the capacity planning horizon

n – number of different machine types used by the firm

m – number of different product types produced by the company

Objective function:

$$\min z = \sum_{t=1}^{T} \left(\sum_{i=1}^{n} x_i \cdot c_i + \sum_{i=1}^{n} x_i \cdot to_i^t \cdot co_i\right) ,$$

Subject to:

$$\sum_{j=1}^{m} D_j^t \cdot h_{ji} \leq x_i \cdot (tr_i + to_i^t) \quad i = \overline{1, n}; \; t = \overline{1, T}$$

$$to_i^t \leq tr_i \cdot otl\ (\%) \quad i = \overline{1, n}; \; t = \overline{1, T}$$

$$x_i \geq 0 \quad i = \overline{1, n}$$

$$to_i^t \geq 0 \quad i = \overline{1, n}; t = \overline{1, T}$$

$$x_i \text{ integer}$$

6. Case study

In the present case study we analyze some aspects of the capacity planning process at a Romanian small-sized enterprise from the textile industry, based on a paper presented on an international conference (Naghi et al. 2009). The firm executes textile operations on a make-to-order basis, working in „lohn" system. The „lohn" production system means that materials, parts, subassemblies and semi-finite products needed to execute the production process are delivered by the customer, who places the order. In such a system basic MRP tasks like material handling, inventory control and procurement are handled by the customer.

After only six months of operations the firm was forced to declare bankruptcy, due to the extremely high operating expenses. In the present case study we analyze if the firm – using the capacity planning model presented in the previous chapter – could have improved the efficiency of the production system by rationalizing capacities and decrease operating expenses.

6.1. Production resources

Looking at the material resources used by the firm these were specific to the textile and clothing industry. All types of material resources were delivered by the client, who was responsible for shipping the right quantity at the right time for the firm. The effect of the "lohn" system on the cost-structure of such a firm can be easily understood if we look at the percentage of material costs related to the total costs of the firm in one period. Using data from the monthly income statement of the firm we can calculate the average value of this ratio over the lifetime of the firm, which was equal to 0.545%, a percentage that can be considered insignificant.

Having such low material costs, machine operating costs and the cost of labor accounted for a major part of the firm's total expenses. Consequently, capacity decisions were a major determinant of the firm's overall performance. The firm was using 10 different types of machines (for simplicity let us denote them with capital letters: A, B, ... , J), each of them requiring one qualified worker. The machines were rented on a monthly basis (for a fee of 50 RON/equipment/month). The actual number of different machine types is presented in the table below:

Table 2. Number of different machine types used by the firm

	A	B	C	D	E	F	G	H	I	J
No. of machines	2	2	1	1	10	4	1	3	1	1

Source: own calculations

6.2. Parameters of the integer programming model

As capacities were rented on a monthly basis, the length of the planning horizon is set to one month, and average order cycle time was one week. Therefore, the value of T (number of weeks in a month) is set to 4.

The number of different machine types: $n = 10$.

The number if different product types produced by the company: $m = 6$. Further on, we will denote the different product types with *T1*, *T2*, *T3*, *T4*, *T5* and *T6*.

To construct the master production schedule (MPS) we use order entries from the month with the maximum demand. Having the order entries of this month we construct the MPS, indicating produced quantities for each week and each product type:

Table 3. Master production schedule for a month

MPS	T1	T2	T3	T4	T5	T6
Week 1	0	0	0	72	360	138
Week 2	0	383	0	107	0	0
Week 3	216	336	0	0	0	0
Week 4	312	0	297	0	0	0

Source: own calculations

Data from the table above represent the values of the *D* matrix, containing the produced quantities of every product *j* in week *t*.

To construct the operations list, which contains the duration and type of operations needed for every type of product, we use the technological descriptions of the production process for every product type. The table below contains manufacturing times in minutes for one unit of each product type on each machine. If a certain machine is not needed to produce a certain product type, manufacturing time is set to zero.

Data from the 4. table represent the values of the *H* matrix containing values of h_{ji} ($j = \overline{1, m}$ $i = \overline{1, n}$) – manufacturing time needed for product *j* (in columns) on machine *i* (in rows).

Total regular operating time in a week for each machine (tr_i), expressed in minutes is equal to:

Days in a week:	5	
Effective operating hours:	7	
Minutes/hour:	60	
	2100	min.

Table 4. Manufacturing times (minutes)

		Product type					
		T1	T2	T3	T4	T5	T6
Machine type	A	3.904	7.861	0.000	1.202	2.372	1.657
	B	4.075	0.301	0.869	1.109	1.365	1.109
	C	5.240	4.831	0.000	3.911	3.911	3.911
	D	0.329	0.329	0.000	0.329	0.329	0.329
	E	19.759	19.970	6.675	11.697	12.940	11.697
	F	0.000	3.857	1.779	1.039	2.519	2.960
	G	1.260	0.630	0.000	1.260	1.260	1.260
	H	5.155	10.313	7.962	9.024	10.819	10.619
	I	0.000	0.000	0.000	2.252	3.770	2.252
	J	0.000	0.000	0.000	2.162	2.131	2.162

Source: own calculations

Note that the effective operating hours are less than 8 hours per day, due to 30 minutes maintenance time and a 30 minute lunch-break. Regular operating time is equal to 2100 minutes for every type of machine:

$$tr_i = 2100 \text{ min} \quad i = \overline{1, n}$$

The maximum limit of overtime is set to 10% of regular operating time per week (*otl(%)=10%*), which is equal to a maximum of 3.5 hours overtime per week.

Calculating weekly operating costs for the different types of machines includes the cost of capital, cost of labor force needed to operate a machine and the cost of maintenance and breakdowns. Supposing that monthly rent is 50 RON/machine, monthly gross salary of one qualified worker is 900 RON and maintenance costs are 50 RON/machine, total operating cost per machine in regular time can be calculated as follows:

Rent per week:	12.5	+
Labor cost per week:	225	
Maintenance cost per week:	12.5	
	250	RON

In our case total weekly operating cost is the same for each type of machine. Therefore, regular operating costs are equal to 250 RON for every machine:

$$c_i = 250\ RON \quad i = \overline{1, n}$$

Overtime operating costs for each machine type will include only the cost of labor (which is 25% higher than in regular time) and the additional cost of maintenance. We calculate overtime operating cost per minute, since values of to_i^t – total overtime of one unit of machine *i* in week *t* are also expressed in minutes.

Labor cost per minute:	0.117 +
Maintenance cost per minute:	0.005
	0.122 RON

Note that labor cost per minute in overtime is 25% higher than in regular time. Overtime operating costs are constant for every machine type.

$$c_i = 0{,}122\ RON \quad i = 1, n$$

6.3. Building and solving the integer programming model

Having all the parameters calculated as seen above we can build an integer programming model to search for the optimal capacity planning decision at our firm.

Objective function:

$$\min z = \sum_{t=1}^{4} \left(\sum_{i=1}^{10} x_i \cdot 250 + \sum_{i=1}^{10} x_i \cdot to_i^t \cdot 0.122\right)$$

Subject to:

$$\sum_{j=1}^{6} D_j^t \cdot h_{ji} \le x_i \cdot (2100 + to_i^t) \quad i = \overline{1, 10};\ t = \overline{1, 4}$$

$$to_i^t \le 2100 \cdot 10\% \quad i = \overline{1, 10};\ t = \overline{1, 4}$$

$$x_i \ge 0 \quad i = \overline{1, 10},\ x_i\ integer$$

$$to_i^t \ge 0 \quad i = \overline{1, 10};\ t = \overline{1, 4}$$

Left-hand side parameters and the optimal right-hand side values (for each machine *i* and each week *t*) of the first constraint can be found in the Appendix.

By calculating the optimal solution to this linear programming model (for example with Microsoft Excel's Solver function) we get the optimal values of the decision variables (number of machines, quantity of overtime used) at which the value of total operating cost per month (z) is minimal.

The table below contains the optimal integer values for each machine type to be used (x_i):

Table 5. Optimal number of different machine types

	A	B	C	D	E	F	G	H	I	J
No. of machines	2	1	2	1	5	1	1	3	1	1

Source: own calculations

This optimal solution requires an overtime of 95.57 minutes in week 3 only for machine E, which means that:

$$to_5^3 = 95.57 \text{, and}$$

$$to_i^t = 0 \quad i = \overline{1,10}\,;\ t = \overline{1,4} \text{ where } i \neq 5 \text{ and } t \neq 3$$

Using the optimal values of the decision variables we calculate the optimal value of the objective function:

$$z = 4558.49 \ RON$$

Hence, total operating cost of capacities in a month (including regular and overtime) is equal to 4558,49 RON, from which:

- Regular time cost = 4500 RON
- Overtime cost = 58.49 RON

To evaluate what improvements this model could have brought to the firm, we calculate the total operating cost per month based on the initial capacity configuration (see *Table 2*) in which case the z value equals 6500 RON. This value is much higher then the optimal objective function value, meaning that an almost 30% cost decrease would have been achievable (-29.87%). It is not sure if this cost reduction could have been the most critical factor to avoid bankruptcy, but it substantially improves the efficiency of the production system, increasing the competitiveness of the firm.

The model can also be used to make optimal decisions about the timing of capacity expansions or reductions. By running this linear programming model for several consecutive months the decision maker can follow the optimal level of capacities for each period and decide about expanding it or – as in our case – reducing it.

7. Conclusions

In the present paper we reviewed the main challenges of the capacity planning process and argued that capacity decisions can greatly influence the overall performance of a firm. We analyzed the structure and hierarchy of capacity planning decision and identified information (input data) needed to perform the capacity planning process.

Based on the information provided by an MRP/MRP II based production planning and control system we developed a linear programming model with integer variables, which determines the optimal dimension of production capacities by minimizing total operating costs. As demonstrated in the case study, this model can be used to bring substantial improvements to the efficiency of a production system and can also help decision makers to make optimal decisions about capacity expansions or reductions at the right moment of time. In this latter case the integer linear programming model has to be run using as input data the master production schedules of several future time periods. The model indicates the optimal capacity levels for each period; however, it does not determine the optimal capacity dimension for a longer period of time.

Still, one of the model's most important limitations is that it executes capacity planning only on an aggregate level, by making a rough-cut capacity check based on the master production schedule. The model does not take into account other parameters from a lower level of aggregation, like lot sizing rules, setup times or bottleneck capacities. However, it takes into consideration the possibility of a firm to use overtime production. The model can be further refined by adding other constraints, reaching down to lower levels of aggregation and including other special costs like setup costs.

Appendix

1. The matrix of the necessary machine times for each machine type in each week to satisfy market demand (Left-hand side values of the first constraint, L):

Machine	A	B	C	D	E	F	G	H	I	J
Week 1	1169.1	724.3	2229.3	187.5	7114.8	390.1	718.2	6010.0	1830.1	1221.2
Week 2	3139.4	233.9	2268.8	161.2	8900.1	1588.4	376.1	4915.4	241.0	231.3
Week 3	3484.6	981.3	2755.1	181.6	10977.9	1296.0	483.8	4578.6	0.0	0.0
Week 4	1218.0	1529.5	1634.9	102.6	8147.3	528.4	393.1	3973.1	0.0	0.0

Every element of the matrix above is calculated as follows:

$$L_{ti} = \sum_{j=1}^{6} D_j^t \cdot h_{ji} \quad i = \overline{1,\ 10};\ \ t = \overline{1,\ 4}$$

2. Available machine times per machine type in each week, in case of optimal capacity configuration - assuming optimal number of different machine types (see Table 5)

(Right-hand side of the first constraint, R):

Machine	A	B	C	D	E	F	G	H	I	J
Week 1	4200	2100	4200	2100	10500	2100	2100	6300	2100	2100
Week 2	4200	2100	4200	2100	10500	2100	2100	6300	2100	2100
Week 3	4200	2100	4200	2100	10977.9	2100	2100	6300	2100	2100
Week 4	4200	2100	4200	2100	10500	2100	2100	6300	2100	2100

Every element of the matrix above is calculated as follows:

$$R_{ti} = x_i \cdot (2100 + to_i^t) \quad i = \overline{1,\ 10};\ \ t = \overline{1,\ 4}$$

References

Bahl, H.C. - Taj, S. - Corcoran, W. 1991. *A linear-programming model formulation for optimal product-mix decisions in material-requirements-planning environments.* International Journal of Production Research, 29(5), 1025-1034.

Balachandran, B.V. - Balakrishnan, R. - Sivaramakrishnan, K. 1997. *Capacity planning with demand uncertainty.* The Engineering Economist, 43(1), 49-71.

Brealy, R. - Myers, S. 2005. *Principles of corporate finance.* Hungarian edition, Panem, Budapest.

Diaz, B. - Laguna, M. 1996. *Modelling the load levelling problem in master production scheduling for MRP systems.* International Journal of Production Research. 34(2), 483-493.

Ding, F.-Y. - Raghavan, B. - Pollard, S. 2007. *Supplier capacity analisys for a manufacturing firm with case study.* Production Planning & Control, 18(6), 514-525.

Du, T.C. - Wolfe, P.M. 2000. *Building an active material requirements planning system.* International Journal of Production Research. 38(2), 241-252.

Duchessi, P. - Schaninger, C.M. - Hobbs, D.R. 1989. *Implementing a Manufacturing Planning and Control Information System.* California Management Review. 31(3), 75-90.

Gould, L.S. 1998. *Introducing APS: getting production in lock step with customer demand.* Automotive Manufacturing & Production. 110(5), 54-59.

Gupta, A. - Lödding, H. - Tseng, M.M. 2006. *An approach of capability representation for improving capacity planning.* International Journal of Production Research, 44(17), 3419-3431.

Hammersfahr, R.D. - Pope, J.A. - Ardalan, A. 1993. *Strategic planning for production capacity.* International Journal of Operations & Productions Management, 13(5), 41-54.

Krajewski, L. - Ritzman, L. - Malhotra, M. 2007. *Operations management. Processes and value chains.* Prentice Hall, New Jersey.

Naghi, M. - Stegerean, R. - Szász, L. 2009. *Reorganizing the production system for increasing competitiveness.* Managerial Challenges of the Contemporary Society – international conference, 29.05.2009, Cluj-Napoca, Romania.

Ram, B. - Naghshineh-Pour, M. R. - Yu, X. 2006. *Material requirements planning with flexible bills-of-material.* International Journal of Production Research, 44(2), 399-415.

Slack, N., Chambers, S., Johnston, R. 2007. *Operations management.* Pearson Education Limited, Harlow, Essex, England.

Stegerean, R. 2002. *Sisteme moderne de conducere a producţiei.* Editura Dacia, Cluj-Napoca.

Stevenson, W.J. 1996. *Production/operations management.* Irwin, Chicago.

Vörös, J. 2007. *Termelési-szolgáltatási rendszerek vezetése.* Janus Pannonius Egyetemi Kiadó, Pécs, Hungary.

Wortman, J.C. - Euwe, M.J. - Taal, M. - Wiers, V.C.S. 1996. *A review of capacity planning techniques within standard software packages.* Production Planning & Control, 7(2), 117-128.

Wuttipornpun, T. - Yenradee, P. 2004. *Development of finite capacity material requirement planning system for assembly operations.* Production Planning & Control, 15(5), 534-549.

Return to schooling in Hungary before and after the transition years

MELINDA ANTAL[1]

Abstract

In this paper, I compared the return to schooling in Hungary by using datasets available from the Hungarian Wage Survey carried out in 1986 and in 2000, with more than 600 thousand observations altogether. The results are in conformity with the expectations and other empirical researcher's works, showing an increase in the return to schooling of 74% in these 14 years, and large increases in returns to education for those who attended a high school or a university/college. The lower positioned education levels didn't bring significant changes in their premiums, this fact being one of the most plausible explanations why attendance to vocational schools dropped so dramatically after the communism collapsed. I also searched for explanations and solutions for the puzzle: why changes occurred in these 14 years, highlighting some possibilities which could be used as extension to the present work, solving the data selection problems faced with the current dataset.

Keywords: return to schooling, wage inequality/ differentials, human capital, transition economies, Hungary

I. Introduction

Hungary in many aspects is similar to the other neighboring countries, especially in what concerns the evolution of the educational and academic system and also of the youth labor market. In the past twenty years there was a huge increase in demand for schooling in Europe, and especially in the Center-Eastern European countries. The education system in this part of the world changed very rapidly and enormously in a relatively short time period – for example many teachers switched from preaching about socialist ideologies to apostolate about free markets and capitalism. Step by step, the mechanism of the whole system became more market oriented, serving the needs of those who enrolled and those who were anxiously searching for young professionals to grease the wheels of their own businesses. Universities, grad schools or even post graduate schools face higher number of applicants each year, while the vocational schools became less preferred, among applicants. Many say it is a fashion to go to university, but the true underlying reason may be in the fact, that the premium of schooling has increased, and young people actually realized this before any other policy or advertisement of a university.

Empirical research has been conducted in many instances about the same or similar topic using evidence from Hungary and neighboring countries. It

[1] Central European University, Budapest, Hungary

has been done with data from more years, or including variables with the most different purposes. The present paper aims to reanalyze the findings of some highly respected researchers, like Campos and Jolliffe (2007), with a larger dataset, but highlighting only two important years of this process: 1986 – the pre-transition year, when not even the most progressive society form the Soviet bloc opened itself for reforms, and 2000 – when the transition period came near to its end, not like in Romania, Bulgaria or Ukraine. The first year analyzed is characterized mostly by wages set below equilibrium, equalitarian distribution of income and artificially compressed returns to skill. But the most interesting aspect of that era lays in the fact that unemployment in that time was something inadmissible from the society's point of view; hence there is a very little proportion of the labor force that didn't enter the labor market. To understand, what happened beneath the increase of enrollment to school ratios, it is important to calculate the rate of returns to different schooling levels in at least two time periods, that aren't close to each other, but also being aware of the social, constitutional and professional dissimilarities between the two eras. I expect to find an increase in the return to every educational level, especially for the higher ones, increase in the premium of an additional year of education, and a smaller return to school of those cohorts who graduated after 1989. The latter expectation is based on the general opinion in Hungary, that people graduating after the communism are not so well prepared, because of the reduction in government expenditures on education and because the changes occurred in the curricula, especially in the fields of mathematics, engineering or other technology related sciences.

II. Data and empirical specification

I will carry out my empirical analysis using data from the Hungarian Wage Survey, covering two years, 1986 and 2000, with a total of 664 815 observations. To gather evidence for the expectations expressed above, I will pursue with three methods: (1) by computing the rate of return to an additional year of schooling; (2) by computing the rate of return to every level of education in the two periods; (3) by examining those people's return to schooling, who graduated just before the data collection. The sample for the year 1986, used in my empirical analysis, grasps almost entirely the true distribution of the population and their wages. The 1.a Figure illustrates the kernel density of the log of real wages from 1986, while Figure 1.b shows the same density from year 2000. It can be seen, that the first one – as expected – has a lognormal distribution, being skewed to the right, meaning that there is a larger proportion of those workers, who earn less (below the median and average), than those who earn very much compared to average. The second figure, on the other hand, shows a two mode distribution, meaning that the population is heterogeneous. The explanation would be that in 2000 there were not present the same constraints for working, each individual could choose freely between entering the job market and staying out. If the return of the owned skills or education was too small, one had the option to not participate in 2000, not like in the communist era, when the unemployment was seen as a major prejudice brought to the entire society. Hence the sample for 2000 doesn't contain those who have chosen not to participate in the labor market, making the sample selection bias an issue present in the estimations from this year.

To estimate the wage equations I used the standard Mincer equation:

$$log(w_i)=\beta_0 + \beta_1 S_i + \beta_2 EXP_i + \beta_3 EXP^2 + \beta_4 X_i + u_i \qquad (1)$$

Here S stands for years of schooling, EXP[1] is the potential experience, while X can stand for demographic or institutional characteristics, as well for spatial price differences. Because the data is pooled, for X I included a gender dummy, that is 1 for females and zero otherwise, to be able to capture also the dynamics of the gender gap in wages. The left hand side variables in every case will be the log of real gross monthly earnings, (in 2005 forints) including base salary and other pecuniary items of worker compensation, like regular bonuses, premiums, overtime pay, allowances, etc. and 1/12 of last year's irregular premium and bonuses (incl. 13th month salary e.g.). Experience is a crucial factor, which needs to be included, but because of its difficult characteristic, it is something often asked in the questionnaires through indirect tools. The present work will rely on potential experiences, which are calculated as follows:

Potential experience = Age of the individual – 6 years[2] – the years needed to fulfill the given schooling level.

In the second part of my work, to be able to analyze the evolution of the returns to different educational levels, I used an extension of the previous standard Mincer equation:

[1] Experience is included in simple and also in quadratic form to be able to show if there is a diminishing return of experience. The suspicion that experience is not a variable which influences wages linearly is quite a common thought, but it will gain no importance if the maxima of the function will not lie between reasonable time intervals (e.g. between the age of starting a career and retirement).

[2] The average age when a Hungarian child goes to school.

$$log(w_i)=\beta_0 + \beta_1 ELEM_i + \beta_2 VOC_i + \beta_3 HIGH_i + \beta_4 UNI_i + \\ + \beta_5 EXP_i + \beta_6 EXP^2 + \beta_7 FEMALE_i + u_i \qquad (2)$$

In the above equation I included 5 categories of highest individual educational level: ELEM – elementary, VOC – vocational, HIGH – high school and UNI – university or college[3]. The other explanatory variables are the same as described in previous paragraphs.

The aim of the third extension of my analysis is to gather some evidence for or against the general belief, conform which after the fall of communism the quality of higher education declined. If this is to be true the return to each year of schooling also had to drop in fourteen years of transition for those cohorts who are under the age of 24 and have at least a high school diploma. For simplicity I will only include in the samples those who are less than 24 years old, have at least a high school degree and are males. Since examined cohorts have very few or no experience at all, I will also omit the experience variables from the estimated equation:

$$log(w_i)=\beta_0 + \beta_1 S_i + u_i \qquad (3)$$

III. Results

Being in conformity with the general expectations, in Table 1 it is shown how the return to an additional year of schooling has risen with 74 percent, from 0.084 to 0.146, between the two time periods. What wasn't expected is the fact that based on the estimated coefficients the gender wage gap didn't widened as the competitive markets settled in, but rather narrowed, from a 36% negative difference to 7.7 % discrimination only. The expected widening of the gender gap has been based on the intuition that wages aren't suppressed anymore like in communism, but dispersed on a larger scale. It is also interesting to calculate the turnover point of the experience. This point shows until which year is the return of experience positive – has a diminishing but positive return[4], and after which it will start "harming". While in 1986 this point was at the 40[th] year of experience, by 2000 it increased to 50 years, meaning that experience is present as a positive factor in people's carrier for a much longer period (almost their entire carrier).

[3] The base group is 'less than elementary'.

[4] It can be calculated with the simple method:

$$\frac{\partial \log(SALARY)}{\partial EXP} = \hat{\beta}_{exp} + 2 * \hat{\beta}_{exp^2} EXP = 0 \Leftrightarrow EXP \approx -\frac{\hat{\beta}_{exp}}{2 * \hat{\beta}_{exp^1}}$$

The changes occurred in the return to the different education levels are captured in Table 2. It is very interesting to find, that conform the estimated coefficients the returns to elementary and vocational schooling levels changed the less, only couple of percents of increase reported, while high school and university/college level's premium rise much more significantly. The return to high school increased with 51.8%, from 0.405 to 0.615 in 14 years. One explanation for the large difference could be that in socialism high school was an option only for those who wanted to go to university later on, but vocational schools were preferred by everyone who just wanted to work in any of the manufacturing industries. With vocational schools people were able to gain specific skills and become breadwinners at very young ages; therefore this solution was chosen by a larger proportion of the population, but with a high school degree in socialism one didn't have so many options. In 2000 the share of those who opted for vocational schools in the previous couple of years had fallen dramatically, high school becoming something much more accessible and favorable, mainly because many jobs first criteria was a high school degree. Significant changes occurred also in the return to university or college degrees: they went from a premium of 0.895 to 1.292, an increase of almost 45%, to a return that has been already very high relatively to the other educational levels. The turnover points of the experience functions evolved differently from the previous case; instead of a shift to the right from the same 40^{th} year in 1986 it diminished to 33.33 years of experience, causing uncertainty about the true direction. Ideally the four turnover points would have to be close to each other in pairs, by years. The gender wage gap shows the similar tendencies as in the previous case, with female's wage inequalities narrowing substantially, from -36.36% to -12.44%.

The third case's estimation output can be seen in Table 3, and there is clearly no evidence for the decrease of quality of higher education after the transition period. It might not be evidence that would prove the contrary either though. The increase, between 1986 and 2000, of the return to an additional year of schooling has been quite significant, having a magnitude of 216%, growing from a premium of 0.04 to 0.15. Once again, the massive rise in the return to schooling seems to have a bigger impact on the overall young employment than the diminishing allocations from the government or the changes in the curricula.

IV. Conclusion

The three main parts of my analysis – the return to an additional year of schooling, the return to education levels and the evidence against the diminishing quality of higher education – have all ended up with the same findings: a huge increase in each of these returns can be perceived and proved. But these very significant numbers, with signs that are in conformity with the expectations and general intuition should not be considered as the absolute measures for what happened in reality. One major fault in these evidences is the fact that in the sample from 2000 those individuals are missing, who didn't enter the labor market. It would be of a great interest to see what would have been their return to education and for which reasons they opted out. Was it because their reservation wage, let's assume the unemployment benefit, was above to their educational return? With current data it would be very difficult to say, but certainly there is room for broader analysis and research in this topic. One of the few solutions to this problem of sample selection was brought in by DiNardo, Fortin and Lemieux in the Heckman Selection framework in 2002, and would be interesting to apply it in a further research as a continuation of the present work.

References

Andren, Daniela, John S. Earle and Dana Sapatoru, The Wage Effects of Schooling under Socialism and in Transition: Evidence from Romania, 1950-2000, *Journal of Comparative Economics*, Vol. 33(2), June 2005: 300-323.

Campos, Nauro, and Dean Jolliffe, *Earnings, Schooling and Economic Reform: New Econometric Evidence from Hungary (1986-2004)*.World Bank Economic Review 21(3), 509-526, 2007.

DiNardo, John, *Propensity Score Reweighting and Changes in Wage Distributions*, July 2002 – preliminary and incomplete work.

DiNardo, John, Nicole M. Fortin, Thomas Lemieux, Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach, *Econometrica*, Vol.64, No.5. (Sep., 1996), pp.1001-1044.

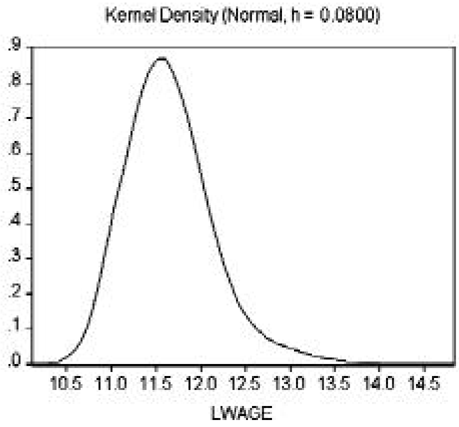
Chase, Robert, Markets for Communist Human Capital: Returns to Education and Experience in the Czech Republic and Slovakia, *Industrial and Labor Relations Review*, Vol 51(3), April 1998.

Kézdi et al, Crisis in the Outcomes of Vocational Training, *Munkaerőpiaci Tükör 2008*. MTA-KTI, Budapest, 2008.

Kertesi, Gábor and János Köllő, Economic Transformation and the Revolution of Human Capital – Hungary, 1986 – 1999, *Research in Labor Economics*, Vol. 20, 2002.

Munich, Daniel, Jan Svejnar, and Katherine Terrel, Returns to Human Capital under the Communist Wage Grid and During the Transition to a Market Economy, *Review of Economics and Statistics*, Vol. 83(1), 100-123, 2005.

Appendix



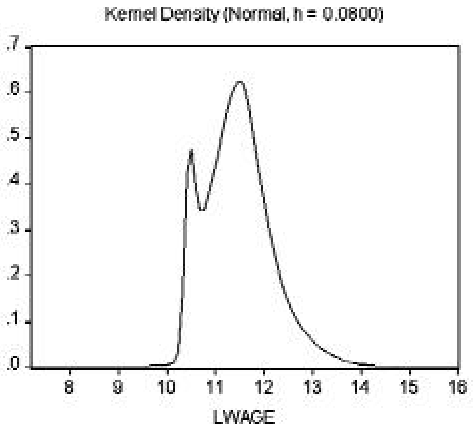


Figure 1.a and 1.b: The kernel density of log real wages in 1986 and 2000

Table 1. Returns to years of schooling

	1986	2000	Change 1986-2000
School Years	0.0840128 (0.000240)	0.146437 (0.000912)	74%
Experience	0.039385 (0.000165)	0.019440 (0.000623)	-51%
Experience²	-0.000542 (3.65E-06)	-0.000265 (1.40E-05)	-51%
Female	-0.359248 (0.001010)	-0.077065 (0.003475)	-79%
Constant	10.39538 (0.003217)	9.355915 (0.012214)	-10%
R^2	0.415965	0.239836	

Source: Authors' analysis based on the Hungarian Wage Survey data described in the text.

Notes: Dependent variable is the log of monthly wages. Standard errors, in parentheses, are robust to White heteroscedasticity. All listed parameters are statistically significant with a p-value less than 0.001. The point estimate for Experience^2 in 2000 has the smallest t-statistic with an absolute value of 18.26.

Table 2. Returns to Educational Levels

	1986	2000	Change 1986-2000
Elementary	0.133104 (0.001997)	0.172056 (0.018536)	29%
Vocational	0.275760 (0.002196)	0.284068 (0.018510)	3%
High School	0.405476 (0.002210)	0.615453 (0.018584)	52%
University/ College	0.895196 (0.003004)	1.292580 (0.019559)	44%
Experience	0.039501 (0.000169)	0.021724 (0.000620)	-45%
Experience^2	-0.000570 (3.78E-06)	-0.000328 (1.40E-05)	-42%
Female	-0.363626 (0.001037)	-0.124373 (0.003542)	-66%
Constant	10.98193 (0.002535)	10.71680 (0.019060)	-2%
R^2	0.424814	0.260450	

Source: Authors' analysis based on the Hungarian Wage Survey data described in the text.

Notes: Dependent variable is the log of monthly wages. Standard errors, in parentheses, are robust to White heteroscedasticity. All listed parameters are statistically significant with a p-value less than 0.001. The point estimate for elementary in 2000 has the smallest t-statistic with a value of 9.28.

Table 3. Comparing selection corrected returns to education by age

	1986	2000	Change 1986-2000
Elementary	0.048360 (0.002006)	0.153065 (0.007291)	217%
Constant	10.62918 (0.025119)	9.418897 (0.090842)	-11%
R^2	0.020706	0.089637	

Source: Authors' analysis based on the Hungarian Wage Survey data described in the text.

Notes: Dependent variable is the log of monthly wages. Standard errors, in parentheses, are robust to White heteroscedasticity. All listed parameters are statistically significant with a p-value less than 0.001.

Influencing factors of early-stage entrepreneurial activity in Romania

LEHEL GYÖRFY[1] – ANNAMÁRIA BENYOVSZKI[1] – ÁGNES NAGY[2] – ISTVÁN PETE[1] – TÜNDE PETRA PETRU[1]

Abstract

In Romania a representative sample of adult population was interviewed using a standard GEM questionnaire. After emphasizing the special situation of Romanian entrepreneurship in international context we aimed to determine the influencing factors of opportunity-motivated and necessity-motivated early-stage entrepreneurs, using socio-demographic and perceptual variables.

Keyword: Entrepreneurship, opportunity-motivated early-stage entrepreneurs, necessity-motivated early-stage entrepreneurs.

1. Introduction

The unending debate on the concept of the entrepreneur persists also today, researchers having the duty to define the terms they use [Bygrave, Hofer, 1991]. However, recent works indicate that the empirical definitions regarding the person of the entrepreneur are easily comparable, recommending the rejection of definitions focused on the spiritually doted entrepreneur's opened mind for the innovation and pointing that there is a large scale of categories for a person to fit in, from "very entrepreneur" to "absolutely non-entrepreneur" [van Praag 2005]. These findings justify the analyses focused on finding the factors, which influence entrepreneurial activity with a significant probability in individual cases.

We have to notice also that ongoing debates on how the entrepreneur can be defined have been replaced by debates on an extended view on the entrepreneurial process, as a whole. We accept Bygrave and Hofer's [1991] extended view on the entrepreneurial process, confirmed by Shane and Ventakaraman's [2000] summarizing remarks, partially concretized in the entrepreneurial life-cycle model [Szerb 2000]. We consider that birth of a business can be considered a phase of the entrepreneurial activity, but not its starting point or its final result. The existence, the discovery of the entrepreneurial opportunity and the decision to exploit it are considered the starting point of any entrepreneurial activity [Shane, Ventakaraman 2000]. Taking all this in consideration, the definition of Global Entrepreneurship Monitor on the entrepreneur's person and the phases of the entrepreneurial process has been accepted.

[1] Faculty of Economic and Business Administration Babeş-Bolyai University
[2] Member in the Board of Directors of the National Bank of Romania

Global Entrepreneurship Monitor (GEM) is a large-scale research program launched in 1997 by leading researchers in the field of entrepreneurship at London Business School and Babson College. The first research was published in 1999 and it included 10 countries. Since then the project has been extended to include 42 countries in 2007, 43 countries in 2008. The main aim of GEM research is to study the complex relationship between entrepreneurship and economic growth, to measure the level of entrepreneurial activity between countries, to uncover factors determining the levels of entrepreneurial activity and to identify policies which may stimulate the level of entrepreneurial activity. GEM, as a research program that focuses on a major driver of economic growth, entrepreneurship, also admits the widely acknowledged phenomena that entrepreneurship is one of the most important forces shaping the changes in the economic landscape [Acs et al. 1999, Bosma et al. 2008, Nagy et al. 2008].

In each country, a survey company conducts a telephone survey or face-to--face interview of the adult population. In Romania in 2008 a representative sample of 1746 adults between 18 and 64 years was interviewed using a standard GEM questionnaire. This survey was carried out to measure the entrepreneurial behaviour and the attitudes of adult population in Romania [Nagy et al. 2008]. The survey data are used to calculate the Total Entrepreneurial Activity Index, the only comparable measure of entrepreneurial activity across countries [Bosma et al. 2008].

GEM used the following terms in assessing the entrepreneurial activity of the adult population:

- ***Nascent Entrepreneurs*** are those who are actively planning a new venture. These entrepreneurs have done something during the previous 12 months to help start a new business, that he or she will at least partly own. Activities such as organizing the start up team, looking for equipment, saving money for the start up or writing a business plan would all be considered as active commitments to starting a business. Wages or salaries will not have been paid for more than three months in respect of the new business.

- ***Young Business Entrepreneurs*** are those entrepreneurs who at least partly own and manage a new business that is between 4 and 42 months old and have not paid salaries for longer than this period. These new ventures are in the first 42 month after the new venture has been set up.

- **Early-Stage Entrepreneurs** refers to the early-stage entrepreneurial activity among the adult population aged 18-64 years inclusive, identified as nascent or young business entrepreneurs. In those cases when the respondent is involved both as nascent and young business entrepreneur then the respondent is counted only once as a nascent entrepreneur.

- **Opportunity-Motivated Early-Stage Entrepreneurs** are those early-stage entrepreneurs who are pulled to entrepreneurship, there are two major drivers – desire of independence and increase their income.

- **Necessity-Motivated Early-Stage Entrepreneurs** are those early-stage entrepreneurs who are pushed into entrepreneurship, they maintain that they have no other way earning a living.

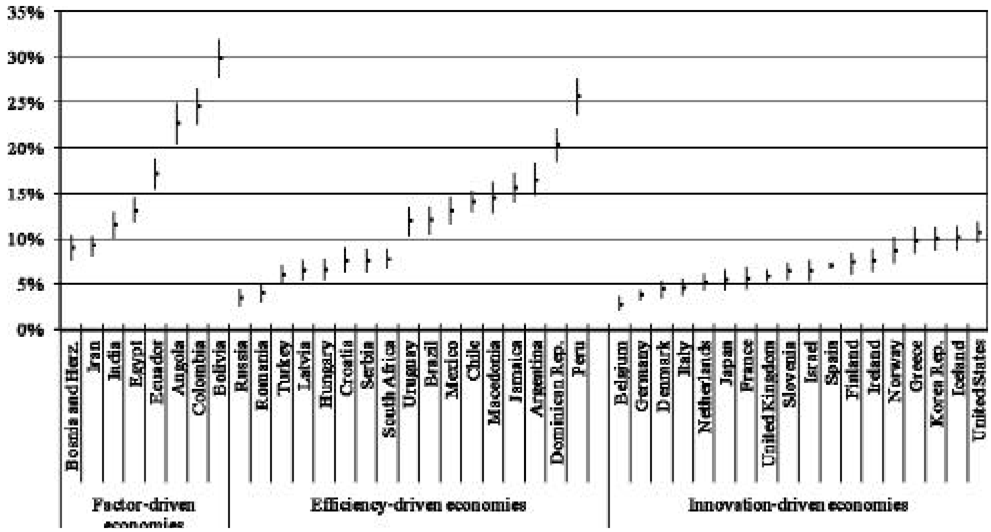
- **Established Business Owners** are those entrepreneurs who have set up businesses that they have continued to own and manage and which had paid wages and salaries for more than 42 months.

The paper, accepting Arenius and Minniti's [2005] and Karadeniz's [2009] recommendations focuses on the characteristics of the population i.e. the demographic composition, the resources, the abilities of individuals, and their attitudes towards entrepreneurship, taking in account Arenius and Minniti's [2005] classification of those factors as "socio-demographic factors, perceptual variables, and contextual factors". Many factors influence an individual's decision to set a business: a perception of opportunities within their environment, whether they have sufficient knowledge and skills, if they know other people who are engaged in entrepreneurial activity and a reduced reluctance to become involved in entrepreneurial activity through fear of failure [Arenius, Minniti 2005].

The paper aims to identify which of the above-mentioned factors influence significantly the Romanian opportunity-motivated and necessity-motivated early-stage entrepreneurial activity. More specifically, the studied factors were grouped in demographic variables (such as age, gender, income level, education level and work status) and perceptual variables (such as networking, fear of failure, alertness to opportunities, self-confidence) [Arenius and Minniti 2005, Karadeniz 2009] on entrepreneurial activities in Romania, one of the lowest among low- and middle-income countries [Nagy et al. 2008].

2. Overview on the Romanian entrepreneurship in international view

The general overview on the Romanian entrepreneurship in international comparison indicates a low early-stage entrepreneurial activity (TEA) rate. Figure 1 presents early-stage entrepreneurial activity (TEA) rates for each GEM 2008 country. The countries are grouped by phase of economic development and ranked within groups in ascending order of the national point estimate for TEA. If the vertical bars on either side of the point estimates for TEA of any two countries do not overlap, this means that they have statistically different TEA rates. This figure serves as a benchmark for countries in similar phases of economic development. In factor-driven economies a reduction in the TEA rate may be seen as a good sign, and is especially likely when the general economic climate is doing well and job opportunities increase. Such reduction in TEA would typically be due to a decline in the rate of necessity entrepreneurship. In innovation-driven economies, a high TEA rate may be specific to regional economic, demographic and cultural contexts and may be composed of entrepreneurs who may vary in type and aspiration [Bosma at al., 2009].



Source: Bosma et al., 2009, p 21.

Figure 1: Early-stage entrepreneurial activity (TEA) rates for each GEM 2008 country

Overall, Romania's early-stage entrepreneurial activity rate measures 3.98% with 2.54% of the adult population being nascent entrepreneurs, i.e. more than 2.5 of every 100 adults, aged between 18-64 years, are in the process of starting a business. These figures are lower than those recorded in most Central Eastern European countries (e.g. Hungary, Croatia, Serbia and Latvia) and among the lowest among the efficiency-driven economies and also of all GEM countries this year. Table 1 lists all prevalence rates of different phases of entrepreneurial activity for Romania in 2008.

Only 25.75% of the adult population perceives good conditions to start a business in the next six months, this figure being higher than in Hungary and Latvia, but lower than in Croatia and Serbia and again one of the lowest among all GEM efficiency-driven economies this year.

In Romania, 37.9% of the adult population reported an acquaintance with an entrepreneur, much higher than in Hungary and Latvia, but much lower than in Croatia and Serbia. Only 23.8% feel they have the necessary skills to start a business and about half (56.2%) considers that the media focuses strongly enough on entrepreneurship.

Table 1: Entrepreneurial activity in Romania

	Percentage	
Entrepreneurial activity	**2007**	**2008**
Nascent entrepreneurs	2,9	2,54
Young business entrepreneurs	1,3	1,56
Established business owners	2,5	2,07
Early-stage entrepreneurs	4,02	3,98

Source: own calculation in Györfy et al. 2008, own calculations in GEM 2007 and 2008, Adult Population Survey, Romania

Table 2: Individual perceptions regarding entrepreneurial activity in Romania

Perceptions	**2007**	**2008**
Fear of failure rate[3]	28,3%	41,48%
Perceived capabilities[4]	29,4%	23,77%
Knows a person who started a business in the past 2 years	41,6%	37,88%
Prefers that everyone had a uniform standard of living	46,6%	48,83%
Perceived opportunities[5]	26,2%	25,75%
Thinks that those who are successful at starting a new business have a high level of status and respect	62,5%	68,53%
Media attention for entrepreneurship[6]	50,4%	56,19%

Source: own calculation in GEM 2007 and 2008, Adult Population Survey, Romania

[3] Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who indicate that fear of failure would prevent them from setting up a business.

[4] Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who believe they have the required skills and knowledge to start a business.

[5] Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who see good opportunities to start a business in the area where they live

[6] Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who agree with the statement that in their country, they fill often see stories in the public media about successful new businesses.

The main change in entrepreneurial motivation is the share of those that chose to start a business to maintain their income or have been motivated by necessity (from 17.2% in 2007 to 41.7% in 2008). The high increase can be attributed to the fact that there was a high level of mixed motivation in 2007, the year before the first signs of the world economic crisis appeared.

The ratio of opportunity (1.9%) to necessity (1.2%) entrepreneurship indicates 1.54 times more opportunity-oriented ventures, which is higher than in the other countries in the region, due to the economic growth of the previous seven years.

Table 3 represents the individual perceptions regarding opportunity-motivated and necessity-motivated early-stage entrepreneurial activity in Romania. Despite the fact that the fears of failure rate increased from 2007 to 2008, only the 15.1% of the necessity-motivated early-stage entrepreneurs think that fear of failure would prevent them from starting a new business. The opportunity-motivated and necessity-motivated early-stage entrepreneurs in their opinion have the required knowledge and skills to start a business.

Table 3: Individual perceptions regarding opportunity-motivated and necessity-motivated early-stage entrepreneurial activity in Romania

	Involved in opportunity-motivated early-stage entrepreneurial activity	Involved in necessity-motivated early-stage entrepreneurial activity
Fear of failure would prevent to start a business	21.3%	15.1%
Has the required knowledge/skills to start a business	87.8%	88.5%
Knows a person who started a business in the past 2 years	88.4%	88.5%
All inhabitants prefer uniform living standard	56.3%	67.5%
Sees good opportunities for starting a business in the next 6 months	42.2%	72.2%
Lots of media coverage for new businesses	70.7%	68.1%

Source: own calculation in GEM 2007 and 2008, Adult Population Survey, Romania

On bases of our correlation analyses we can affirm that the necessity-motivated entrepreneurs see good opportunities for business start-ups in the next six month. Both necessity-motivated and opportunity-motivated early-stage entrepreneurs consider they possess the required knowledge and skills to start a new business. No significant correlation at the 0.05 level were found between any kind of early-stage entrepreneurial activity and the appreciation of the media coverage for businesses, as well as with the consideration of uniform living standard preference.

Table 4. Correlation between individual perceptions and opportunity-motivated, respectively necessity-motivated entrepreneurial activity in Romania

	Involved in opportunity-motivated early-stage entrepreneurial activity	Involved in necessity-motivated early-stage entrepreneurial activity
Fear of failure would prevent to start a business	-0.031	-0.035
Has the required knowledge/skills to start a business	0.157**	0.148**
Knows a person who started a business in the past 2 years	0.1**	0.107**
All inhabitants prefer uniform living standard	0.025	0.037
Sees good opportunities for starting a business in the next 6 months	0.033	0.109**
Lots of media coverage for new businesses	0.016	0.04

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Source: own calculation in GEM 2008, Adult Population Survey, Romania

3. Influencing factors of opportunity-motivated and necessity-motivated early-stage entrepreneurial activity in Romania

Using the GEM Adult Population Survey data for 2008, according to recent methodological recommendations [Arenius and Minniti 2005, Karadeniz 2009] we estimate two logistic regressions in order do determine the main influencing factors for opportunity-motivated[7] and necessity-motivated[8] early-stage entrepreneurship in Romania, using the following set of explanatory variables:

Table 5. Variables used in the model

Notation	Name	Values
TEAOPP (dependent variable for model 1)	Opportunity-motivated early-stage entrepreneur	No/Yes
TEANEC (dependent variable for model 2)	Necessity-motivated early-stage entrepreneur	No/Yes
Gender	Gender	Male/Female
Education	Educational level	Low/Medium/High
WORK	Work status	Full-time/Part-time/Unemployed/Retired or disabled/Student/Homemaker/Other
KNOWEN	Knowing other entrepreneurs	No/Yes
SUSKILL	Perception regarding the trust in own entrepreneurial skills	No/Yes
NBMEDI	Perception on the proper promotion of entrepreneurial successes by the mass media	No/Yes
Age	Age categories	19-24/25-34/35-44/45-54/55-64
Household size	Total size of household including respondent	1-15

The logistic models were estimated using the STATA statistical software.

According to the univariate tests done, the following variables were maintained as influencing factors of the probability of becoming an opportunity-motivated early-stage entrepreneur:

[7] Model 1.
[8] Model 2.

- gender
- knowing other entrepreneurs (KNOWEN)
- perception regarding the trust in own entrepreneurial skills (SUSKILL)
- educational level (Education)
- work status
- household size.

The statistical analyses emphasized that the other variables have an insignificant influence in explaining the phenomena of being an opportunity-motivated early-stage entrepreneur in Romania in 2008.

Table 6. The results of the logistic regression on the estimation sample for the dependent variable: *opportunity-motivated early-stage entrepreneur* (Number of observations: 1667)[9]

Explanatory variable	**Coefficient**	**Standard Error**	**Z Statistics**	**P value**
Constant	-3.315489	0.7698976	-4.31	0.000
Gender	-1.167832	0.4455577	-2.62	0.009
Education	0.3227106	0.1280909	2.52	0.012
Work	-0.3562309	0.1814057	-1.96	0.050
KNOWEN	0.1408834	0.0425706	3.31	0.001
SUSKIL	0.0825966	0.0413386	2.00	0.046
Household size	-0.0211871	0.009062	-2.34	0.019
Pseudo R^2 = 0.1744 Wald $\chi^2(6)$= 59.12(p value 0.0000) Log pseudolikelihood = -141.10648				

Source: Own calculations in STATA on basis of GEM Adult Population Survey for Romania, 2008

The values of the statistic tests indicate that the obtained model respects the exigencies of good econometrical standards. The variables are statistically significant[10]. The explanatory variables have the expected sign. The general explanatory level of the model is not very good, but it is acceptable, taking in account the value of the pseudo R^2 = 0.1744.

[9] 18-64 years old

[10] The statistical relevance of the selected criteria is emphasized by the good values of the z statistics coefficients of the estimated function.

In the model which describes the influencing factors of the probability of becoming a necessity-motivated early-stage entrepreneur in Romania in 2008 the following variables were maintained:

- educational level
- knowing other entrepreneurs (KNOWEN)
- age (AGE)
- perception on the proper promotion of entrepreneurial successes by the mass media (NBMEDI)
- perception regarding the trust in own entrepreneurial skills (SUSKIL).

Table 7. The results of the logistic regression on the estimation sample for the dependent variable: *necessity-motivated early-stage entrepreneur* (Number of observations: 1656)[11]

Explanatory variable	**Coefficient**	**Standard Error**	**Z Statistics**	**P value**
Constant	-2.041982	0.9990117	-2.04	0.041
Education	-1.005142	0.3792035	-2.65	0.008
KNOWEN	0.2098581	0.0294491	7.13	0.000
SUSKIL	0.0816407	0.0247822	3.29	0.001
NBMEDI	-0.1171978	0.0339891	-3.45	0.001
Age	-0.0003091	0.0001632	-1.89	0.058
Pseudo R^2 = 0.1042 Wald $\chi^2(5)$= 92.80 (p value 0.0000) Log pseudolikelihood = -100.69837				

Source: Own calculations in STATA on basis of GEM Adult Population Survey for Romania, 2008

The statistical tests on the level of the estimation sample indicate that the model obtained respects the exigencies of a good econometrical performance. The coefficients are statistically significant[12]. The signs of the variables education, KNOWEN and SUSKIL have the expected sign. NBMEDI indicates that Romanian necessity-motivated early-stage entrepreneurs are unsatisfied by how entrepreneurial successes are promoted by the mass-media, feeling a need

[11] 18-64 years old

[12] The statistical relevance of the selected criteria is emphasized by good values of the z-statistics associated to the coefficents of the estimated function.

for a better promotion, starting from their own situation. The sign of the variable AGE can be explained by the fact that Romanian necessity-motivated early-stage entrepreneurs are mostly fresh graduates, who are pushed into entrepreneurial activity. The general explanatory power of the model is acceptable, according to the pseudo $R^2 = 0.1042$.

The results of the estimation in case of both models indicate high values of the area under the ROC curve, 84.88% for the first model (opportunity-motivated early-stage entrepreneurs) and 75.22% for the second model (necessity-motivated early-stage entrepreneurs), with both values above the 75% reference limit, supported also by the form of both ROC curves, as it can be seen in the Appendix.

Conclusions

One of the lowest rates of early-stage entrepreneurial activity was found in Romania (3.98%) with 2.54% of the adult population being nascent entrepreneurs, i.e. more than 2.5 of every 100 adults, aged between 18-64 years, are in the process of starting a business. These figures are lower than those recorded in most Central Eastern European countries (e.g. Hungary, Croatia, Serbia and Latvia) and among the lowest of all GEM countries in 2008.

These low rates can be explained by the lack of entrepreneurial tradition, activity and education before the 90's during the socialist period, the unfavorable entrepreneurial environment in the transition period of the 90's, as well as the population's acceptance regarding the less risky jobs offered by big firms in the period of economic growth after 2000.

Starting from these facts, this paper aimed to emphasize the factors, which influence the status of opportunity-motivated and necessity-motivated early-stage entrepreneurship in Romania. The significant explanatory variables of probability of becoming an opportunity-motivated early-stage entrepreneur in the logistic regression were: the gender, knowing other entrepreneurs (KNOWEN), perception regarding the trust in own entrepreneurial skills (SUSKIL), educational level, work status, household size. While in the case of necessity-motivated early- stage entrepreneurs: educational level, knowing other entrepreneurs (KNOWEN), age, perception on the proper promotion of entrepreneurial successes by the mass media (NBMEDI), perception regarding the trust in own entrepreneurial skills (SUSKIL).

References

Acs, Z.J., Armington, C., Robb, A., 1999: Measures of job flow dynamics in US economy. Upper Marlboro, Maryland, US Bureau of the Census, Center for Economic Studies, discussion paper.

Arenius, P. and Minitti, M., 2005: Perceptual variables and nascent entrepreneurship, *Small Business Economics*, *24*, 233-247.

Bosma, N., Jones, K., Autio, E. and Levie, J., Global Entrepreneurship Monitor 2007, Executive Report, Babson College, London Business School and Global Entrepreneurship Research Consortium (GERA), 2008.

Bosma, N., Acs, J., Autio, E., Coduras A. and Levie, J., Global Entrepreneurship Monitor 2008, Executive Report, Babson College, London Business School and Global Entrepreneurship Research Consortium (GERA), 2009.

Bygrave W.-Hofer C.W. 1991: *Theorizing about entrepreneurship.* Entrepreneurship Theory and Practice, Winter, p. 13-22.

Györfy L., Nagy, A., Matiş D. Pete Ş., Benyovszki A., Petru T.P. 2008: *Monitorizarea globală al antreprenoriatului în România*, Raportul de ţară al României, Editura Abel (CNCSIS28), 47 p., A4, Cluj-Napoca

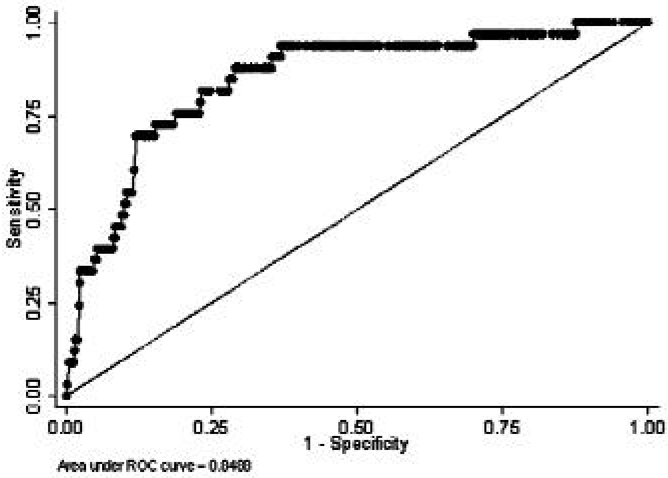
Nagy, Á., Matiş, D., Györfy, L.Z., Benyovszki, A., Petru, T.P., 2008: *Main Characteristics of Entrepreneurial Activity in Romania*, în Benyovszki A., Györfy L., Pete Ş., Petru P. :Entrepreneurship and Economic Growth International Conference 28-29th March, 2008, Cluj-Napoca, Ed. Abel (CNCSIS) ISBN 978-973-114-061-2, p.108-114.

Shane S., Venkataraman S. 2000: *The Promise of Entrepreneurship as a Field of Research*, Academy of Management Review, vol. 25. nr. 1., p. 217-226

Szerb L. 2000: *Kisvállalati gazdaságtan és vállalkozástan.*, Bornus Nyomda, Pécs

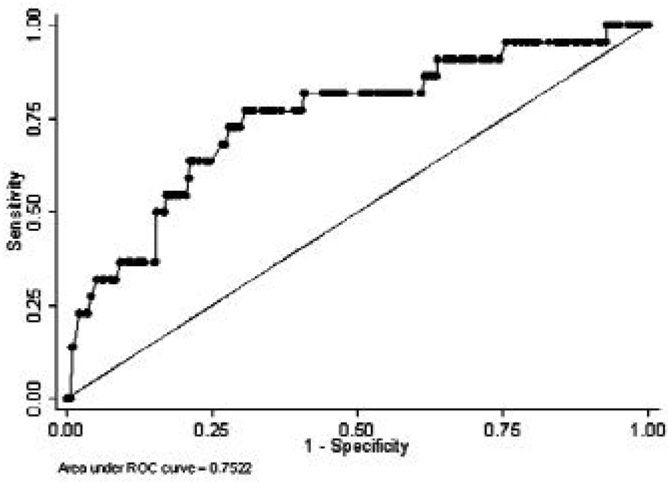
Van Praag, M. 2005: Successful Entrepreneurship, Edward Elgar, London

Appendix



Source: Own calculations in STATA on basis of GEM Adult Population Survey for Romania, 2008

Figure 1. ROC curve – Logistic model, opportunity-motivated early-stage entrepreneurs



Source: Own calculations in STATA on basis of GEM Adult Population Survey for Romania, 2008

Figure 2. ROC curve – Logistic model, necessity-motivated early-stage entrepreneurs

Traditional or advanced cost calculation systems? – This is the question in every organization

ILDIKÓ RÉKA CARDOȘ[1] – ISTVÁN PETE[1] – DUMITRU MATIȘ[1]

Abstract

In present context preoccupations regarding cost calculation, control and cost reduction are major challenges within organizations. Globalization represents a major change, which leads to performance and performance measurement. We are also the witnesses of technological and organizational mutations and evolutions, the automation of the production processes, the evolution of demands and competition, the new forms of competition.

These phenomena are raising serious doubts on the classical instruments of managerial accounting and the traditional cost calculation methods. An answer appeared and we are facing new challenges and perspectives regarding cost calculation.

The purpose of this article – after analyzing the existing literature in the field – is to make a comparison between the traditional and modern, complex cost calculation systems and to emphasize that new cost systems such as ABC and ABM represent major innovations and permits not only the cost calculation and analysis but also measuring performances, defining strategies and are oriented through competition and customers.

Keywords: traditional and complex cost calculation systems, job order costing, process costing, ABC/ABM

Introduction

Changes in the business environment are having significant influences on production processes, management, cost accounting and management accounting systems. Due to technological changes, both the structure and the composition of product costs have been changed substantially. Concerning product cost structure, the ratio of fixed costs to variable costs has increased (Kerremans *et al.*, 1991) and many costs viewed as indirect costs in traditional companies are in fact "direct costs in high-tech companies" (Seed, 1984).

Technological change has an impact on both cost composition and structure (Kerremans *et al.*, 1991). This change in cost structure created a need for organizations to review their existing management accounting system and consider important to implement new systems within their activities.

Another important fact is that nowadays, in a worldwide competitive environment companies are facing new challenges in terms of products or services, quality, delivery terms, after sales services and customer satisfaction. Until re-

[1] Babeş-Bolyai University, Faculty of Economics and Business Administration

cently management accounting systems have not reported on these variables despite the fact they represent key competitive variables.

Usually, companies are using their cost systems to (Kaplan & Cooper, 1998):

- design products and services that both meet customers' expectations and can be produced and delivered at a profit;
- signal where either continuous or discontinuous improvements in quality, efficiency and speed are needed;
- assist employees in their learning and continuous improvement activities;
- guide product mix and investment decisions;
- negotiate about price, product features, quality, delivery and service with customers;
- efficient and effective distribution and service processes to targeted market and customer segments.

Still, many companies are not gaining competitive advantages from these enhanced cost systems because they rely on information from a cost system designed for a simpler technological age when competition was only local instead of global, and companies were producing standardized products and services and when speed, quality and performances were less critical for success. Using these systems managers don't have timely and relevant information to guide their improvement activities and they don't have accurate and valid information to shape their strategic decisions about processes, products services and customers.

However, in response to the changing environment, cost and management accounting systems, besides financial information, must place greater emphasis on the collection and reporting of non-financial, quantitative and qualitative information, especially on those variables that are necessary to compete effectively and which supports the strategies of an organization.

In order to compete in today's competitive and often tumultuous environments, companies must become more "customer-driven" and to make customer satisfaction a top priority. In order to provide customer satisfaction organizations must concentrate on those key success factors that directly affects costs, product quality, time and innovations. These new approaches require continuous improvement, employee improvement and value-chain analysis.

"New management accounting techniques have aimed at helping business decisions and taking control in an increasingly sophisticated way, more so than has previously done before. Such things as strategic management accounting, activity based costing (ABC), strategic cost management, …, non-financial measures, balanced scorecard (BSC) and target costing have been suggested. Some of these, for example, ABC and BSC, have also gained a degree of popularity in practice." (Jarvenpaa, 2007:100)

Activity Based Cost (ABC) and Activity Based Management (ABM) Systems emerged to meet the need for accurate information about the cost of resource demands by individual products, services and customers and these systems also enabled indirect and support expenses to be driven first to activities and processes and then to products, services and customers. In this way managers have obtained a clearer picture of the economics of their operations.

Research methodology

Usually, the originality of a research topic depends on critical reading of wide literature in order to identify and distinguish the main ideas and methodologies from which contributions to knowledge might be made. It is very difficult to see how academic research could lead to new applications of a methodology or to contribute to knowledge without a systematic search and critical reading of the available literature in the field both on national and international level.

In other words, knowledge generation and understanding is an emergent process and not a universal product. In order to know the nature and character of the implications of a development, we need to know the intellectual context of that development (Hart, 1998).

Quality is also important when doing research and it means (Zimerman, 2001; Lukka & Mouritsen, 2002) rigor and consistency, clarity and brevity, effective analysis and synthesis. Ideas undertaken from the available literature must justify the approach to the research topic, the selection of methods and demonstration that the research contributes to something new.

Qualitative researchers, unlike their quantitative counterparts, do not intend to test hypotheses at the beginning of their research process. Theory is used not to obtain predictions but to gain understanding of a certain phenomenon. Data analysis is a process of reality construction whereby the researcher, the theory, and the method used in the research, together with the data derived from the research, are all interdependent and interrelated (Siti-Nabiha, 2009).

This article is a qualitative and theoretical study and its purpose is to present the new perspectives in cost calculation, to make a comparison between traditional and new and complex cost systems in order to emphasize that cost calculation by using a traditional method or cost system does not accomplish the requirements of managers and organizations especially in high-tech companies. Thus organizations must focus toward complex cost systems. The background of this paper is formed by information and data gathered from the existing literature and practice on national, European and international level.

Tradicional cost calculation systems

Many companies use a traditional cost system to measure the manufacturing costs of products in a two-step process: (1) the measurement of costs that are applicable to manufacturing operations during a given period and (2) the assignment of these costs to products. These systems accumulate all manufacturing costs such as materials, labor and factory overhead and assign them to cost objectives: finished goods and work in process by using one of the two basic approaches to cost calculation: *job-order costing* and *process costing*.

Job-order costing is the cost accumulation system under which costs are accumulated by jobs, contracts, or orders and the use of this method is appropriate when the products are manufactured in identifiable lots or batches or when the products are manufactured to customer specifications. Job-order costing is widely used by custom manufacturers such as printing, aircraft, and construction companies, service businesses and professional services. Job-order costing keeps track of costs as follows: direct material and direct labor are traced to a particular job. Costs that are not directly traceable - factory overhead - are applied to individual jobs using a predetermined overhead (application) rate.

Process costing is a cost accumulation system that aggregates manufacturing costs by departments or by production processes. Total manufacturing costs are accumulated by two major categories, direct materials and conversion costs (the sum of direct labor and factory overhead applied). Unit cost is determined by dividing the total costs charged to a cost center by the output of that cost center. In that sense, the unit costs are averages. Process costing is appropriate for companies that produce a continuous mass of similar units through a series of operations or processes in industries as petroleum, chemicals, oil refining, textiles, and food processing.

The basic differences between the two cost systems are as follows:

Table 1. Differences between Job-order Costing and Process Costing

	JOB-ORDER COSTING	**PROCESS COSTING**
1. Cost unit	Job, order or contract	Physical unit
2. Costs are accumulated	By jobs	By departments
3. Subsidiary record	Job cost sheet	Cost of production report
4. Used by	Custom manufacturers	Processing industries
5. Permits computation of	(a) unit cost for inventory costing purposes (b) profit or loss on each job	A unit cost to be used to compute the cost of goods completed and work in progress.

Source: Shim and Siegel, 1998:310

As we can see, the distinction between the presented cost systems is that while job-order costing focuses on applying costs to specific jobs or orders, process costing accumulates accounting data by the production department (or cost center) and averages over all of the production that occurred in the department.

Although the traditional cost systems can be used successfully in different production sectors, in time appeared a major force in the rationalization of the production process: the automation. (Kerremans et al, 1991)

Society and organizations are confronted with technological evolution and as the result of these changes they are experiencing significant changes in size, form, production and labor process. Although production methods and processes have been developed and make use of advanced technologies, management accounting and cost systems have lagged behind because they are not useful in a "high-tech" environment (Cooper&Kaplan, 1989) and management has different accounting information needs. "The challenge is to provide correct information in time so that it is useful for planning and control purposes." (Kerremans et al., 1991:147)

The growth in the automation of manufacturing has changed both the structure and the composition of total product cost.

• Concerning the structure of product costs we can observe that the ratio of fixed costs to variable cost has increased and many costs viewed as indirect cost in traditional companies are in fact direct cost in high-tech organizations.

• Concerning the structure of product costs we can observe that the significance of direct labor costs has diminished and often became insignificant while overhead cost has increased and has become more important.

Another important aspect is that traditional cost systems were designed decades ago, during the 1980's, when most companies marketed a narrow range of products, direct labor costs represented only a small fraction of total costs and indirect costs were relatively small and the distortions arising from overhead allocations were not significant. After the 1990's companies started to market a wide range of products, indirect costs were no longer unimportant and the introduction of more sophisticated cost systems started to become necessary. Furthermore, the intense global competition resulted in decision errors from poor cost information. These aspects determined the appearance of complex cost systems such as: Activity Based Costing and Activity Based Management.

Advanced (complex) cost calculation systems

Activity-based costing (ABC) is defined as a methodology that measures the cost and performance of activities, resources, and cost objects. Specifically, resources are assigned to activities, then activities are assigned to cost objects based on their use. ABC recognizes the causal relationships of cost drivers to activities. (Institute of Management Accountants, 1998)

ABC begins (Hughes & Gjerde, 2003) with the companies' products, determines the activities used in the production and delivery of those products, and computes the costs of the various activities. The costs of the activities used in the production of a product are then assigned to that product in a manner that approximates a causal relationship. As a result, advocates insist that ABC systems provide more useful information for cost management purposes than traditional systems do. These differences are significant for companies with large amounts of overhead, multiple products, and high product diversity.

The major differences between traditional cost systems and ABC are as follows:

Table 2. Differences between Traditional cost systems and ABC

	TRADITIONAL	**ABC**
Cost pools	One or limited number	Many to reflect different activities
2. Applied rate	Volume based, financial	Activity based, non-financial
3.Suited for	Labor-intensive, low-overhead companies	Capital-intensive, product-diverse, high-overhead companies
4. Benefits	Simple, inexpensive	Accurate product costing, possible elimination of non-value-added activities

Source: Shim and Siegel, 1998:337

In today's competitive environment organizations require a reliable cost system and relevant cost information to survive. By implementing an ABC system managers will obtain accurate information about the true cost of products, services, processes, activities, distribution channels, customer segments, contracts, and projects.

Needy et al (2003) suggests that the implementation process of an ABC system should rely on the following four steps: (1) cost system evaluation; (2) ABC design; (3) ABC implementation; and (4) system evaluation and validation.

Benefits of an ABC system are numerous. They include (Shim and Siegel, 1998):

• Improved products or services, improved decisions about pricing, services and strategies;

• Cost reduction by eliminating the non-value-added activities;

• Greater control of costs because of its focus on the behavior of costs at their origin, both short-term and long-term;

• More accurate evaluation of performance by programs and responsibility centers;

ABC's originators recommended it for economic, normative, realist and deterministic reasons – that is, it represents best value, accurately represents financial events and aids rational decision-making and contracting. Alleged benefits include: increased cost awareness and understanding; better tracing of costs to objects; superior allocation of overheads to cost objects; and financial (cost driver rates) and non-financial (cost driver volumes) measures for cost management and operational decision. (Hopper & Major, 2007)

The clearer picture from ABC systems led naturally to activity-based management (ABM). ABM enables the organization (Kaplan & Cooper, 1998) to accomplish its outcomes with fewer demands on organizational resources.

Activity-based management (ABM) is subsequently defined by CAM-I (Consortium for Advanced Manufacturing-International) as a discipline that focuses on the management of activities as the route to improving the value received by the customer and the profit achieved by providing this value. ABM includes cost driver analysis, activity analysis, and performance measurement, drawing on ABC as its major source of data. Using ABC data, ABM focuses on how to redirect and improve the use of resources to increase the value created for customers and other stakeholders.

Movement from ABC (for product profitability assessment) to ABM (for more general managerial control and decision support) has been supplemented by the broadening of ABC/M application to different types of business, to different functional specializations within business and to the complementarities of ABC/M to other new high-profile management and accounting techniques. (Bjornenak & Falconer, 2002: 504)

Together, ABC and ABM methodologies provide the tools and the knowledge base for making informed decisions – decisions, which relate to the pricing, management, and improvement of products and services. They are utilized to gain a fuller understanding of the real cost dynamics and cost structures involved in business operations. ABM together with ABC principles can enable managers to better understand (a) both product and customer profitability, (b) the cost of business processes, and (c) how to improve them.

ABC and ABM are a continuum of value. ABM is the application of ABC data to manage product portfolios and business processes better. ABC becomes ABM (management) when it is used to (CIMA, 2001):

- design products and services that meet or exceed customers' expectations and can be produced and delivered at a profit;
- signal where either continuous or discontinuous (re-engineering) improvements in quality, efficiency and speed are needed;
- guide product mix and investment decisions;
- choose among alternative suppliers;
- negotiate about price, product features, quality, delivery and service with customers;
- employ efficient and effective distribution and service processes to target market and customer segments;
- improve the value of an organization's products and services.

ABC/ABM systems are a very effective means for improving company performance on many fronts. An organization can realize the power of ABC and ABM when the right individuals access the right information in the best format for improving performance

The use of cost calculation systems in practice

Traditional cost calculation systems were developed decades ago and they are still used today worldwide (Horngren et al, 2003:109) in services (audit firms, consultancy companies, postal services), trade (product delivery, grain trade, timber trade) and production sphere (aircraft assembling, construction, oil refining, beverages).

A study made by Joye&Blayney (1990) shows that both job-order costing and process costing are widely used in several industries.

Other surveys (Ask&Ax, 1997; Inoue, 1998) identified that companies around the world are using mostly one of the traditional cost calculation methods at the expense of other methods. Still the percentages are close, there are no large variations.

With regard to the usage of ABC/M cost calculation systems a study made in the USA (CAM-I 1995) shows that companies adopted Activity Based Cost systems in order to: (1) determine/calculate the cost of products and services; (2) reduce costs; (3) enhance the production process; (4) elaborate price strategies.

Similar ideas emerge from surveys made in Europe (UK, Netherlands, Ireland). Researchers (Innes&Mitchell, 1995; Groot, 1999) concluded that in European countries there are relatively high adoption rates of the ABC/M couple and they found that the benefits of using the method were: (1) accurate infor-

Table 3 – Traditional cost calculation systems used in various industries

	Food industry	Textile industry	Steel industry	Chemical industry	Oil industry
Process costing	96%	91%	92%	75%	100%
Job-order costing	4%	18%	25%	25%	25%
Others	-	-	8%	12%	-

	Printing and publishing industry	Furniture and accessories	Machinery and computers	Electronic products
Process costing	20%	38%	43%	55%
Job-order costing	73%	63%	65%	58%
Others	13%	-	9%	10%

Source: Joye&Blayney (1990)[2]

Table 4 – The use of cost calculation systems worldwide

Cost calculation systems used	USA	Canada	Australia	Japan	Sweden	UK
Other cost calculation systems	31%	48%	33%	31%	42%	52%
Traditional cost calculation systems	69%	52%	67%	69%	58%	48%

Source: Ask&Ax, 1997; Inoue, 1998

mation regarding the costs of products and services; (2) improved cost control and better cost management; (3) performance measurement; (4) more accurate customer profitability analysis.

A recent study (Cohen et al, 2005) reveals high adoption rates of ABC/ABM in the USA and UK and smaller adoption rates in other European countries.

[2] The data shown in the table exceed 100% because the analyzed companies use more than one costing method.

Rates less than 10 percent characterize the European countries with the exceptions of the Netherlands where 12 percent of firms had implemented ABC, as well as Belgium. In France adoption rates were higher, about 20 percent.

The same survey shows that the reasons to implement ABC/ABM are driven by the need to improve customer profitability, to gain accurate and relevant cost information for pricing or budgeting, to modernize their cost systems, improve cost control and improve their business processes. However the implementation process has also disadvantages and presents difficulties such as the reluctance of employees or managers, difficulties in identifying and selecting activities, problems when collecting data for these new systems.

Besides ABC adopters there are companies that consider ABC implementation as a future target and companies that do not consider adopting ABC. According to the findings of relevant researchers the main reasons of rejecting the implementation process of ABC/ABM might be: satisfaction with the existing traditional cost systems, lack of management support and interest, implementation process being associated with high costs, consumption of time and resources.

Conclusions

From the examination of the literature in the field of managerial accounting and cost accounting we can conclude that traditional cost accounting and cost calculation systems do not provide detailed quantitative cost data and business process information that safety managers need. Without such data, managers do not know where to focus decision-making efforts in order to become more cost-competitive.

If we look back, traditional cost systems were developed in the early 1900's and are still widely used today. Advanced cost systems emerged in the late 1980's and many organizations have implemented these methods with real success.

Still there are organizations that continue to operate in a traditional way. Managers often use traditional systems and the information of these because they have little or no alternative or when the system is used to generate information for performance evaluation and the correlation between usage and success is higher in case of traditional systems.

Both traditional and advanced systems vary in their level of sophistication but in general traditional cost systems tend to be simplistic whereas advanced systems tend to be sophisticated.

Simplistic (traditional) systems are inexpensive to operate, they can generate inaccurate cost assignments and inaccurate costs and this can lead to mistakes and errors in the decision making process. These systems are not well equipped to provide regular, complete and reliable information on customer profitability.

On the other way ***advanced and complex cost systems*** are more expensive to operate but they minimize errors and mistakes regarding cost, they link the activities with competitive strategies. Usually, the implementation of these systems often requires higher costs and difficulties might appear during the use of these because various activities can appear. The implementation processes bring new rules and suppose a change of attitude and behavior and needs quite a long assimilation period before the general use within each company.

All in all the optimal cost system varies for different organizations. Within companies if the indirect costs have a low percentage of total costs and a fairly standardized product range, it will be more appropriate to use a traditional cost system because this may not result in the reporting of inaccurate cost. Else if there is a high proportion of indirect costs and products consume resources in different proportions, the optimal cost system might be a more sophisticated one because they are able to capture the diverse resource consumptions and assign the high level of indirect costs to different cost objects.

Knowing the managerial needs regarding costs, activities and strategies, each company needs to consider what method or system contributes to their unique needs. Management accounting systems must help organizations to achieve quality goals providing reports and measures that motivate and evaluate managerial efforts to improve quality, must develop cost systems that accurately measure costs and profitability.

References

Ask U., Ax C. (1997) *A Survey of Cost Accounting Practice in a Manufacturing Setting – the Sweedish Case*, Journal of Theory and Practice of Management, nr. 2 pp. 36-44

Bjornenak T., Falconer M. (2002) *The development of activity-based costing journal literature, 1987-2000*, The European Accounting Review, Vol. 11, No. 3, pp. 481-508;

Cohen S., Venieris G., Kaimenaki E. (2005) *ABC: adopters, supporters, deniers and unawares*, Managerial Auditing Journal, Vol. 20, No. 9, pp. 981-1000;

Cooper, R & Kaplan, R.S. (1989) “How cost accounting distorts product costs”, *Management Accounting*, April, pag. 20-27;

Groot T. (1999) *Activity Based Costing in U.S. and Dutch Food Companies*, Advances in Management Accounting, (7) pp. 47-63;

Hopper T., Major M. (2007) *Extending Institutional Analysis through Theore-*

tical Triangulation: Regulation and Activity-Based Costing in Portuguese Telecommunications, European Accounting Review, Vol. 16, No. 1, pp. 59-97;

Horngren Ch., Datar S., Foster G. (2006) *Contabilitatea costurilor, o abordare managerială*, Ediţia a XI-a, Editura Arc,

Hughes S.B, Gjerde K.P. (2003) *Do Different Cost Systems Make a Difference?*, Management Accounting Quarterly, Vol. 5, No. 1;

Innes J., Mitchell F. (1995) *A Survey of Activity Based Costing in the UK's Largest Companies,* Management Accounting Research, June, pp. 137-53

Inoue S. (1998) *A Comparative Study of Recent Developement of Cost Management Problems in USA, UK, Canada and Japan*, Economic Review

Jarvenpaa M. (2007) *Making Business Partners: A Case Study on how Management Accounting Culture was Changed*, European Accounting Review, Vol. 16, No. 1, pp. 99-142;

Joye M., Blayney P. (1990) *Cost and management accounting practices in Australian manufacturing companies : survey results.* University of Sydney, Accounting and Finance Foundation.

Kaplan R.S., Cooper R. (1998) *Cost&Effect . Using Integrated Cost Systems to Drive Profitability and Performance*, Harvard Business School Press;

Kerremans, M., Theunisse, H., Van Overloop. G. (1991) "Impact of Automation on Cost Accounting", *Accounting Business Research*, vol. 21, issue 82:147-155;

Lukka K., Mouritsen J. (2002) *Homogeneity or heterogeneity of research in management accounting?*, The European Accounting Review, Vol. 11, No. 4, pp. 805-811;

Needy, K.L., Nachtmann, H., Roztocki, N., Warner, R.C., and Bidanda, B. (2003) *Implementing activity-based costing systems in small manufacturing firms: A field study,* Engineering Management Journal, Vol 15. Iss 1, p 3;

Seed, A.H. (1984) "Cost accounting in the age of robotics", *Management Accounting* (NAA), October, pag. 39-43;

Shim, J.K., Siegel, J.G. (1998) *Schaum's Outline of Theory and Problems of Managerial Accounting*, Second Edition, McGraw Hill;

Zimmerman J. L. (2001) *Conjectures regarding empirical managerial accounting research*, Journal of Accounting and Economics, 32, pp. 411–27

Institute of Management Accounting

CIMA – Activity based management – an overview, Technical briefing, April 2001;

Guide for authors

The Economist's Forum invites papers presenting the conclusions of theoretical or applied economic studies, scientific debates, or book reviews. The articles can be written in Hungarian or English (for the special issue). The articles should be submitted to one of the following e-mail addresses:

balint.nagy@econ.ubbcluj.ro

office@rmkt.ro

The text should be between 15 and 20 printed pages, numbered, A4 format, characters Times New Roman 12, single spacing.

The first must contain the title of the article, the author's name, their complete scientific title and affiliation (professional address, phone, e-mail), followed an abstract of 5-10 lines, that should present the main results of the article. The abstract will be followed by 5-7 keywords.

The authors are also required to submit an English and Romanian abstract with keywords in a separate document.

The presentation of bibliographical references:

In the text the references quotes will appear between brackets, with the name and the publication date, e.g.: (Gyerőffy 1997).

For two co-authors they will use for example (Black and Scholes, 1973).

In the case of three or more than three authors, only the first will be mentioned, under the form (Barberis et al., 1998).

If two references have the same author and the same publication year, they will be differentiated through letters (Fama, 1965a). These letters will also appear in the bibliography. At the end of the article the references will be presented as follows:

Periodicals: The list of the authors including the first name initial, the year of publication, the title of the article, the name of the periodical in italics without abbreviations, the number of the volume and the number of pages.

Books: The list of authors including the first name initial and the year of publication, the title of the book in italics without abbreviations, the publishing house, the place of publication.

An MRP-based integer programming model for capacity planning

LEVENTE SZÁSZ[1, 2]

Abstract

Capacity planning decisions represent an important topic in the operations management literature, as they greatly influence the performances of the firm and determine if the firm is able to satisfy market demand in each period. In order to be able to deal with uncertainties and fluctuations of market demand and other elements of the internal and external environment, capacity planning decisions are broken down into several levels of aggregation. This paper builds a general integer programming model for capacity planning at the master production scheduling (MPS) level. Input data and parameters for the model can be gathered from a typical MRP/MRP II-based information system. Using the integer programming model we can determine the optimal level of production capacities, at which operating costs are minimal. The last chapter of the article presents a case study, where we use the integer programming model built to investigate what cost reductions are possible by optimizing capacity levels at a small-sized firm from the textile industry.
Keywords: capacity planning, MRP/MRP II system, production planning and control, integer programming, master production schedule.

Return to schooling in Hungary before and after the transition years

MELINDA ANTAL[1]

Abstract

In this paper, I compared the return to schooling in Hungary by using datasets available from the Hungarian Wage Survey carried out in 1986 and in 2000, with more than 600 thousand observations altogether. The results are in conformity with the expectations and other empirical researcher’s works, showing an increase in the return to schooling of 74% in these 14 years, and large increases in returns to education for those who attended a high school or a university/college. The lower positioned education levels didn’t bring significant changes in their premiums, this fact being one of the most plausible explanations why attendance to vocational schools dropped so dramatically after the communism collapsed. I also searched for explanations and solutions for the puzzle: why changes occurred in these 14 years, highlighting some possibilities which could be used as extension to the present work, solving the data selection problems faced with the current dataset.
Keywords: return to schooling, wage inequality/ differentials, human capital, transition economies, Hungary

Influencing factors of early-stage entrepreneurial activity in Romania

LEHEL GYÖRFY[1] **– ANNAMÁRIA BENYOVSZKI**[1] **– ÁGNES NAGY**[2] **– ISTVÁN PETE**[1] **– TÜNDE PETRA PETRU**[1]

Abstract

In Romania a representative sample of adult population was interviewed using a standard GEM questionnaire. After emphasizing the special situation of Romanian entrepreneurship in international context we aimed to determine the influencing factors of opportunity-motivated and necessity-motivated early-stage entrepreneurs, using socio-demographic and perceptual variables.
Keyword: Entrepreneurship, opportunity-motivated early-stage entrepreneurs, necessity-motivated early-stage entrepreneurs.

Traditional or advanced cost calculation systems? – This is the question in every organization

ILDIKÓ RÉKA CARDOS[1] – ISTVÁN PETE[1] – DUMITRU MATIS[1]

Abstract
In present context preoccupations regarding cost calculation, control and cost reduction are major challenges within organizations. Globalization represents a major change, which leads to performance and performance measurement. We are also the witnesses of technological and organizational mutations and evolutions, the automation of the production processes, the evolution of demands and competition, the new forms of competition. These phenomena are raising serious doubts on the classical instruments of managerial accounting and the traditional cost calculation methods. An answer appeared and we are facing new challenges and perspectives regarding cost calculation.
The purpose of this article – after analyzing the existing literature in the field – is to make a comparison between the traditional and modern, complex cost calculation systems and to emphasize that new cost systems such as ABC and ABM represent major innovations and permits not only the cost calculation and analysis but also measuring performances, defining strategies and are oriented through competition and customers.
Keywords: traditional and complex cost calculation systems, job order costing, process costing, ABC/ABM