Company Restructuring Tied to Information and Communication Technologies and Productivity’s Rise

Corneliu Russu

Institutul Național de Cercetări Economice, Centrul de Economia Industriei și Serviciilor, Calea 13 Septembrie Nr.13, Sector 5, București
email: Iei@Rol.Ro

Abstract
The 2003 European Competitiveness Report of the European Commission devoted a chapter to the effects of investments in information and communication technologies (ICT) on the level of firms productivity. The chapter is very interesting for its comprehensive vision about a primordial tendency in current strategies and practices of enterprises, the methodological elements it refers to, and conclusions drawn from studies carried out in this sense. The main theoretical, methodological and practical ideas of that chapter are highlighted below.

Key words: organizational changes, information and communication technologies, productivity

In the last years, the firms restructuring in order to modernize activity and increase their competitiveness is closely linked to introduction and extension of information and communication technologies (ICT) use, the most spectacular being known under the denominations of Enterprise Resource Planning – ERP, Supply Chain Management – SCM and Customer Relationship Management – CRM; to these complex systems one can add e-procurement (or online procurement) and e-marketplaces.

E-business represents electronic communications networks which allow enterprises to exchange information of diverse natures, and it encompasses electronic business processes (personnel recruitment, strategic planning, tactical planning, tactical and operational planning, stock control and administration, customer support, financial operations state etc.) and e-commerce (purchasing and sales).

ERP consists of a set of software applications which allow for uninterrupted integration and control of information concerning a firm’s activity and its business context, namely referred providers, products, customers, employees, economic-financial performances etc. to. Data bank that ERP is based on, is used for all operations carried out by the firm in the process of its activity – orders scheduling, stock control and administration, production planning and scheduling, sales, accountancy, human resources management, financial planning and execution etc., the respective data being recorded, processed and reported in unitary manner. Introduction of ERP in a firm is a long lasting process, very toilsome and, consequently, very expensive, which comprises the current state diagnosis, re-design of current functioning system depending on

conclusions of analysis carried out, data conversion in order to make them able to be used in the new system, personnel training, implementation of the system and its testing. Analysis of data gathered from 5000 US manufacturing enterprises engaged in ERP investments pointed out that the cost of licensing the software is only 30% of the overall cost of implementing the ERP system; to this one must add the expenditures for equipment procurement (18%), consultants and the programmers’ fees (24%), personnel training (11%), and implementation team (14%). ERP is useful, concomitantly, as information basis for two other modern business e-applications - SCM și CRM.

SCM covers the whole purchasing chain of firm, from raw material production process to setting out relationship with customers, providing integrated information about orders, forecasting, purchasing and production plans and schedules, stock level and its restoring, capacity to improve services’ quality and to reduce money immobilization in stock.

CRM, tied also to ERP, is a set of business processes which allow for the optimization of products shipment, service activity and information from purchaser to customer.

Empirical evidence demonstrates that benefits resulted from investments in ICT and introduction of e-business applications, which are expensive and need time, are considerably amplified when the respective investments are connected to changes of business strategy, business practices and organization structure of firms. Consequently, firms should make thorough assessment of their capabilities to introduce ICT and their effects, and policies at sectorial and national levels should strongly spur their introduction and swift diffusion.

E-procurement is an e-business application which allow for all designated beneficiaries to procure products and services by a web interface and to send orders by the same way to purchasers. E-procurement technologies comprise e-procurement specific software, auctions B2B (business to business), B2B exchange market, and providing consortiums.

E-market places (or e-Hubs, net marketplaces, B2B exchanges) represent digital „meeting” places which provide participants with two types of services: connecting a large number of potential partners, providers and buyers, for listing the goods they want to sell, respectively to buy; making easy potential partners interaction before, during or after decision making to do business together.

Organizational changes required by the introduction of these modern systems and methods to carry on firms’ activity may be of different natures, covering the following forms:

- Work processes changes and implementation of new work organization forms, including the use of different production inputs, the flow of work, job design, responsibilities sharing within the collective effort;
- Introduction of new practices in human resources management, including new material incentives, full transparency of specific information, extension of participative management, work scheduling, collective work, and autonomous working groups;
- Changes in organization structure of the firm, including diminishing of hierarchical lines, extension of authority’s delegation, deeper decentralization of firm’s activities, reconsidering decision making prerogatives, flexibilization of structure by extending use of dynamic organization forms – task force, project team etc;
- Improvement of industrial relations practices, especially those related to setting up more effective strategies and institutional structures in the field of employers – trade unions relationship;
Diversity of elements involved in systems and methods mentioned above, as well as organizational changes engendered by their implementation probably explain the scarcity of bibliographical references about their effects on firms’ performances, in the main, and on its productivity and competitiveness, especially. Consequently, methodological elements to assess the respective effects are not yet established. The overwhelming majority of studies published on this theme are based on interviews, case studies about certain firms, and industrial sectorial studies, most of them focusing on American firms. The relationship between investments in ICT, organizational changes and their effects on productivity made up the subject matter of some empirical studies which allow to draw some interesting conclusions:

1. There is a conspicuous and significant interaction between investments in ICT and the degree of firm activities’ decentralization, on one hand, and the level of productivity specific for respective firm, on the other hand;

2. Introduction of modern practices – transparency of decision making processes, remuneration depending on individual performances, decentralization of decisional prerogatives, intense investments in personnel training – have obvious effects on productivity increase.

For instance, a research carried out by the Danish Ministry of Business and Industry within 515 Danish manufacturing firms put in evidence that those which have not invested in ICT and achieved organizational changes have registered, during the period 1990-1993, 0,5% annual average increase of productivity, while the firms which have invested in new equipment and adopted new forms of work organization attained the level of 1,5% of the same indicator.

Evidently, methodological elements necessary to determine the effects of introduction ICT systems and new modern management systems related to (ERP, SCM, CRM), as well as of organizational changes, are far from being conceptually crystallized and operationalized for carrying out relevant studies. However, there are numerous concerns in this sense, confirmed by the large number of scientific studies and empirical attempts devoted to measuring the effects of these changes on productivity and competitiveness of firms. For the time being, the tools used for carrying out comparative analysis are, as was pointed out before, interviews, opinion inquiries, case studies, and analysis of correlation coefficients between use of ERP and changes of work productivity level.

**Methodological Details regarding Research at the Level of Representative Companies Panel**

The evaluation of organizational changes effects on productivity makes it necessary for the existence of relevant data gathered from a panel comprising firms belonging to different sectors. Relevant and comparable data at the international level to achieve such an analysis do not exist, and national data are very poor; this is the reason that explains why the analysis whose results were showed in the European Competitiveness Report 2003 of the European Commission was carried out for Germany, using a study regarding the panel of economic units IAB.

The units included in panel provided annually data, starting from 1993, concerning their turnover, number of employees, personnel problems, personnel training, investments, ICT use, innovation potential, public subsidies received. The variables describing re-organizations engendered by personnel participation to management, investments in ICT and personnel training referred to a certain year (1997), and the effects on productivity were estimated for cross sections by a production function available for the period 1998-2000.
A first assessment model regarding these effects is based on cross regression of a simple production function in which capital stock, work inputs, variables related to organizational changes and control variables are regressed depending on the value added. The organizational change is achieved by three re-organizations meant to ensure a better participation of employees to the company activity - amplifying responsibilities at lower levels of hierarchy, team working and self-responsible teams. The three measures are aggregated in an independent factor - „re-organization” within a factorial analysis.

The effects of re-organizations which ensured a better participation of the employees to management were estimated on the basis of Cobb-Douglas production function, in which independent variable is value added, and explanatory variables are capital, employees number, re-organization, investments in ICT, and continuous personnel training, finally adding other control variables. The impact of „re-organization” factor on productivity was determined with a Cobb-Douglas production function for cross-section:

\[ \ln Y_t = \alpha \ln K_t + \beta \ln L_t + \gamma R_{t-1} + \phi ICT_t + \varphi T_t + \delta X_t + \epsilon_t \]  

with t = 1998-2000, where: \( Y \) represents value added; \( K \) – capital; \( L \) – number of employees; \( R \) – „re-organization” factor; \( ICT \) – representation of investments in ICT; \( T \) – representation of investments in continuous training; \( X \) – vector of control variables including the weight of qualified employees, the legal form of the firm, representation of exporters, units with work councils and collective bargaining, and the state of the technical equipment; the symbol 1 pointed out the delays which are between 1 for 1998 and 3 for the 2000 cross estimation (because re-organizations have not instant effect on productivity); parameters \( \alpha, \beta, \gamma, \phi, \varphi \) and \( \delta \) – regression coefficients to be estimated; \( \epsilon \) – normally distributed error term with expected value zero and variance \( \sigma^2 \).

Cross regressions can only offer preliminary indications on possible productivity effects of the company re-organizations, because possibly important unnoticed characteristics of analyzed firm and personnel measures endogeneity are not taken into account.

A second assessment model is based on instrumental variables regressions if the outputs of applying the first model were influenced because the organizational changes (re-organization factor) are endogenous.

Under these conditions, it is advisable to take into consideration external instruments intuitively by explaining the variable selection process within the analyzed unit and by presenting necessary statistical features.

For instance, data gathered from units already checked up highlighted relevant aspects regarding the personnel training and human resources problems. In this sense, there were set up three types of external instruments: three variables in connection with personnel problems, regarding discrepancies of abilities and organizational changes (representation variable has value 1 if unit is expecting, as personnel problems, to find out on labor market persons having necessary skills, to encounter some difficulties caused by maternal leaves, and to face a large demand of personnel for qualification and training); four forms of personnel training expected to increase in the following two years – external formal courses, personnel rotation on jobs, self-inductive training, and quality circles (representation variable has value 1 if unit is expecting that incidence of these training forms will increase in the next two years). Each variable so designated is correlated with organizational changes because it is foreseeable that initiated measures will determine the increase of higher qualification needs.

Relation used to determine the factor ”organizational change” is:

\[ R = \alpha_1 I_1 + \ldots + \alpha_7 I_7 + \delta X + \epsilon \]  

where: \( I_1 - I_7 \) represent identifying variables; \( X \) – vector of control variables from the previous equation.
If endogeneity of unit’s decisions to achieve organizational changes is adequately reflected by chosen variables, estimation of cross production function can be deformed because other explanatory variables, especially labor and capital, are endogenous. The endogeneity of these variables and other in production function can be determined by the fact that invariables factors which have not taken into consideration – for instance, technological changes, management’s quality, or industrial relationship – influence explicative variables and value added.

Given these conditions, the third model for estimating the effects of a unit re-organization on its productivity supposes an estimating procedure in two steps.

In the first step, parameters of inputs factors which vary in time are determined on the basis of Cobb-Douglas production function with data gathered from the mentioned above panel for the period 1997-2000, while the effects of invariable determinants are regressed according to fixed effects resulting from analysis of panel in the second step. The estimation of fixed effects in the first step is made with the relation:

$$\ln Y_t = \alpha \ln K_t + \beta \ln L_t + v + \epsilon_t,$$

with $t = 1997-2000$, where: $v$ represents the unobserved time invariant fixed effect specific for the unit; $\epsilon_t$ – idiosyncratic component of the error term.

On the basis of regression outputs in this first step, the average fixed effect $\bar{v}$ during the period 1997-2000 is calculated for each unit. The average fixed effect can be interpreted as the average unit specific to the difference from productivity foreseen on the basis of inputs in its activity.

This dimension fixed in time points out as to the superiority or inferiority of total factors productivity specific for analyzed unit in comparison with other units. The vector of explanatory variables in the second step contains almost all invariable characteristics of the unit – re-organization factor, investments in ICT, continuous training representation and $X$ – vector of control variables, according to the relation:

$$\bar{v} = \gamma R + \phi T IC + \phi T + \delta X + \epsilon$$

An application of these methodological elements has demonstrated that the effects of reorganizations within a firm on its productivity can be made evident with sufficient accuracy if fixed unobserved effects and variables endogeneity are controlled. Endogeneity control ensures productivity’s increase under the re-organization impact on average fixed effect.

Regression makes it evident that more significant productivity increases when the three measures of re-organization are correlated and started in the same period; consequently, the firm which acts in this way gets a competitive advantage on productivity ground as against other firms which have initiated only one out of the three measures mentioned.

**Empirical Evidences**

Certain analyses carried out on methodological basis presented above for countries comprised in the sample EU – 4 proved in a conclusive way:

- the existence of some positive correlation coefficients between the use of different types of e-business practices and productivity changes;
- the existence of a negative correlation between the introduction of SCM and productivity level changes, due, probably, to the fact that the use of this e-business system is more frequent in resources-oriented industries;
- the stronger increase of productivity when the introduction of e-business practices is correlated with achievement of organizational changes mentioned above;
that the industrial sectors characterized by an intense use of e-procurement have a higher rate of productivity increase;

that the most important organizational changes engendered by the introduction of ICT and e-business practices are those performed on work processes, organizational structures, and relationship with providers;

the positive impact of e-business introduction on internal work processes, the most significant being experienced by telecommunication sector, computer services, publishing houses, and mass-media;

the close correlation between the diffusion of e-business practices and intensity of ICT use.

On the basis of these empirical evidences, the European Commission set up some guidelines for the policies aiming at the introduction of e-business practices and stimulation of organizational changes with a view to faster and better assimilation of these practices:

improving managerial comprehension and abilities for using e-business practices in small and medium sized enterprises (SMEs);

stimulation of setting up solutions concerning the use of friendly e-business practices in SMEs;

promoting SMEs participation to business network and e-marketplaces;

speeding up the application of measures established by the Action Plan e-Europe 2002, which focused on key objectives of achievement Internet communications less expensive, faster and surer, stronger investments in human capital (knowledge and skills), and stimulation of the complex use of Internet.

References


Rezumat

Raportul European asupra Competitivității din anul 2003, elaborat de Comisia Europeană, a dedicat un capitol efectelor investițiilor în tehnologiile informării și comunicării (ICT) la nivelul productivității firmei. Capitolul apare ca fiind foarte interesant datorită vizionii comprehensive asupra tendinței principale a strategiilor și practicilor curente ale întreprinderilor, elementelor metodologice la care se referă și concluziilor extrase pe baza studiilor desfășurate în acest scop. Acest articol reliefează cele mai importante idei la nivel teoretic, metodologic și practic ale acestui capitol.