Information Technology, organizational change and productivity growth: an empirical analysis of the Italian insurance industry

Calogero Matassa
Politecnico di Torino, DSPEA
Corso Duca degli Abruzzi, 24
10129 Torino
Tel. +39 011 564 7295; Fax +39 011 564 7299

Paolo Neirotti
Politecnico di Torino, DSPEA
Corso Duca degli Abruzzi, 24
10129 Torino
Tel. +39 011 564 7295; Fax +39 011 564 7299
paolo.neirotti@polito.it

Emilio Paolucci
Politecnico di Torino, DSPEA
Corso Duca degli Abruzzi, 24
10129 Torino
Tel. +39 011 564 7295; Fax +39 011 564 7299
emilio.paolucci@polito.it

Abstract

Research into the relationship between investments in IT and increased productivity growth has so far produced ambiguous results, although it has demonstrated a clear relationship between investments in technology and organizational changes.
In this context, the present article, using Italian insurance companies as examples, intends to highlight the ways in which combined investments in IT and organizational changes are able to influence productivity, thus allowing some of the limitations of traditional bureaucratic organizational forms to be overcome.
The results obtained show how the use of IT allowed insurance companies to achieve organizational models characterized by new methods of centralization and sharing of technical and market knowledge.
Through IT, such knowledge has been codified, standardized, and made available to all members of the organization, regardless of their ability to fully understand the technical aspects. The resulting organizational model is characterized by a polarization of the structures around two types of competencies: a core of technical experts and a multiplicity of sales channels. The advantages to productivity derive from the unbundling of these two types of knowledge within the organization, which has allowed new scale economies to be achieved, from a reduction of control costs, investments and duplications, to the exploitation of new forms of complementary relationships among the assets of insurance companies and those of other organizations.

Keywords
Organizational change, IT investments, productivity, centralization – decentralization of decision making

1. Introduction

The role of IT in increasing the productivity and efficiency of single enterprises or industrial sectors has been the subject of many studies, not always with unequivocal results. The common aspect of these studies - whether based on industry level approaches or on evaluations carried out at the level of an economic system - is the relevant difficulty in supporting the effects of IT on productivity with empirical evidence. This lack of empirical evidence finally resulted in the formulation of the productivity paradox (for a review see Brynjolfsson & Yang 1996), which points out that the benefits of IT are evident everywhere except in econometric analysis (Solow 1987). Even firm level research conducted from the end of the eighties achieved contrasting results (Strassman 1990; Parsons, Gottlieb and Denny 1990; Zachary 1991; Weill 1992; Diewert & Smith 1994; Brynjolfsson & Hitt 1996). More recent productivity studies have shown the positive effects of combining investments in IT with organizational changes, even though (mainly for lack of reliable data) the dynamics of the organizational models are only partially explained (Brynjolfsson, Bresnhan & Hitt 1998).

The intent of the article is to contribute to this debate by presenting the results of a study carried out on a sample of Italian insurance companies. The analysis has been addressed to investigate not only *if*, but also *how* IT affects productivity. The insurance industry, which has already been the subject of analyses related to the effects of IT on productivity, is suitable for such an analysis for the following reasons:

1. in Europe the industry is currently undergoing a process of deregulation; the related increasing levels of competetition in the industry represent a pressure to reduce costs and improve productivity;
2. the information-intensive nature of the insurance sector affects all the activities of the value chain (from risk evaluation to claim management), which are based on the ability to process information efficiently. For this reason investments in IT, which represent almost all investments in technical capital, affect productivity more than in other sectors;
3. the nature of the economic cycle in this industry (where revenues precede costs) makes it critical for companies to monitor risk assessment and risk rating activities retroactively, preventing them from focusing on the logic of simple automation.

Given the particularities of the insurance industry and the approaches of most recent studies on the effect of IT on productivity, we believe it is important to analyze the connections between productivity and technology with respect to changes in the organizational processes, in order to take into account not only improvements in efficiency, but also the impact on the effectiveness of risk evaluation and risk selection processes.

The article is divided into the following parts:

4. Chapter 2 summarizes the contributions found in literature on connections between IT, organizational changes and productivity, quoting also results related to the insurance sector;
5. In chapter 3, on the basis of findings obtained by some case studies on some of the main European insurance companies, three hypotheses concerning the role of IT and organizational changes in productivity are presented;
6. Chapter 4 reports the results of the empirical evidence from a sample of 44 Italian companies which supports the research hypotheses;
7. The conclusion discusses the possible development of the obtained results.

2. The debate on the connection between IT and productivity

The relevance of the debate on IT as a tool for increasing productivity is mainly due to the long-term impact of productivity itself in determining the competitiveness and survival of companies.

Even though the concept of productivity is easy to define (quantity of output produced per input unit), its measurement is becoming ever more complex, due to the impossibility (compared to the situation in the past where mass-production was prevalent) of limiting the analysis to the observation of the number of physical units produced, and also due to the difficulty of measuring input and output.

On one hand, contributions to the input do not come only from the physical quantities of capital and labor, but also from "organizational capital" (relationships with customers and suppliers, reorganization of business processes, acquisition and accumulation of new technical expertise, etc.). "Organizational capital" is difficult to formalize and it is not possible to find common accounting principles for it. On the other hand, output, especially in the services sector, is becoming more and more intangible, with a tendency on the part of the companies to pursue a performance mix measured in terms of quality, efficiency and impact on profitability.

Information Technology was seen as a general purpose technology capable of modifying the production methodologies of goods and services, but it did not bring noticeable productivity improvements for years, thus raising doubts about its "usefulness" and about evaluation criteria employed. During the 1980s these doubts, strengthened by statistical surveys, led to the *productivity paradox*. Only in the 1990s, the availability of firm-level data brought to light the positive contribution of IT (Dewan & Min 1997).

These studies, in pointing out the effects of reduced coordination and control costs, highlight a contribution of IT which goes beyond a logic of mere replacement of labor with technical capital (a phenomenon which can be traced back to the automation of routine activities).

On the whole, studies on the role of IT in organizations have considered the effects on middle management in terms of numerical consistency, decision-making autonomy and professional content of the duties performed. Leavitt and Whisler (1958) pointed out the effects of an improved ability to process information on the managers' decision-making abilities; Bolton and Dewatripoint (1994) argue that communication cost reduction facilitates coordination activities performed within a hierarchy. Bradley (1989), studying the psychosocial anspects of the introduction of computers in the late 1970s in an insurance company, points out delayering phenomena, the move of decision making power down in the organization and the enlargement of data processing department.

Other researches have investigated the effects of decision-making and control processes on the dynamics of decentralization trends. Malone (1997) explains how centralization and decentralization are able to coexist because of the process of dissemination of IT in businesses, particularly in the sphere of those he defines as 'connected decentralized' structures. Appelbaum and Albin (1989) points out different decentralization choices (connected to a contingent view of managerial decision) of decision making processes in the underwriting processes of two insurance companies. Brynjolfsson and Hitt (1998) show evidence of IT's positive contribution to productivity when forms of organization

decentralization occurr. The logic of decentralization is related to the ability of IT to reduce the internal costs of transaction and coordination.

The theory of transaction costs and the agency theory point out how decision-making decentralization can lead to further costs due to the opportunistic behavior of the individuals. Gurbaxani and Wang (1991) argue that IT, by reducing the costs of collecting and processing information, makes it possible to increase decision-making decentralization without reducing the degree of control over opportunistic and/or technically incorrect behavior.

A different way of looking at the advantages of IT is an evaluation of the complementary nature revealed between technological and organizational investments according to the resource-based perspective (Teece 1986; Clemons & Row 1991). This literature stream underlines how, beyond the centralization and decentralization phenomena, the importance of IT as an instrument of productivity improvement can be traced back to the ability to build and share a portfolio of heterogeneous resources (both tangible and intangible) which are difficult to imitate and obtain through market transactions. Therefore, these resources can represent the source of a long-lasting competitive advantage (Powell & Dent-Micallef 1997).

Finally, researches specifically focused on the use of IT in the insurance sector shows that the joint adoption of IT and new organizational forms are positively related to increases in productivity (Harris & Katz 1991a; 1991b; Francalanci & Galal 1998), and show that the decentralization of decision-making processes is a key goal of the transformation processes currently performed in the insurance sector (Jarvenpaa & Stoddard 1994). Although they were able to show the presence of such a connection, these studies had some difficulties defining the changes at an organization level. Francalanci and Galal (1998) used the composition of the workforce (subdivided into clerical workers, professionals and managers) as a variable useful for keeping track of the evolution of the decentralization trend.

Cummins and Rubio Misas (2001), using data of a sample of Spanish insurance companies, give evidence of productivity and efficiency gains in the industry along the 1990s, even though they show that several firms still operate with low tecnical efficiency and with decreasing returns to scale. Furthermore, most recent contributions (for instance, Applegate 2002) focus on the strategies of the traditional players about on-line distribution channels, emphasizing the lower variable costs per transaction of these channels and the potential productivity gains that are connected to the use of these channels for less complex insurance products.

Taken together, these contributions show that the IT–productivity combination can be connected not only to automation processes, but above all to the establishment of new organizational methods which are the result of expensive and time-consuming technological and organizational investments aimed at redesigning the flow of communications, the decision-making and working processes. The following paragraph is devoted to examining these aspects in greater detail.

3. Analysis of organizational change in insurance companies

The analysis of the organizational context in which the effects of IT on productivity and on changes in the work processes were studied was conducted through 10 case studies[1] on some of the largest European insurance groups.

3.1 IT investments and organizational change: the evidence of case studies

The case studies pointed out the presence of a general process of restructuring begun at the beginning of the 1990s, accompanied by substantial investments in IT intended to increase productivity. Besides cost reductions in data processing, the deregulation of the sector and the opportunities offered by the change of welfare and of the pension systems in Europe represent further drivers for this change.

The case studies pointed that in the 1990s IT investments were aimed at obtaining a substantial increase of productivity as a consequence of the reduction of control costs, staffs costs and distribution costs. Most of the insurance companies tried to combine these effects with their dimensional growth, reasoning that IT investment would enable them to overcome the traditional trade-off between their dimensional growth and the higher control costs of the insured risks.

In terms of change in the organizational models, the case studies highlighted a common logic based on the unbundling of both technical activities and sales activities within the company, thereby creating two poles around which to focus organizational structures and professional skills:

8. a technical core, in which to concentrate the knowledge required for the evaluation and management of risks and for product development, as well as most of the control activities required to issue non-standard policies (activities performed in the past by the territorial organization of the companies).
9. a multi-channel sales network, through which marketing knowledge was in large part decentralized, thus increasing the level of proxy for the decisions relevant to the features of the insurance products offered. In this case, the goal was the reduction of investments and the impact of distribution costs, while at the same time increasing the collection of premiums.

[1] Case studies were carried out on Generali and RAS in Italy; Allianz and Colonia Nordstern in Germany; CGA, Prudential e Royal & Sun Alliance in the United Kingdom; AXA-UAP, Groupama and Predica in France.

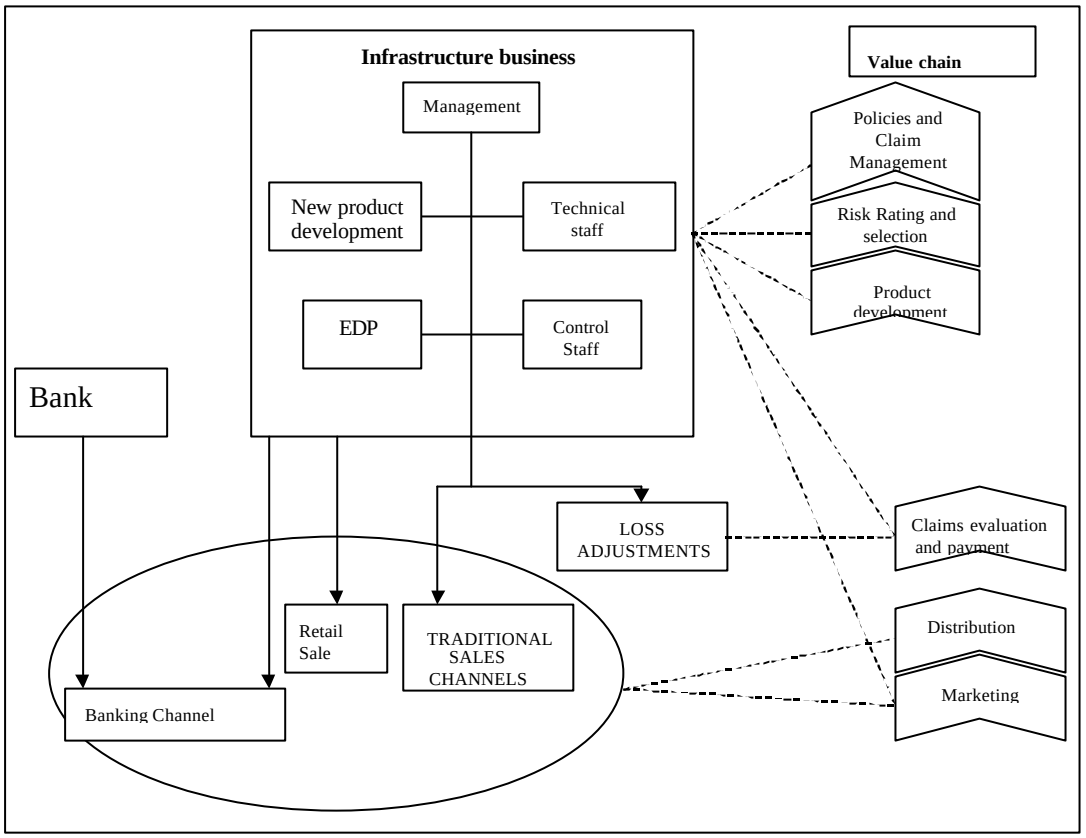

Figure 1. Exemplification of the change in organizational models

This analysis gives evidence of a complex mix of centralization and decentralization choices (similar to that one described by Malone in 1997), where IT investments and organizational change are closely connected. The effects of the polarization of organizational structures have an impact on several kinds of dynamics.

10. The change of organizational models has had as its focal point the re-engineering of the "technical" processes (risk evaluation, policy issuing and claims management) and of the "market" processes (marketing and sales). Their information-intensive nature has made it easier to eliminate the intermediate activities between the technical core and the sales channels, bringing about the implementation of more efficient control policies (regarding quality, costs, and assumed risks, etc.). Larger companies have began sooner than smaller the computerization of front office, providing most of the agents and of the customer representatives with on-line PC and with tools (in some cases, web portals) for supporting them in the distribution process.

11. Computer automation of the procedures for the issue of policies has reduced internal transaction and control costs: for example, in the presence of apparently higher grades of decentralization policy issue software increased the standardization of activities (technical knowledge has been incorporated into the software and made accessible on-line to all sales channels), and decreased the risks of mistakes and of opportunistic behavior. At the same time, the reduction of the costs of information processing and integration facilitated the standardization and measurement of the performance of individuals and of organizational units (for the latter a more precise value of the contribution given by the Expenses Ratio

(ER) and the Loss Ratio (LR) is reached[2]). IT also favored the empowerment process and granted the persons in charge of issuing the policies real time access to all the available information on customers and products. This development stage corresponded on one side to the beginning of decentralization and outsourcing of some customer contact activities, and on another side with the streamlining of the territorial structure which served as a connection between the technological core and the sales channels.

12. By reducing internal control and coordination costs, investments in IT made possible new connections between the technical core and the sales channels, allowing, for example, several complementary sales channels owned by the insurance companies themselves or by enterprises from other sectors to be connected to the technical core itself. One example is the use of the bank channel for policy sales activities, which allows the technical skills of "traditional" companies to be integrated with access to a wider client market at the banks – all at competitive costs. Moreover, the banks contribute additional market knowledge. In this way the insurance companies can concentrate their resources on their own core business, without having the additional costs needed to enter new segments of the market. Distribution activities become an independent area which can be performed more efficiently by companies specialized in customer contact, and not necessarily belonging to the insurance sector (figure 1). In order to get productivity gains, some companies are progressively eliminating the role of the agent for the distribution of less complex insurance products, relying or the Internet and Telephone Channel. In the USA Progressive, Geico, USAA have adopted this model, operating as "direct writers", while other companies have built partnerships with e-marketplaces for distributing products whose underwriting process can be easily automated.

13. With the codification of technical knowledge in software, the underwriting process, at least for less complex risks to evaluate, progressively evolves towards an activity in which the adopted software is a "commodity", an asset which is easily available to all the players. Thus, companies perceive the IT adopted in the underwriting process as an asset trough which each player will not distinguish by its competitors. Companies perceive that claim management and customer relationship will progressively become the core processes, in which a player can differentiate by competitors, building a lasting competitive advantage.

In most of the analysed firms, an organizational structure based on the type of customer has progressively replaced the former organization structure based on product. This choice reduced the need to process information at the cost of assets duplication and of lower productivity. This was made possible thanks to the capacity of IT to give all sales channels real time access to all the information available concerning customers and products, thus simplifying cross-selling strategies. Also, the concept of product has been progressively changing, with an increasing standardization with respect to the 1980s.

Investments in IT carried out in the past few years had also the goal of streamling the claim management process, which represents a relevant cost item, both because of the structural costs (related to the peripheral network of experts, inspectors, loss adjusters), and because of those costs generated by delays and mistakes in the evaluation of the amount of the claim.

[2] The Expenses Ratio (ER) is the ratio between management and commission expenses and collected premiums; the Loss Ratio (LR) is the ratio between paid claims and collected premiums. While the ER is a measure of technical efficiency, the LR measures the capability of the company of selecting and evaluating the risk.

The re-engineering of the process relies on the progressive elimination of paper based flow and on the growth of monitoring capability (through some decentralization choices and through the adoption of software for the fraud detection). The streamling of the process can lead to reductions in the time to settle a claim and to make easier for a claim handler or for a customer to track the status of the claim, by centralizing the information about claims. Beyond leading to cost savings, these reengineering programmes can produce benefits in terms of the companies' image, which is affected by the time employed to settle a claim.

In this process, a progressive divergence between the center of the organization and its periphery is occurring, with centralization and decentralization dynamics similar to those described earlier. For damages of lesser extent with standard characteristics some companies are delegating the evaluation and the settlement either to agents. The peripheral organization in charge of claim management deals with accidents that are more important: the involvement of the company core is higher or lower depending on the extent of the damages. However, the criticality of this activity on the profitability and on the customer satisfaction, which is less suitable to be controlled by IT, make decentralization or outsourcing more problematic.

The organizational changes described above seem to affect only partially pure life insurance and banking companies. In these firms, the choice to sell products with a mainly financial content leads to completely different organizational design choices, in which sales and brand creation costs are very low as a consequence of the use of the banking network as the main distribution channel.

However, complexity, timing and costs of the actions required to put into practice the organizational changes described above (especially those related to organizing in rather different ways work and to updating individual professional skills) explain the lack of immediate evidence of productivity improvement as a consequence of IT investments. Considering some trends between 1992 and 2000 about some productivity and technical efficiency indexes in a sample of the first 12 Italian insurance companies (in terms of market shares), we can have evidence of improvements in the productivity levels in almost the 12 companies, if we take into account the number of policies per employees and the ratio between management expenses and the number of policies (table A.1 and A.2 in the appendix). On the other hand, the less widespread presence (just 6 companies obtained improvements in this index between 1992 and 2000) of a reduction of the expense ratio in the considered time horizon in this sample confirms the considerations about the lack of a determinism (at least, currently) in the relationships between technology and performance (table A.3 in the appendix).

3.2 IT investments and organizational change: the hypotheses

The effects of processes of organizational transformation and IT investments on productivity have been summarized in three hypotheses; in these hypotheses it has been assumed that only combined and congruent investments in IT and in organizational changes may lead to higher productivity.

H1 *The combination of investments in IT and in organizational changes aimed at the codification and centralization of technical skills contributes to an increase in productivity*

This hypothesis takes up the idea that IT improves productivity (mainly in terms of ER reduction) if used to centralize technical skills (also accomplished through product standardization and simplification), to extend responsibilities and control in management functions (Pinsonneault & Kraemer 1993) and to increase managers' decision-making power. Massive investments in IT supported the transformation from paper to electronic documents and the consequent progressive "dematerialization" of the policy, with a growing formalization/standardization of information and of issuing procedures. At the micro-organizational level, all this facilitated the centralization of technical skills and the reduction of control costs, overcoming the restrictions of spatial proximity and information sharing between technical staff and policy sales staff, making the information needed to perform risk evaluation activities available to them in real time.

H2 *The combination of investments in IT and in organizational changes aimed at the decentralization of market expertise contributes to an increase in productivity*

Hypothesis H2 evaluates the aspects related to the use of IT in the decentralization of the responsibilities of customer acquisition and commercial management to the sales channels, which are assigned the task of following the evolution of the needs expressed by the market. With simplified technical and control components, the sales channels are free to concentrate on increasing the number of policies issued, on the practice of cross-selling and on acquiring new customers.

The expected effect of this decentralization process in terms of productivity is an improvement of the ER and of the premiums per employee, deriving from:

- Reduction of duplication in the sales structure;
- The possibility of using standard procedures and interfaces in the connection between the technical core and the sales channels (banks, phone sales, internet, agents, brokers)
- Simplification of front office outsourcing processes and generally of all the non-core activities needed for policy distribution

H3 *The centralization of technical skills and decentralization of claim management activities made possible by IT lead to greater risk control and damage evaluation abilities, with an improvement of the Loss Ratio.*

This hypothesis is aimed at showing if and how IT investments, by increasing the companies' ability to process information also furnished the companies with the tools needed to improve their capacity to control the risks they underwrite, even given a higher empowerment level. In this case it is expected that empowerment logic be targeted both toward the simplification of reimbursement claim forms, and toward increasing the ability to correctly evaluate the amount to be reimbursed.

4. Data analysis and hypotheses test

Data used to verify the hypotheses were available from the annual ANIA (Italian National Association of Insurance Companies) survey concerning staff composition, amount and nature of IT investments, premiums and cost performance. The analysis refers to a sample of 44 companies which mainly operate in property and casualty insurance and for which complete information is available for the period from 1992 to 2000. The time horizon considered allows us to appraise the organizational change dynamics that occurred in the companies.

Table 1 shows the types of the 44 companies considered (8 of which belong to European groups). Banking insurance companies and companies working mainly in the life insurance sector (having a life/accident ratio greater than 50%) have been excluded because their models and organizational processes are too different from those described above. The companies in the sample collected about 55% of the sector premiums and employed about 60% of the employees in 2000.

Companies	**Life insurance policies / Accident policies**			
	< 10%	10% - 30%	30%-50%	Total
Number of Italian companies	27	6	3	36
Number of foreign companies	7	0	1	8
Total companies	34	6	4	44

Table 1. Incidence of the life insurance sector for the companies considered in the panel (average values 1992 – 2000)

When processing the data, the effects of mergers and/or acquisitions have been taken into account. In considering data about companies involved in these operations, for the purpose of hypothesis verification, we have considered the separate companies as a single entity even before the merger/acquisition. Values for the years preceding the merger/acquisition were obtained by adding the values of the companies merged/acquired.

Furthermore, even though the current regulation framework imposes the accounting separation between life and property and casualty lines, in estimating the effects of IT and organizational variables the life and accidental damages areas have been considered as together in order to avoid distortion related to accounting choices of some common costs (related to IT investments and to other common resources) in only one of the two areas of activity.

In choosing the model, we referred to some work published in the most recent literature that estimated the joint effect of organizational variables and of IT investments variable upon productivity. Brynjolfsson and Hitt analyzed time period between 1987 and 1994 on a sample of 380 American companies using translogarithmic models (obtained assuming a Cobb-Douglas production function). The econometric model took into account the efficiency effects determined by changes in the organizational structure. Francalanci and Galal (see also (Harris, Katz, 91)) considered 52 American insurance companies in the life sector and assumed linear relations between organizational variables and IT investments.

For estimating the effect of IT upon productivity, we used three different regression models, in which the dependant variables were three performance indicators that are specific of the industry: premiums per representative, Expense Ratio and Loss Ratio. Other indices could furnish useful information in terms of productivity (as, for example, the number of policies issued), but they are not very suitable for econometric models due to problems of homogeneity in statistical data and, in some cases, for their not strictly economic nature. Furthermore, the decision to employ these three productivity indicators takes into account the distorting effects of specific strategic choices on productivity (e.g. strategies for extension of the market share at the cost of a reduction in profitability).

In order to test the hypotheses, the following variables have been used:

14. *IT* = the amount of IT investment per employee. Besides pointing out the importance given to IT investments and their amount, this variable is a proxy of the skill stock accumulated inside the companies in the years preceding the decision to invest in IT usage. The choice to use the IT investment level per employee (and not its annual variation) was made because it is a better indicator an organization's ability to select, implement and employ those technologies. Moreover, in the presence of an appreciable reduction of the price/performance ratio for those technologies in the considered time period, it is possible to have very small variations of IT investments even with a significant increase in the overall technological equipment.

15. *ST* = the ratio of the central staff employees to the total number of employees. This variable shows the process of centralization of technical skills, and, according to the hypotheses we have formulated, must have a positive effect on the increase of productivity.

16. *ST x IT* = the product of the IT and ST variables has been used to evaluate the presence of the combined effects of IT investments and organizational changes on productivity.

17. *VTA* = the ratio of the number of installed and connected on-line computer terminals to the number of agencies[3]. This variable captures the type of investments (stand-alone vs. on-line) better than their amount; it only partly shows the presence of decentralization choices in action, but there are no other such relevant variables available. High values in the ratio of computer terminals to the number of agencies are important in order to provide control and the prompt issuing of policies, to give the sales network all the necessary information related to the customer, and to allow the collection and/or sharing of data in digital format. The ratio of computer terminals per agency, therefore, represents the degree of decentralization in market responsibilities. It is therefore expected that VTA value positively affects productivity, resulting in a decrease in control costs.

18. *VTS* = the ratio of the number of computer terminals dedicated to the on-line connection of the inspectors' offices and number of employees in the inspection and damages reimbursement offices. This variable takes into account the degree of decentralization in claim management: high values are required to delegate more responsibility in claim adjustment and damages reimbursement to the peripheral organization, and to reduce the number of employees in the company.

19. *RVD* = the number of life insurance policies divided by the number of property damage policies. This variable, giving the weight of the life insurance sector in each

[3] The ratio is expressed in thousands of agency.

considered company, is expected to provide a positive contribution, because it becomes possible to spread the fixed costs of a "technical" and/or "commercial" nature over a greater number of policies, and also due to the fact that the life insurance sector often offers highly standardized products for which the risk can more easily be evaluated a priori;

20. *S* = a dummy equal to one for the non-Italian companies included in the panel. This variable has been used to point out possible differences in the strategies employed by these companies in terms of market share acquisition, customer selection, segmentation of the market, and profitability goals.

The methodological considerations above led to the formulation of three econometric models which employ these variables describing the amount of IT investments and organizational changes. In particular, the model in equation (A) refers to the verification of hypothesis **H1**, according to which the coefficients of the variables *IT*, *ST* and *StxIT* taken together do not equal zero. For the verification of hypothesis **H2**, the coefficients of the variables *IT* and *VTA* are used, and for hypothesis **H3** the coefficients of variables *ST* and *VTS* are employed.

$$PR_{it} = \alpha_0 + \alpha_{ST} ST_{it} + \alpha_{VTA} VTA_{it} + \alpha_{IT} IT_{it} + \alpha_{STxIT} ST_{it} x IT_{it} + \alpha_{RVD} RVD_{it} + dummy_i + \varepsilon_{it} \qquad (A)$$

$$ER_{it} = \alpha_0 + \alpha_{ST} ST_{it} + \alpha_{VTA} VTA_{it} + \alpha_{IT} IT_{it} + \alpha_{STxIT} ST_{it} x IT_{it} + \alpha_{RVD} RVD_{it} + dummy_i + \varepsilon_{it} \qquad (B)$$

$$LR_{it} = \alpha_0 + \alpha_{ST} ST_{it} + \alpha_{VTA} VTA_{it} + \alpha_{IT} IT_{it} + \alpha_{STxIT} ST_{it} x IT_{it} + \alpha_{RVD} RVD_{it} + dummy_i + \varepsilon_{it} \qquad (C)$$

The cross-sectional and time series nature of the available data (44 companies for a time period of eight years) allows us to make use of a sufficiently broad sample dimension. The coefficient estimate was performed using both the ordinary least squares (OLS) method on the pooled series, and the TSLS method (or two-stage GLS). This second method furnishes the correct assessors even in conditions of eteroschedasticity which may be of interest in a panel in which a sectional dimension prevails. The values obtained for R^2 may be considered satisfactory for cross-section – time series analyses. The linear model evaluates the impact of the organizational factors and of IT investments on the dependent variable in the same way. The panel does not allow us to evaluate the effects of delay over eight years, and effects of some exogenous variables (related, for example, to changes in characteristics of the insurance market) on the dependent variables not taken into consideration. Monetary values have been deflated to 1991.

Table 6 shows the coefficients estimated using the OLS method. The table columns indicate the estimated models, while the rows contain the estimated values for the coefficients of each variable considered.

Negative values of the estimated coefficients for the independent variables indicate a reduction in the premiums per representative PR, while the dependent variables ER and LR indicate an improvement in productivity and in risk assessment ability.

Variables	**PR**	**ER**	**LR**
α_0	-597.05**	0.33***	0.67***
	(273.76)	(0.011)	(0.018)
α_{IT}	-278.94***	0.002*	0.006***
	(32.79)	(0.001)	(0.002)
α_{ST}	1555.15 ***	-0.002	-0.058***
	(348.70)	(0.014)	(0.002)
α_{VTA}	59.52 ***	-0..0027***	-0.0038***
	(20.25)	(0.0008)	(0.001)
α_{VTS}	0.067	-2.19E-05	4.45E-05
	(0.46)	(1.85E-05)	(3.06E-05)
$\alpha_{ST\ x\ IT}$	534.31 ***	-0.0046***	-0.0074***
	(35.95)	(0.001)	(0.002)
α_{RVD}	4311.45***	-0.129***	-0.622***
	(552.71)	(0.022)	(0.036)
α_S	-395.85*	0.025***	-0.063***
	(246.33)	(0.0099)	(0.016)
N	395	395	395
R^2	61.5%	22.8%	54.9%
R^2_{adj}	60.8%	21.4%	54.1%

Table 2. Coefficient estimates of the models (SE in parentheses)
**p<0,1; ** p<0,05; *** p<0,01.*

The results reported in table 2 fully confirm hypotheses H1 and H2. Hypothesis H3, however, is proven only in part, confirming the need to read profitability performance from different points of view.

21. Analysis results show that the impact of IT investments alone on productivity is negative, with a decrease both in terms of *ER* and of premiums per employee; at the same time it leads to a worsening of the *LR*;

22. the sign of the coefficients of the organizational variable *ST* and of the product *ST x IT* bears out the positive effects of the centralization of technical skills and IT investments on productivity (hypothesis H1), highlighting the *PR* increase and the *ER* decrease. At the same time, a greater ability in the selection of risks is shown, with a decrease in *LR* (hypothesis H3). The relevance in all models of the *ST x IT* product underlines the importance of combined investments in technology and organizational centralization.

23. The coefficient of the *VTA* variable is relevant in every model and it confirms the advantages of market skill decentralization and *IT* employment in terms of productivity (hypothesis H2). The on-line connection of agencies, required to decentralize the issuing of policies and the management of some administrative activities, allows a higher number

of premiums to be collected per representative, reduces collection costs, and positively influences risk control abilities (*LR* improvement).

24. The coefficient of the *VTS* variable shows that, at the current time, the progressive connection of the damage inspector offices aimed at increasing delegation of claim management activities has no particular effect on productivity as a whole. This may be a transitory effect, being a change introduced only recently. Furthermore, the result is consistent with the greater difficulties in getting a relevant streamlining through the implementation of new IT applications the claim management process, with respect to automation of the underwriting process.

25. The relevance of *RVD* in all models confirms the presence of synergies between the life and accident sectors in terms of collection cost reduction. Its effect on the *LR* is not clear.

26. The relevance of the *S* coefficients underlines the differences in the choices made by foreign companies compared to the Italian ones, showing their effect on productivity. Foreign companies operating in Italy show a worse *ER* (possibly as a consequence of a smaller increase of premiums collecting and of their smaller size), and at the same time prove to be more careful with risk portfolio management, achieving a better *LR.*

5. Conclusions

This paper has analyzed the joint effects of IT investments and organizational changes on productivity in the Italian insurance sector. The results obtained show that the increase in productivity is bound not only to IT investments, but also to the implementation of important changes in work processes, in organizational models, and in insured risk selection and evaluation skills. On the other hand, the descriptive statistics on the sub sample of the first 12 Italian insurance companies, even though they confirm the growth of productivity along the past few years, seem to suggest how not necessarily the general attitude of the industry to invest in new IT tools is leading in each company to improvements in the technical efficiency (whose proxy is represented by the expense ratio).

These results are fully consistent with those of other studies that identified the combination of IT investments and decision-making power decentralization and delegation trends as the sources of increases in productivity. With respect to these studies, the results of the research we conducted brought up some issues that made us consider the decentralization and empowerment increase dynamics more critically, showing a more general change in efficiency research criteria through new forms of organization design based on two complementary trends which are manifested through different “phenomena” (the automation of routine activities, a large reduction of administrators and staff, etc.):

- the centralization and standardization of technical skills, which are transformed from implicit to explicit and made more easily “accessible” to a wide subset of an organization’s members. In this process IT investments make the articulation and the centralization of technical skills easier.
- The decentralization of market knowledge, even though the spheres of discretionary power in which it can be used tend to be reduced *a priori* by policy-issuing software. Market knowledge is based on “tacit” and personal knowledge, which is in continuous evolution and its standardization is not always convenient or possible. In this case, the role of IT is to make the most complete possible set of information available to the sales

channels, and to facilitate the process of controlling the authority proxy on the activities connected to policy issue. Some of the accident control and claims activities (especially those related to small accidents where IT offers the best advantages) also go through decentralization processes, with results which are not yet satisfactory.

The overall picture that emerges indicates that productivity increases are in direct proportion to the possibility for companies to implement new forms of bureaucratic organization and administrative activities based on the coding and reuse of the technical skills, though the relevant costs and time required for the changes must be taken into account. These models are characterized by radical changes in the base principles of job design, where the empowerment and proxy phenomena are balanced by a reduction of discretionary power in decision-making.

We believe that the analysis of these aspects related to the change in the bureaucratic organizational forms in other information-intensive areas (such as banking) must be the aim of future more in-depth analyses of the relationship between IT and productivity. Following are some possible guidelines for such future studies:

- Under which conditions will the approach of coding/centralization of technical knowledge aimed at obtaining scale economies and standardizing the modalities of their use prevail?
- In which spheres will the organizational structures tend to polarize around two extremes: a core which develops and spreads distinct and strategic knowledge, and a periphery which "adapts" this knowledge to "local conditions"?
- If the presence of the "intermediate core" in organizational structures could no longer be needed in the future, will the standardization of access to technical knowledge create the premises for the outsourcing of front office functions (policy issuing, bank account operations, information requests, etc.) to other companies or to the customer? In this sense, it is expected that the development of Internet portals will lead to further productivity growth through the downsizing of the technical core of the organizations and the corresponding dimensional increase of "technical support staff".
- Will the reduction of control costs make it possible to redesign work flow, so as to more accurately measure individual results, make use of new job enrichment, create more room for the personal skills of the individuals?

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8. Appendix

Company ranking	1992	1993	1994	1995	1996	1997	1998	1999	2000	**D** (2000-1992)**	CAGR* [92-96]**	CAGR [96_00]**
# 1	1368.79	1454.48	1542.04	1564.60	1624.73	1693.36	1802.41	1858.92	1952.34	583.55	3.49%	3.74%
# 2	1594.27	1697.09	1836.58	1965.86	1966.59	2196.50	2398.84	2512.17	2573.00	978.73	4.29%	5.52%
# 3	1857.77	1925.97	2029.11	2125.58	2173.14	2282.51	2379.12	2600.17	2685.18	827.41	3.19%	4.32%
# 4	1983.35	2092.93	2345.98	2543.00	2606.35	2664.21	2690.83	3384.14	3612.92	1,629.56	5.62%	6.75%
# 5	2574.28	2537.87	2562.73	2509.14	2218.69	2430.14	2659.90	2562.57	2550.89	***-23.39***	-2.93%	2.83%
# 6	2101.46	2281.40	2483.11	2617.48	2726.49	2836.61	2872.04	2793.88	2846.47	745.01	5.35%	0.86%
# 7	2019.43	2177.66	2880.17	2906.81	3497.11	3863.34	3997.42	2819.12	3110.03	1,090.60	11.61%	-2.32%
# 8	1906.04	1947.50	2042.83	2100.46	2085.76	2127.89	2147.37	2285.46	2338.16	432.13	1.82%	2.31%
# 9	2129.79	2003.80	1982.91	2035.41	2157.83	2281.18	2371.87	2293.80	2289.55	159.76	0.26%	1.19%
# 12	1952.70	2033.71	2176.23	2214.87	2237.45	2354.46	2296.59	2363.65	2383.78	431.08	2.76%	1.28%
# 13	1551.55	1615.39	1682.89	1794.19	1820.62	1833.50	1761.55	1826.52	1845.06	293.51	3.25%	0.27%
# 14	1463.49	1548.03	1627.41	1645.33	1634.26	1686.83	1723.54	1704.14	1729.90	266.41	2.23%	1.14%

Table A.1. The number of policies per employees between 1992 and 2000 in 12 of the first 15 Italian insurance companies

* *CAGR: compound average growth rate*

*** the digits in bold point out a worsening in the performance indicator in the considered time horizon*

Company ranking	Management expenses per policy (Euro)***									Δ (2000-1992)**	CAGR [92-96]**	CAGR [96_00]**
	1992	1993	1994	1995	1996	1997	1998	1999	2000			
# 1	38.5	37.5	37.1	36.8	35.7	36.1	32.8	34.0	30.6	-15.25	-1.49%	-3.03%
# 2	25.2	23.2	21.8	20.0	19.6	19.5	16.2	15.1	13.9	-21.96	-4.96%	-6.63%
# 3	20.5	19.6	19.7	18.9	18.1	18.7	16.5	19.6	13.3	-14.00	-2.48%	-6.01%
# 4	20.1	21.2	20.4	18.7	17.8	18.3	17.0	14.5	12.6	-14.52	-2.49%	-6.57%
# 5	16.6	17.5	17.5	17.2	20.4	19.3	18.1	19.3	16.6	0.00	**4.18%**	-4.01%
# 6	17.6	16.3	15.1	14.4	15.1	14.0	12.9	12.4	12.9	-9.02	-3.04%	-3.03%
# 7	18.6	16.7	12.0	12.5	11.1	10.0	9.4	13.4	11.5	-13.79	-9.75%	**0.60%**
# 8	17.3	17.0	16.8	16.8	17.4	17.3	16.0	15.3	14.3	-5.87	**0.09%**	-3.86%
# 9	16.8	16.7	18.0	18.9	19.5	20.4	16.1	16.6	15.6	-2.38	2.99%	-4.36%
# 12	20.1	19.9	19.6	18.6	20.0	19.2	21.2	21.1	20.1	**0.09**	-0.05%	**0.09%**
# 13	23.6	22.6	23.2	22.1	22.6	22.7	22.0	22.0	23.4	-0.42	-0.87%	0.69%
# 14	25.6	24.4	24.3	23.7	24.3	24.0	22.6	23.2	22.2	-6.57	-1.10%	-1.71%

Table A.2. The management expenses per policy between 1992 and 2000 in 12 of the first 15 Italian insurance companies

*** the digits in bold point out a worsening in the performance indicator in the considered time horizon*

**** the values are deflated to year 1990*

Company ranking	1992	1993	1994	1995	1996	1997	1998	1999	2000	D (2000-1992)**	CAGR [92-96]**	CAGR [96_00]**
# 1	21.17%	26.32%	25.79%	24.92%	25.08%	23.60%	22.13%	19.96%	20.00%	-1.17%	**3.45%**	-4.43%
# 2	25.07%	28.11%	28.75%	31.70%	32.44%	29.35%	29.82%	27.00%	25.89%	**0.82%**	**5.29%**	-4.41%
# 3	21.74%	27.37%	27.37%	27.87%	29.37%	26.74%	28.35%	27.66%	27.72%	**5.97%**	**6.20%**	-1.15%
# 4	19.82%	25.41%	23.91%	20.37%	20.15%	21.84%	17.31%	17.00%	17.91%	-1.91%	0.32%	-2.32%
# 5	27.73%	30.47%	30.86%	27.25%	30.92%	27.28%	29.80%	33.91%	34.02%	**6.29%**	**2.20%**	**1.93%**
# 6	21.17%	29.56%	28.70%	26.52%	25.89%	19.95%	20.70%	18.07%	16.71%	-4.46%	**4.10%**	-8.38%
# 7	24.05%	28.25%	27.18%	27.19%	27.98%	33.46%	20.77%	15.29%	15.00%	-9.05%	3.08%	-11.72%
# 8	21.61%	27.74%	27.62%	27.38%	27.43%	27.92%	23.79%	23.04%	21.95%	**0.34%**	**4.89%**	-4.36%
# 9	28.46%	33.98%	32.08%	30.33%	30.31%	28.15%	26.48%	24.09%	24.67%	-3.79%	**1.27%**	-4.03%
# 12	21.97%	31.59%	30.54%	28.91%	29.21%	28.08%	29.00%	28.29%	17.14%	-4.83%	**5.87%**	-10.12%
# 13	24.16%	30.41%	30.16%	29.42%	30.25%	28.34%	28.13%	27.43%	27.17%	**3.01%**	**4.60%**	-2.13%
# 14	24.49%	31.59%	30.90%	30.38%	30.33%	23.80%	26.26%	25.74%	26.44%	**1.95%**	**4.37%**	-2.71%

Table A.3. The expense ratios between 1992 and 2000 in 12 of the first 15 Italian insurance companies

*** the digits in bold point out a worsening in the performance indicator in the considered time horizon*