Automating Coordination Mechanisms

Markets, Hierarchies, and Associations

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Abstract

This paper revisits the ”move to the market” hypothesis proposed by Malone et al. (1987) and argues that, although compatible with empirical results, the theoretical basis of this hypothesis is flawed since no clear distinction is made between coordination mechanisms and forms of governance. Based on this distinction, a theoretical framework is developed which has two main advantages compared to other modes of explanation: (1) it can easily deal with a number of theoretical inconsistencies created by existing modes of explaining IT’s impact on the organization of economic activity; (2) it allows for deriving a number of hypotheses which, if not rejected by empirical tests, allow for a greater degree of confidence in the nature of the causal relationship between IT and the organization of economic activity. The paper proceeds by first developing a set of hypotheses concerning IT’s impact on coordination mechanisms and, building upon this analysis, developing a second set of hypotheses concerning IT’s impact on governance forms. As a novelty, these hypotheses predict the increasing importance of associative forms of governance as IT is used to automate coordination mechanisms. Implications of these hypotheses from a management and a regulatory point of view are tentatively discussed.

Keywords: information technology, organizational structure, institutional structure, coordination

1. Introduction

In an influential paper published as early as 1987, Malone et al. have proposed that one effect of applying information and communication technologies in the sphere of economic activity will be increased use of markets to coordinate economic activity at the expense of hierarchical forms of coordination. It seems that among the many hypotheses made during the dawn of the Internet era this one stands alone as not already having been refuted by current developments (Coltman et al. 2000). Indeed, available empirical evidence actually supports this hypothesis as there is a statistical association between IT spending and decreasing degrees of vertical integration as well as of sheer firm size (Brynjolfsson et al. 1994).

Nevertheless, this ”move to the market” hypothesis has been criticized on theoretical grounds. Specifically, two alternative predictions have been offered which became known as the ”move to the middle” and the ”mixed modes of operations” hypotheses (see Clemons et al. 1993 and Lockett/Holland 1993 respectively). The ”move to the middle” hypothesis claims that IT will lead to both, more market coordination and increased levels of ”explicit coordination” within market relationships. The ”mixed modes of operations” hypothesis suggests that those two coordination mechanisms could be combined, leading to market coordination within hierarchies and hierarchical coordination within market relationships (see Klein 2000 for a synopsis of this discussion).

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Given the current focus on electronic retailing and electronic forms of interaction between firms the question arises why one should revisit the ”move to the markets” hypothesis. The reason is that the question about the causal mechanism between using information technology and coordinating economic activity has not yet been settled. Apart from the debate which followed in the wake of the ”move to the market” hypothesis this can also be seen by Brynjolfsson’s (1994) attempt to offer an alternative explanation for the empirical relationship between decreased degrees of vertical integration and IT spending. Criticizing the transaction cost theoretic explanations proposed by Malone et al. (1987), he uses property rights theory to propose an alternative explanation; moreover, Brynjolfsson (1994) points out that more specific hypotheses need to be developed in order to clarify the causal mechanisms involved in IT’s impact on coordinating economic activity.

In this paper I will argue that both, the transaction cost and the property rights theoretic explanations are flawed because they do not distinguish between two organizational domains, namely that of motivating economic actors to cooperate (rather than to act opportunistically) and that of coordinating their efforts given they are sufficiently motivated to cooperate (Milgrom/Roberts 1992, p. 126). The first issue involves the question of which governance forms (such as markets and hierarchies) should be used; the second issue, in contrast, focuses on coordination mechanisms (such as direct supervision and the price mechanism).

Although these domains are linked, it is important to separate them analytically in order to make their linkage explicit and thus amenable to analysis.[1] Based on such an approach, I will (1) analyze IT’s impact on coordination mechanisms without considering incentive effects and (2) analyze IT’s impact on governance forms by considering coordination and incentive effects simultaneously.

The paper is organized as follows. In the next chapter I will analytically separate the two domains of organization, i.e. forms of governance and coordination mechanisms. In chapter 3 I will then build on coordination theory in order to demonstrate which factors determine the selection of coordination mechanisms. This discussion abstracts from motivational issues, i.e. it will be assumed that actors are sufficiently motivated to cooperate but need appropriate information to guide their actions. In this domain, IT will affect organization structure via changing the costs of available coordination mechanisms by automating them thus leading to shifts in the composition of coordination mechanisms used at any point in time. In chapter 4 I will link this discussion with the question of motivating economic agents to cooperate rather than to act opportunistically involving several forms of governance; based on this analysis, IT’s impact on governance forms will then be explored. In chapter 5 I will develop some ideas how to empirically evaluate the hypotheses which are developed in chapters 3 and 4 and in the concluding chapter I will develop some first ideas concerning the managerial and regulatory implications of these hypotheses.

2. Two theoretical domains of organizing

Up to now, most analyses of IT’s impact on organizational structures are based on assumptions of how IT will affect incentives of economic actors to cooperate rather than to exploit one another, i.e. on the propensity of economic actors to act opportunistically. For example, Malone et al. (1987) suggest that IT will decrease the degree of asset specificity, i.e. the degree to which productive

[1] As Williamson (1987) has pointed out, without limits on information processing and communication capacity (i.e. with unbounded rationality), any type of opportunistic behavior can be anticipated and provided for in perfectly contingent contracts; similarly, without the threat of opportunistic behavior any constraints on information processing and communication capacity can be compensated by perfectly collaborative efforts of the involved actors to adjust to unforeseen events. However, it is less clear how bounded rationality and opportunistic behavior are linked in the space between these extreme cases.

assets are dedicated to individual customers or suppliers thus exposing their owners to potential hold-up problems. Similarly, Brynjolfsson (1994) proposes that IT will lead to information being distributed more widely thus creating economic incentives to distribute ownership of complementary physical assets as well; otherwise, owners of physical assets and owners of ”information assets” could threaten one another by withholding their resources. Distributing ownership of physical assets would unify ownership of physical and information assets once more and thus remedy this potential hold-up problem.[2]

At the same time, it has been argued that information technology will affect the costs of coordinating economic activities directly by automating certain information processing and communication tasks. Malone et al. (1987), for example, have argued that ”[s]ince the essence of coordination involves communicating and processing information, the use of information technology seems likely to decrease these costs ...” (p. 486). More specifically, they suggest that IT will affect coordination costs by allowing more information to be communicated in the same amount of time at lower cost. This would enable the production of an increasing number of complex products to be coordinated by markets rather than within hierarchies because such coordination requires the exchange of complex product descriptions.[3]

Thus, arguments are advanced which are based on IT’s impact on incentives to cooperate/act opportunistically as well as on costs of information processing and communication. Moreover, these arguments are often combined suggesting that the impact of IT resulting from these factors points into the same direction and that IT affects the same organizational dimensions or domains. There are at least three reasons why it is necessary to clearly separate IT’s impact on incentives to act opportunistically and on the costs of information processing, i.e. between the theoretical domains of governance forms and coordination mechanisms.

First, separating IT’s impact on incentives to act opportunistically and on the costs of information processing would have the obvious advantage of allowing for opposite effects of these two causal mechanisms on organizational structures and of distinguishing between possible differences of IT’s impact in the two organizational domains of governance forms and coordination mechanisms.[4]

Second, the nature of these two factors is different in one fundamental respect. Whereas the incentive impact of information technology is subject to intentional design, its costs cutting properties with regard to information processing and communication are not. It is impossible for any one actor (individual or collective) to reverse technological development in order to reduce IT’s ability to economize on information processing and communication costs. In contrast, designing information systems allows for sufficient degrees of freedom to increase as well as decrease asset specificity or the extent to which information is distributed in an organization. Revealingly, Clemons and Row (1992), who argue that IT will simultaneously reduce coordination costs and transaction risk related to the threat of opportunistic behavior (see footnote 4), state that ”... IT *design decisions* can greatly increase or decrease the level of risk. For example, the decision to use off-the-shelf hardware and industry standard protocols will reduce the transaction risk, while the use

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[2] Another example of this approach is the theoretical analysis of Xiao et al. (1998) who investigate IT’s impact on information asymmetry.

[3] Malone et al. (1987) introduce ”complexicty of product description” as a determinant of governance forms in addition to established factors such as asset specificity.

[4] Clemons and Row (1992) explicitly distinguish between coordination costs and transaction risk as components of transaction costs. However, their main argument is that IT's impact will be to reduce both in magnitude thus allowing for more ”explicit” coordination without increasing transaction risk (i.e. degrees of asset specificity). They use this argument as a basis for their ”move to the middle” hypothesis (i.e. more market coordination with fewer business partners) and contrast this hypothesis with that of Malone et al. (1987) who predicted a move towards more market coordination with an increasing number of business partners. This is surprising since Malone et al. also assume that IT will lead to a reduction in coordination costs and asset specificity. For an effort in resolving these issues, see chapter 4.

of custom hardware and proprietary protocols will increase the transaction risk." (p. 20; my emphasis). Indeed, the literature on technological development has amply demonstrated that, with regard to design parameters, there is no such thing as technological necessity in technological development or, as it is known in these literatures, technological determinism (cf. Williams/Edge 1996). Thus, IT's direct impact on governance forms is subject to design decisions rather than being determined by some internal characteristics of information technology.[5] In contrast, IT's impact on coordination mechanisms may be affected by continuously increased degrees of information efficiency (the amount of data which can be processed and/or communicated with a given amount of resources). Therefore, it is necessary to analyze IT's impact on incentives and information processing costs separately.

Third, there is a significant degree of confusion in the IT-related literatures concerning the concepts of markets and hierarchies which could be avoided by separating between these two theoretical domains of organizing. For example, "market coordination" is generally meant to imply both, the use of purchasing contracts (as opposed to employment contracts) for aligning incentives between collaborating economic actors (i.e. for achieving cooperation in an agency relationship) and the use of the price mechanism. Similarly, "hierarchical coordination" implies the application of certain coordination mechanisms such as direct supervision as well as the use of the institutional form of an employment contract to align incentives. Moreover, hierarchical coordination is often equated with "unified ownership" thus implying that a market can be characterized as an arrangement of "distributed ownership" (Brynjolfsson 1994). Also, Malone et al. (1987) define a hierarchy solely in terms of structural properties. Thus, a supplier-buyer relationship with a 1:m structure (i.e. a monopoly) is regarded as a hierarchy. Holland and Locket (1993) speak of a "hierarchy within a market" and a "market within a hierarchy" indicating that firms may use market forms of coordination, i.e. price mechanisms, and vice versa.[6] Clemons and Row (1992) suggest "cooperative relationships" as distinct from both, market and hierarchical forms of governance.

Distinguishing between governance forms and coordination mechanisms can help to increase terminological and conceptual precision. Governance forms pertain to the *institutional* mechanism used to align incentives of collaborating agents. Roughly speaking, these institutional forms fall into two broad categories grouped around the employment and the purchase contract respectively. Obviously, these forms of governance are closely related to the concept of "markets and hierarchies" as elaborated by Williamson (1975). In contrast, coordination mechanisms refer to the methods of providing economic actors with information required to align their actions with those of cooperating actors, i.e. coordination pertains to the question which information economic actors need to collaborate supposed they intend to cooperate (rather than to act opportunistically).

I want to show briefly how this distinction helps to clarify the issues mentioned above. First, consider the relationship between ownership and hierarchical governance. It is often assumed that ownership of physical assets implies the legal right to direct employees and can thus be equated with hierarchical governance. However, recall that in the early stages of the evolution of the manufacture workers were often required to bring their own tools to work (Chandler 1980). Similarly, use of leasing contracts for increasing chunks of "capital" equipment clearly demonstrates that ownership of physical assets is not required for hierarchical governance.7

Second, the confusion emanating from Malone et al.'s conceptualization of monopolistic

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[5] Later (chapter 4) I will show that in a specific sense, IT has a deterministic indirect impact on forms of governance.

[6] Picot et al. (1996) even see firm boundaries "fading" as a result of such flexible combinations or coordination mechanisms.

[7] Of course, it may be difficult to write leasing contracts in which case ownership of physical assets will provide a more transaction cost efficient solution. This, however, is not related " to the question of using employment contracts rather than purchasing contracts or contracts of manufacture to obtain cooperation in collaborative relationships.

markets as hierarchies can be easily resolved by distinguishing between a market as an incorporation of the price mechanism (in which case a monopolistic market would not be considered a market and, by implication, must be considered a hierarchy if there is no third alternative) and a market as a governance form using purchasing contracts or related forms of contracts (in which case a monopolistic market can be considered as one type of market arrangement).

Third, both Holland and Locket (1993) and Clemons and Row (1992) imply some combination or mix of markets and hierarchies which, using the distinction made here, can be re-conceptualized as various combinations of governance forms with coordination mechanisms. A hierarchy could, for example use an internal price mechanism for the allocation of certain scarce resources (say capital to lending departments in a bank, cf. Buhl et al. 1996) and firms in a buyer-suppliers relationship could use joint scheduling techniques for coordinating their production activities.[8]

I will now turn to a more explicit discussion of IT's impact on coordination mechanisms and deal with IT's impact on governance structures in the next chapter. For this purpose, it is necessary to briefly review the literature on coordination mechanisms.

3. IT's impact on coordination mechanisms

Analyzing IT's impact on coordination mechanisms could be done by trying to identify differential impacts of IT on individual coordination mechanisms. However, it has been suggested that the use of coordination mechanisms is constrained by the type of underlying interdependence between activities (Malone/Crowstone 1994). Thus, coordination mechanisms cannot be assumed to be functional equivalents a priori. Rather, only a subset of all available coordination mechanisms may be appropriate for each type of interdependence. Thus, it is necessary to first classify these coordination mechanisms with regard to the type of interdependence they are suitable to coordinate. Then, differential impacts of IT on individual coordination mechanisms within these subsets might be explored. Finally, it might be asked if IT will have an indirect impact on the use of coordination mechanisms by affecting the boundaries between different types of interdependencies thus triggering a second order shift in the composition of coordination mechanisms used for coordinating economic activities.

3.1. Classifying coordination mechanisms

Recently, efforts have been made to unify a body of knowledge under the term ”coordination theory” drawing together insights from computer science, economics, and organization theory (Malone/Crowstone 1994). The idea is to describe types of coordination requirements and match these with possible coordination solutions. In an effort to classify these processes, Thompson's (1967) distinction of three types of interdependencies is used, albeit in a modified form (Malone et al. 1999). Briefly, the differences are as follows. Whereas Thompson describes interdependencies between departments, Malone et al. refer to interdependencies between activities. Thompson distinguishes between pooled, sequential, and reciprocal interdependencies which has been changed to fit, flow, and sharing interdependency by Malone et al.[9] Figure 1 illustrates the concept.

[8] Then, it also becomes clear that flexibly combining coordination mechanisms with governance forms does not imply any fading of firm boundaries as claimed by Picot et al. (1996).

[9] In addition to these three basic forms of interdependencies, Malone et al. (1999) distinguish between three forms of flow interdependencies which are named ”prerequisite” (”right time”), ”accessibility” (”right place”) and ”usability” (”right thing”).

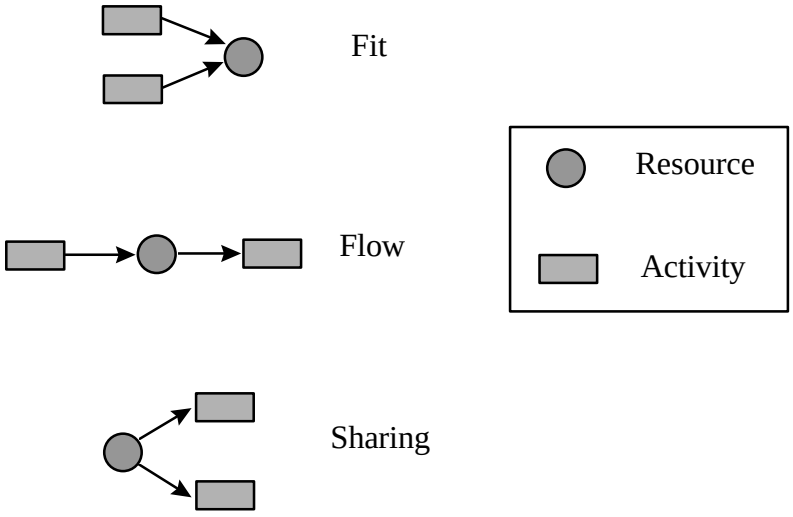

Figure 1: Three basic types of interdependencies among activities (Malone et al. 1999)

Coordination mechanisms are then associated with these forms of interdependencies, albeit in a rather ad hoc fashion without explicating the criteria for associating particular coordination mechanisms with types of interdependencies. Moreover, coordination mechanisms are not theoretically defined but rather empirically derived and compiled in a ”handbook of organizational processes” meant to stimulate designers of organizational processes to consider a variety of alternatives available for a given coordination problem (Malone et al. 1999). Thus, a more explicit approach to classifying coordination mechanisms seems indicated for the purpose of assessing IT’s impact on coordination mechanisms.[10]

Thompson has suggested that the three types of interdependencies are linked to three forms of coordination, namely the use of rules, plans and teams (1967, p. 60). However, organization theory has developed a richer set of coordination mechanisms which should be considered for classification purposes. Mintzberg (1979) proposes to distinguish between five coordination mechanisms: mutual adjustment, direct supervision, and standardization of work output, work process and skills. As this list is quite comprehensive and can be reconciled with other proposals (for example Kieser/Kubicek 1983; for a survey cf. Crowstone 1994), I will use it for the purpose of classifying coordination mechanism.[11] However, in addition to this list of coordination mechanisms the price mechanism needs to be included since it clearly represents a form of coordinating economic activities. Coordination by mutual adjustment implies that actors performing activities which need to be coordinated observe one another as they are carrying out their activities and adjust their own activities as required. Direct supervision means that one person will observe activities to be coordinated and direct agents performing them as required. Standardizing work processes implies that activities are carried out in a predefined way. March and Simon (1958) refer to this coordination mechanism as programming. Standardization of work output means that output targets in terms of physical quantities and deadlines are formulated to coordinate work. If the process of specifying output targets is standardized as well, this coordination mechanism is called planning (Kieser/Kubicek 1983). The price mechanism coordinates by soliciting competing buying and selling bids for scarce resources, ranking buying bids from highest to lowest and selling bids from lowest to highest and matching bids according to their ranking position.[12] Figure 2 summarizes these

[10] Crowstone (1994) has proposed a ”taxonomy of organizational dependencies and coordination mechanisms”. However, this framework does not solve the problems mentioned above.

[11] As standardization of skills is generally done by educational institutions, I do not consider it here.

[12] This description of a price mechanism implies that competition exists among buyers and sellers. If only buyers compete, then the price mechanism becomes a one way buying auction and vice versa.

five coordination mechanisms.

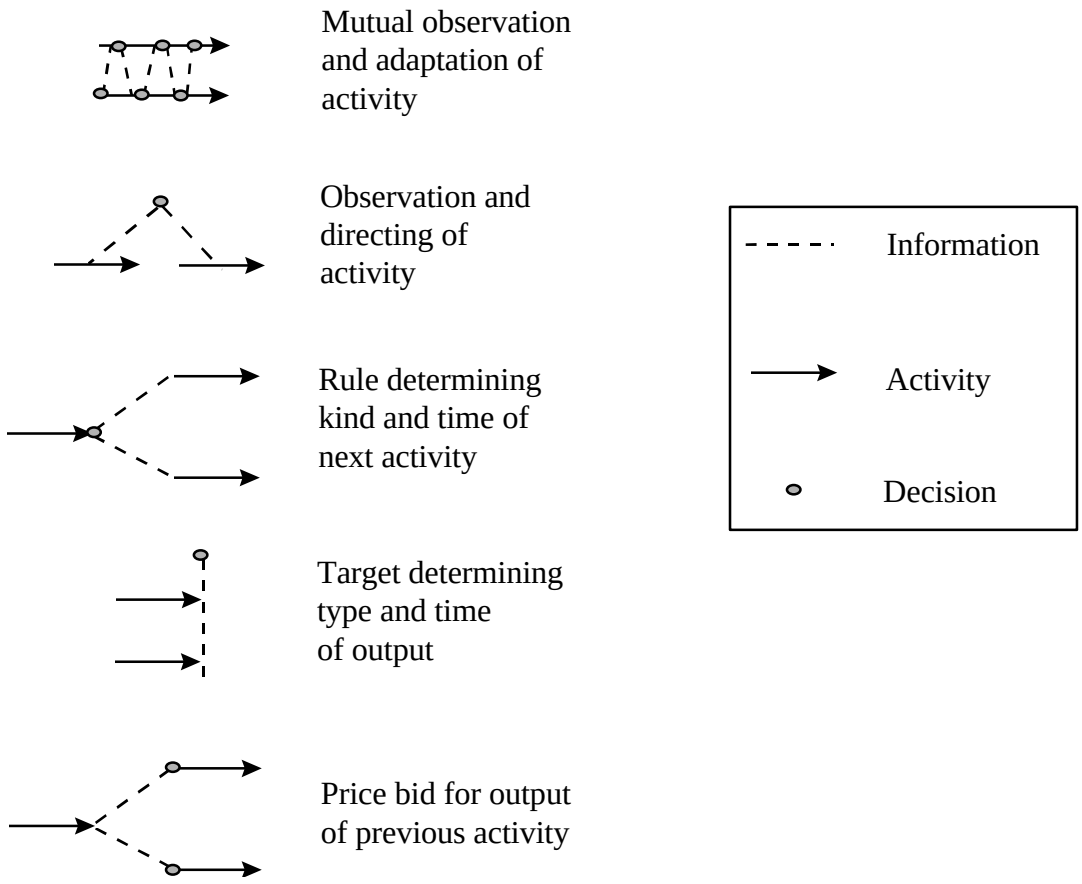

Figure 2: Characteristics of five generic coordination mechanisms

Building upon Malone and Crowstone's (1994) proposal to use the distinction between three types of interdependencies between activities for classifying coordination mechanisms, I will first outline the main coordination requirements for each type of interdependency and then try to associate coordination mechanisms with these requirements. A fit dependency describes a situation in which several activities contribute simultaneously to the creation of one product or service. Hence, the outputs of these activities must be coordinated so that they fit together to form one coherent product or service. As the several outputs are created simultaneously, the activities creating them need to be coordinated concurrently. Thus, coordinating activities in fit interdependencies implies specifying the output of contributing activities as the process is going on. A flow interdependency consists of several activities being linked sequentially, i.e. the output of one activity (the "upstream" activity) is used as the input of another activity (the "downstream" activity). Coordinating these activities requires to ensure a smooth flow of resources along the sequence of activities. Otherwise, either activities cannot be carried out (due to a lack of required inputs) or resources are piling up while waiting for being processed.

A sharing interdependency means that two activities share one resource (or, which is the same, the output of a third activity). Coordination here implies that resources are allocated to those activities which create the highest economic value if resources are completely consumed by these activities or, if they are not completely consumed by the involved activities, to determine priorities

so that activities can be ranked with respect to the order in which they can use shared resources.[13]

When viewing the relationship between these three types of interdependencies from the resource's point of view, it becomes clear that increasing degrees of standardization are involved as one proceeds from fit to flow and from flow to sharing interdependencies.[14] The coordination problem characteristic of fit interdependencies results from the fact that the output of each involved activity cannot be specified in advance. A flow interdependency implies that the output of an upstream activity is standardized according to the input requirements of the downstream activity (this might be termed "vertical standardization"). A shared interdependency requires, in addition, that the input requirements of those activities sharing one resource are standardized (which, accordingly, could be termed as "horizontal standardization"). Figure 3 illustrates these increasing degrees of standardization.

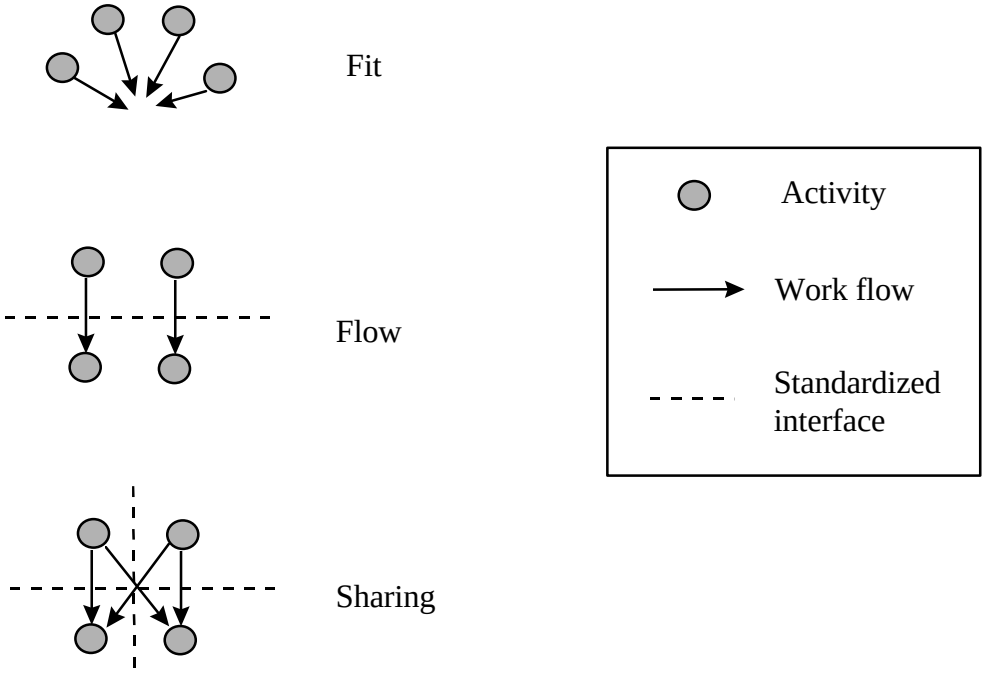

Figure 3: Standardization requirements and interdependencies

As standardization of input requirements itself represents a form of coordination, increasing levels of standardization imply that either the locally available coordination capacity can be applied to an increasing amount of coordination work or that less coordination capacity is required to coordinate a given amount of coordination work as one proceeds from fit to flow and from flow to sharing interdependencies. Using this insight, it is possible to associate coordination mechanisms with types of interdependencies.[15]

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[13] If resources are neither consumed by the involved activities nor are there restrictions with respect to the number of activities which can use them simultaneously, no coordination problem arises.

[14] March and Simon (1958) describe standardization of input specification, including quality characteristics, as a means to increase the "tolerance for subunit interdependencies" (p. 159).

[15] Mintzberg (1979) suggest that there is a certain logic in the succession of coordination mechanisms based on increased degrees of coordination complexity as a firm grows. According to this logic, the firm will use mutual adjustment first, then direct supervision, then either output or process standardization (depending upon which variable is more easily observable) and then again mutual adjustment (when decisions become so complex as to require group decision making). Below, I will argue that there are several plausible "paths" for the succession of coordination mechanisms if IT is considered a critical factor; note, however, that any succession of coordination mechanisms will be heavily influenced by the progression of standardization of input/output requirements as demonstrated above.

Beginning with mutual adjustment, it would seem a waste of (coordination) capacity to apply this mechanisms to both, flow and sharing types of interdependencies because there would be no need for coordinating outputs of activities so that they fit with one another since flow and sharing interdependencies require standardization of input/output requirements. Thus, albeit applicable, it can be expected that empirically this coordination mechanism is associated only with coordination situations characterized by fit interdependencies. In contrast, it would be impossible to apply the price mechanism to situations of fit or flow interdependence since no two activities could bid for the output of a third activity or, vice versa, the output of several activities could not be offered to one or more consuming activities. Thus, these two coordination mechanisms can be unambiguously assigned to types of interdependencies in a one-to-one fashion.

Planning (output standardization) and programming (work process standardization) cannot be applied in coordination situations characterized by fit interdependencies since both imply that input requirements are standardized between sequentially linked activities. Programming defines a procedure how to deal with resources that are moving from task to task which requires that these resources are pre-specified (standardized). Planning determines the physical amount of output to be created at certain deadlines which similarly requires that the type of output to be created is specified in advance. As these requirements are fulfilled for situations characterized by flow and sharing interdependencies, both mechanisms are applicable there.

Direct supervision can be applied in all three types of interdependencies. Supervisors can direct workers so that their outputs fit together, that workflow proceeds in a smooth fashion, or assign resources to activities if they need to be shared by several activities. Thus, direct supervision is the most general coordination mechanism. The association of coordination mechanisms to types of interdependencies is summarized in Figure 4.

Fit	*Flow*	*Sharing*
direct supervision	direct supervision	direct supervision
mutual adjustment	programming	programming
	planning	planning
		price coordination

Figure 4: Classification of coordination mechanisms

3.2. IT’s direct impact on coordination mechanisms

From the above discussion it becomes clear that IT’s impact on coordination mechanisms is constrained by the type of interdependency to be coordinated. Thus, only direct supervision can be considered an alternative to all other coordination mechanisms. In contrast, mutual adjustment and the price mechanism are alternatives only in one subset of coordination mechanisms, namely coordination mechanisms for fit and sharing interdependencies respectively. Planning and programming can be used for both, coordinating flow and sharing interdependencies. Thus, IT’s direct impact on the composition of coordination mechanisms in use at any point in time is limited to comparisons within any one of these three subsets of coordination mechanisms.

Applying the original argument of Malone et al. (1987), one can expect that IT will favor those mechanisms which require a higher degree of information efficiency to be economically viable. Thus, assuming that a situation prevails which is characterized by a distribution of

coordination mechanisms within each subset so that their net-benefits are equal, reducing the costs of any one coordination mechanism relative to those of the other mechanisms will lead to increased use of that mechanism at the expense of the other mechanisms. As IT will reduce the costs of all coordination mechanisms, those mechanisms will benefit the most which are the most demanding in terms of information processing and information exchange capacity. In order to compare coordination mechanisms with regard to their information processing and exchange demands, I will distinguish between three components of information processing and information exchange demand: central intelligence, decentralized intelligence, and communication requirements. For the sake of simplicity, I will distinguish only between three possible properties with respect to these three aspects of information processing and exchange demands: high, low or absent. Figure 5 summarizes the characteristics of coordination mechanisms with respect to their information processing and exchanging requirements.[16]

	direct superv.	*mutual adjust.*	*fixed progr.*	*flexible progr.*	*planning*	*price coord.*
central intelligence	high	none	none	none	high	low
decentral intelligence	low	high	low	high	low	high
communication requirements	low	high	none	high	high	high

Figure 5: Information processing and exchange requirements of coordination mechanisms

Direct supervision requires a high degree of central intelligence but only low degrees of decentralized intelligence as agents performing activities only need to report their progress and execute orders. In contrast, mutual adjustment requires high degrees of decentralized intelligence as each actor needs not only to observe the activities of all other actors but also has to decide on the type of response to these observations while no central intelligence is required. With respect to communication requirements, mutual adjustment is also very demanding relative to direct supervision as communication is ongoing and takes place between [n*(n-1)]/2 actors. In contrast, communication in direct supervision may be ongoing or periodic but takes place only between n+1 actors[17].

In order to characterize the information processing and exchange requirements of programming, it is necessary to distinguish between two types of programming: fixed task-resource

[16] Malone (1997; see also Wyner/Malone 1996) adopts a similar method which, however, considers only communication costs as a component of coordination costs and distinguishes between only three types of coordinating economic activity, namely independent, decentralized decision structures (dubbed ”cowboys”), centralized decision structures (commanders), and ”connected, decentralized decision structures” (”cyber-cowboys” or ”entrepreneurs”).

[17] This formulae assumes that the supervisor is not included in the n actors. Also, the claim that communication in mutual adjustment is more demanding than in direct supervision only holds for n>3 as can be easily verified.

assignments and flexible or contingent assignments. Fixed task-resource assignments require only low degrees of decentralized intelligence as the task is repetitive and simple. In addition, no central intelligence is required as all tasks are pre-specified and no communication takes place as tasks are triggered by the arrival of input resources.[18] In contrast, flexible task-resource assignments require that actors can perform a multitude of tasks as well as recognize which tasks need to be performed contingent upon a number of factors; similarly, flexible task-resource assignments imply substantial communication between agents as one type of contingency consists of the processing status of all or some other agents implying an m:m communication structure.

Planning and the price mechanism are both quite demanding in terms of the required communication capacity. In contrast to mutual adjustment and flexible programming, this demand does not stem from an m:m communication structure (both, planning and the price mechanism imply a central ”clearing” agent) but from the requirement of rapid communication. In the case of planning, this requirements results from the need to have several iterations of central plan consolidation and decentralized plan validation, i.e. a first rough plan will be centrally created on the basis of past information and then distributed to the agents responsible for implementation who will comment on or suggest changes to the plan which will then again be consolidated and so on. The plan will increase in quality as the number of iterations increases. Also, the time horizon of planning may be shortened so as to improve a plan’s accuracy. In production scheduling, for example, planning cycles are reduced to several minutes as a plan approaches execution. The price mechanism also requires extremely rapid communication as bids need to be placed in line with price movements.

In terms of requirements with respect to central and decentralized intelligence, planning and the price mechanism have, however, opposite characteristics. The degree of central intelligence required for the clearing agent operating a price mechanism is low and basically consist of ranking bids and matching them accordingly. Planning algorithms, in contrast, are sophisticated and often need several days runtime even if automated. The most demanding requirements with regard to information processing capacity residing in decentralized actors occurs for the price mechanism as in this case actors have to evaluate inputs and outputs for which they are bidding or which they are offering. In contrast, decentralized agents in planning only have to decide if a (draft) plan can be executed in terms of output quantity and deadlines and report on capacities and work progress.

In order to rank coordination mechanisms with regard to their information processing and exchange requirements, I use the hypothesis that decentralized intelligence is much more demanding than central intelligence as information processing capacity needs to reside in several actors versus in just one (this helps to compare planning on the one hand and flexible programming and mutual adjustment on the other hand). Based on this assumption, the following ranking can be established:

1. fixed programming
2. direct supervision
3. planning
4. mutual adjustment and flexible programming
5. price mechanism

As coordination mechanisms only need to be compared within the subsets identified in the previous chapter in order to assess IT’s impact on coordination mechanisms, the following hypotheses can be generated from the discussion so far:

[18] Note that I do not consider the problem of enforcing process standards which relates to the problem of opportunistic/cooperative behavior. Here, the only concern is with the information required for actors to coordinate their activities with those of others given they intend to cooperate.

Hypothesis 1: In coordination situations characterized by fit interdependencies, direct supervision will be replaced by mutual adjustment as information efficiency increases through automation of coordination mechanisms

Hypothesis 2: In coordination situations characterized by flow interdependencies, fixed programming will be replaced by direct supervision which will be replaced by planning which will be replaced by flexible programming as information efficiency increases through automation of coordination mechanisms.

Hypothesis 3: In coordination situations characterized by sharing interdependencies, direct supervision will be replaced by planning which will be replaced by flexible programming which will be replaced by price coordination as information efficiency increases through automation of coordination mechanisms.[19]

Thus, a much more complex picture emerges as regards the direct impact of IT on coordination mechanisms than has been previously suggested. Depending upon the type of interdependency to be coordinated, different patterns of replacement can be expected. Generally, direct supervision tends to be replaced under the impact of IT by other coordination mechanisms. Which other coordination mechanisms will take its place depends upon the type of interdependency considered. Also, fixed programming can be expected to disappear in situations of flow interdependencies as, indeed, it has mostly done already. However, somewhat surprising flexible programming emerges as the most favored mechanism (as far as the impact of IT is considered) in situations of flow interdependencies which explains the increasing use of workflow management systems. In situations of sharing interdependencies, however, flexible programming may be replaced by increasing uses of the price mechanism. In situations of fit interdependencies, mutual adjustment will emerge as the most favored coordination mechanism as is predicted by Malone and Laubacher (1998).

3.3. IT's indirect impact on coordination mechanisms

As has been demonstrated above (see chapter 3.1), IT's direct impact on the distribution of coordination mechanisms is constrained by the type of interdependency to be coordinated. Thus, shifts triggered directly by information technology can only occur within subsets of coordination mechanisms. However, it is possible that IT has a second-order effect on the distribution of coordination mechanisms by altering the composition of coordination situations with respect to interdependencies. For example, IT may lead to more products being horizontally standardized (see chapter 3.1) thus increasing the number of situations characterized by sharing interdependencies at the expense of flow interdependencies. As a consequence, IT could lead to flexible programming being replaced by price coordination in a number of instances as price coordination is only available in coordination situations characterized by sharing interdependencies.

Indeed, part of Malone et al.'s (1987) original argument is that IT will enable agents to communicate more complex product descriptions thus, in effect, leading to more products being considered as low complexity products. In a similar manner, efforts to use multidimensional product evaluation techniques might contribute to such a second-order effect of information technology. However, any effort to empirically measure such a second-order effect will meet with a serious theoretical issue, namely that of determining cause and effect.

Consider the assumption that IT will allow more complex product descriptions to be exchanged thus facilitating price bidding to be used for coordinating production of these products

[19] Fixed programming cannot be applied in situations of sharing interdependencies as coordination here consists of changing task-resource assignments.

where previously other forms of coordination had to be used. For example, bidders may be asked to specify their product requirements along a number of dimensions in addition to the price they are willing to bid. These specifications could then be matched against similar specifications made by suppliers or sellers of products and prices would be used only for selecting one selling bid among the subset of offers thus determined. Such an approach is used by several new e-commerce services.[20] However, the precondition for its implementation is that (1) product dimensions are clearly specified and (2) scales are defined for assigning values to these dimensions, i.e. product descriptions have to be standardized.

In contrast, techniques exist to communicate the description of extremely complex products which do not depend upon information technology at all. One example is the pro-verbal blueprint used in the communication between engineers. Thus, it can be argued that the implied degree of standardization would be the cause of shifts in the distribution of coordination mechanisms rather than information technology. Empirically testing the (second-order) impact of IT would then imply establishing a causal relationship between efforts to standardize product descriptions and some new functions of IT or lower ”unit” prices for information technology.

To conclude, IT might well have some second-order effects on the distribution of coordination mechanisms which, however, are extremely hard to isolate empirically. Often, IT projects might be promoted with some ”second thoughts” in mind such as changing organizational structures (cf. Orlikowski/Hofman 1997) in which case it would depend upon the intention of those promoting the application of IT if IT was causally responsible for a subsequent shift between coordination mechanisms. The more immediate cause for shifting boundaries between types of interdependencies is, at any rate, the degree of vertical and horizontal product standardization. IT might push efforts aimed at product standardization but it cannot replace them.

4. IT’s impact on forms of governance

Above, I have argued that IT’s direct impact on governance structures cannot be established unambiguously because incentive properties of IT are subject to design decisions (see chapter 2). Thus, IT’s direct impact on forms of governance will depend upon the distribution of power among economic agents rather than some internal characteristics of IT. For example, whether or not IT will be used to increase the ability of firms to monitor agents will depend upon workers’ collective bargaining power rather than IT’s ability to generate detailed information about workers’ performance. This, in turn, will be determined by supply and demand conditions, by the extent to which workers can act collectively, and by political factors. Similarly, whether or not IT will lead to more or less market (price) transparency will be determined by supply and demand conditions and institutional factors (regulation, court rulings) rather than by IT’s ability to both, process more information (thus potentially increasing price/market transparency) and increase the available amount of information (thus potentially reducing price/market transparency) (cf. Coltman et al. 2000).[21]

However, IT will have an unambiguous (deterministic) indirect effect on governance structures in the following sense. The processes of implementing and operating automated coordination mechanisms have incentive properties as well. Thus, automated coordination mechanisms also need to be ”governed”. Then, the ability of governance structures to handle these processes may differ thus favoring the one or the other form given that nothing else changes. I will first compare market and hierarchical structures with respect to programming and planning and second market and hierarchical structures on the one hand and associative forms of economic

[20] Cf. The Economist, ”How to be Perfect”, February 12, 2000.

[21] See also the empirical results on price dispersion on the Internet compiled in Smith et al. 1999.

organization on the other hand with respect to mutual adjustment and price coordination. Fixed programming and direct supervision are only applicable within hierarchies. This is obvious for direct supervision without further explanation. Fixed programming would eliminate any degree of freedom in organizing and supervising work thus eliminating the rationale for having separate firms as in a market arrangement or autonomous actors as in associative forms of economic organization. Thus, fixed programming and direct supervision need not be included in a comparative analysis of governance forms.

4.1. Programming and planning in hierarchies and markets

March and Simon (1958, p. 167) have suggested that any organizational program can be described by three nodes: a source, a point of decision, and a point of action. As planning also involves programming in that the process by which output targets are formulated is standardized, both, planning and programming can be described in terms of these three nodes. Information flows from sources to points of decision where it is processed and information about decisions flows then from points of decision to points of action; closing the loop, points of action are also one type of source by providing information about results of actions to points of decision. In Figure 6 this distinction is applied to programming and planning.

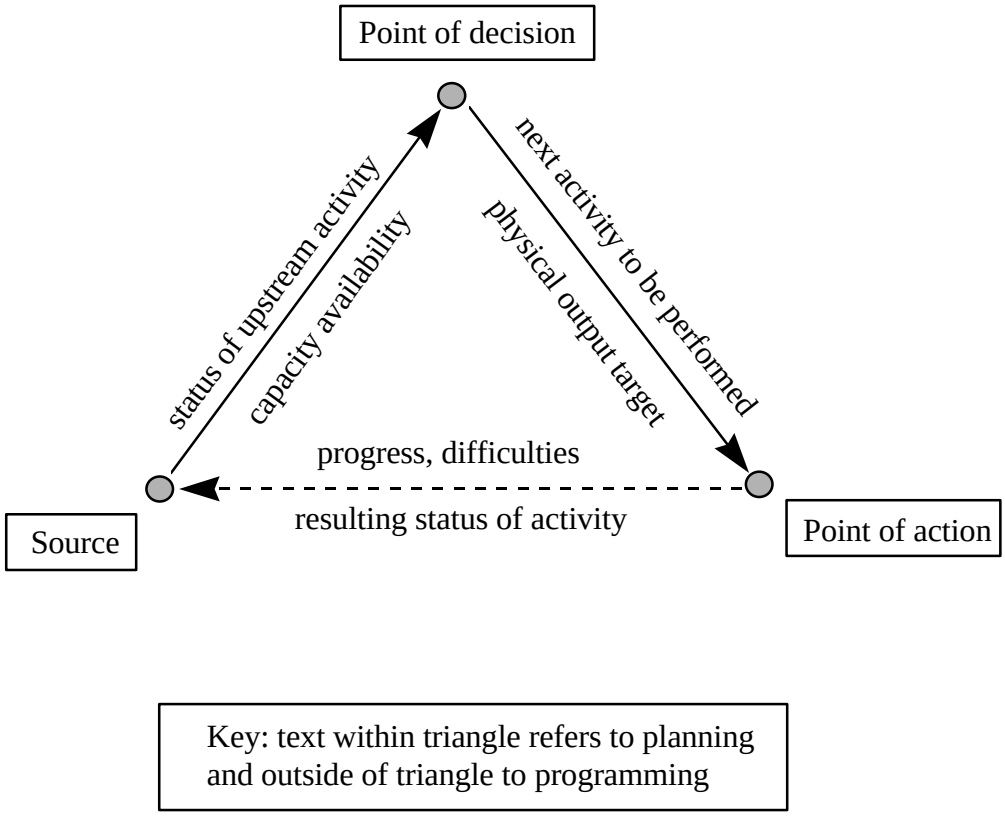

Figure 6: Information flows between sources, points of decision and points of action for programming and planning

Automating the coordination mechanisms of programming and planning then effectively involves elimination of points of decision since the decision process will be replaced by an automated algorithm. Thus, sources will directly communicate with points of action and, in a sense, control the type of action to be carried out. For example, a purchase order which is automatically created from

an inventory management system will trigger the delivery of a number of products by the supplier without involving human decision making.

The elimination of human decision making in the communication flow between sources and points of action has a number of crucial implications.

First, the meaning of the contents of the information flow must be coded in a way understandable to machines. Whereas humans are able to use context information for understanding the meaning of a message, machines are not (Kubicek 1992).

Second, eliminating human decision making in the communication flow between sources and points of action also eliminates the possibility of assigning responsibility for the action taken to the decision maker. Thus, responsibilities need to re-allocated between sources and points of action.

Third, manual and intellectual labor which has been involved in the coordination process will be largely eliminated as a consequence of its automation with the exception of the task of data maintenance at the source. Thus, labor saving effects tend to be unequally distributed between the source and the point of action.

How do the two governance forms of markets and hierarchies cope with these requirements? In a hierarchy, department heads are involved in the negotiation process required for coping with the three issues mentioned above; in a market, this task is performed by company representatives. Thus, the question can be restated in the following manner: In how far do incentives between department heads and company representatives differ with regard to coping with these issues?

Generally, company representatives will think of tasks and responsibilities involved in automating coordination mechanisms in terms of products and services, i.e. they will judge the costs and risks involved with regard to the profit these products and services are expected to contribute to overall profits whereas department heads will think of the same tasks and responsibilities in terms of costs and performance targets. This difference in incentives has two implications.

First, department heads will have to assess any re-allocation arrangement separately with respect to its impact on costs and performance goals. As performance goals are updated only infrequently, changes in tasks or responsibilities cannot be easily reflected by them. Thus, department heads tend to assess any new allocation of tasks and responsibilities only with respect to costs incurred as a result of the automation process. In contrast, company representatives can net costs and benefits in one figure (profit) which enables them to consider both, benefits and costs of automating coordination mechanisms simultaneously. Therefore, decisions to automate coordination mechanisms will be vetoed in hierarchies more often than they will fail to be made in markets.

Second, department heads generally cannot account for imbalances in the distribution of costs and benefits by intra-company side-payments. In contrast, company representatives can compensate for unequal distribution of costs and benefits by adjusting prices. As a consequence, negotiators in a market arrangements will be able to re-allocate tasks and responsibilities involved in the automation of coordination mechanisms in instances where agents in hierarchies are not.[22]

4.2. Mutual adjustment and price coordination in markets, hierarchies and associations

Any economic exchange requires that agents not only agree upon the contents of an exchange, but also on its procedure. This agreement may often be implicit but automated coordination mechanisms involving economic exchange depend upon explicit procedural rules (Kubicek 1992). The procedural aspect can be handled by bilateral negotiations, by a multilateral agreement on exchange procedures between the involved parties or by generalized procedures (such as legal

[22] In this analysis, it is assumed that department heads and company representatives act in the interest of their organizations, i.e. internal agency costs are not considered. This assumption is justified on the ground that only those aspects will be analyzed which pertain to the requirements of automating coordination mechanisms.

rules). Here, I will focus on the comparison between bilateral and multilateral agreements. I call multilateral agreements as forms of governance economic associations. Associations may consist of individuals (professional associations) or of firms (trade associations). In this chapter, I will compare incentive properties of markets, hierarchies and associations with respect to mutual adjustment and price coordination.

Incentive structures of governance forms are often multidimensional. For example, in a hierarchy incentives can be composed of financial compensation packages, promises or opportunities for promotion, the assignment of challenging tasks, and a friendly working atmosphere. With the exception of opportunities for promotion, a market arrangement may contain the same set of incentives, i.e. income from sales (profit), contracting of challenging tasks and friendly working relationships. These component incentives, however, are not always compatible in the sense of having a positive impact on one another or at least of not negatively interfering with one another. For example, so-called intrinsic motivation resulting from a challenging task could be negatively affected by too high a financial compensation (cf. Kohn 1993). Likewise, a friendly working relationship can suffer from a desire to maximize profits within a market arrangement.

This fact provides a clue for analyzing differential properties of governance structures with respect to implementing automated coordination mechanisms when considering the special cases of mutual adjustment and price coordination.

Mutual adjustment requires that individuals work as a team. This requirement, however, may conflict with the desire of team members to be promoted on the basis of individual performance. On the one hand, performance will be evaluated in view of the individual's ability to work out solutions together with other team members; on the other hand, promotion prospects will depend upon an individual's ability to direct others which may often involve unilateral decision making. Since these criteria tend to conflict with one another, incentive structures in hierarchies, which rely on both, direct supervision and mutual adjustment, may be inconsistent. As mutual adjustment increases in importance, this problem is aggravated. In this situation, it would be an advantage to have a non-hierarchical institution evaluate performance in teams since then the promotion incentive will be effectively removed. Thus, hierarchies become increasingly ineffective relative to non-hierarchical forms of governance as mutual adjustment is increasingly used to coordinate economic activities.

A similar conflict of interest can be identified in bilateral negotiations in market arrangements. On the one hand, profit is a driving motive in bilateral negotiations in a market; on the other hand, good working relationships may be important incentives as well. Moreover, the quality of working relationships may be crucial to the functioning of the exchange relationship in general with regard to procedural rules. Overtly focusing on price issues can thus easily damage an exchange relationship. As a consequence, buyer-supplier relationships are often characterized by significant price tolerance relative to competing offers (cf. McGahan 1996). Using price coordination under such a governance structure may therefore be difficult. Trade associations could mitigate this problem as then it would be clear that fair terms of trade will be observed since procedural rules will be brokered by a collective body to whose regulations both parties engaged in an exchange relationship have subscribed and which they are equally able to influence.

Also, within a given buyer-supplier relationship, products exchanged may be standardized to different degrees. Thus, some products may be suitable for pure price coordination while others need tight flow coordination through planning and programming which depend more on trust and good working relationship. Having trade associations govern price coordination thus clearly removes the potential conflict of interest from the exchange relationship.

4.3. Combining IT's impact on coordination mechanisms with that on forms of governance

How do the shifts between coordination mechanisms hypothesized in chapter 3 interact with the properties of the three forms of governance discussed above? The above institutional analysis has been carried out by comparing forms of governance with respect to three groups of coordination mechanisms, namely mutual adjustment, programming and planning, and price coordination. These can be associated with the three types of interdependencies, namely fit, flow, and sharing interdependencies. Accordingly, combining the two analyses can be done for each type of interdependency separately which simplifies the task.

In coordination situations characterized by fit interdependence, only direct supervision and mutual adjustment are applicable. Hypothesis 1 states that direct supervision will be replaced by mutual adjustment as coordination mechanisms are automated. As a result, the relative share of mutual adjustment for coordinating activities linked by fit interdependencies will increase. Above, it has been argued that under this condition, associative forms of governance will become more advantageous relative to hierarchical forms of governance.

In coordination situations characterized by flow interdependencies, fixed programming, direct supervision, planning, and flexible programming are applicable. Hypothesis 2 states that planning and flexible programming will replace the other mechanisms as coordination mechanisms are automated. Above, it has been demonstrated that bilateral market arrangements are better able to handle the requirements of automating planning and flexible programming than hierarchies.

In coordination situations characterized by sharing interdependencies, direct supervision, planning, flexible programming and price coordination are applicable. Hypothesis 3 states that price coordination will dominate the other coordination mechanisms as coordination mechanisms are automated in coordination situations characterized by sharing interdependencies. Above, it has been demonstrated that associative forms of governance are better able to operate a price mechanism than bilateral market arrangements.

Thus, the following hypotheses can be formulated:

> *Hypothesis 4: In coordination situations characterized by fit interdependencies, associative forms of governance will replace hierarchical forms of governance as coordination mechanisms are automated.*
>
> *Hypothesis 5: In coordination situations characterized by flow interdependencies, bilateral market arrangements will replace hierarchical forms of governance as coordination mechanisms are automated.*
>
> *Hypothesis 6: In coordination situations characterized by sharing interdependencies, associative forms of governance will replace bilateral market arrangements as coordination mechanisms are automated.*

Hypothesis 5 corresponds to both, Malone et al.'s "move to the market" hypothesis and to the "move to the middle" hypothesis of Clemons et al. (1993). Hypothesis 4 predicts a move away from hierarchical coordination toward associative forms of economic organization which has been predicted by Malone and Laubacher in another paper (1998). Hypothesis 6 predicts a move away from bilateral market coordination towards associative forms of governance which has not yet been proposed.

The advantage of the analysis presented in this paper is that it is based on IT's main characteristic, namely to process and communicate information as opposed to assumptions about IT's impact on incentive structures. This should make empirical validation of the framework easier.

Moreover, the distinction between governance structures and coordination mechanisms provides a simple explanation for the ”paradox” of simultaneously increasing degrees of outsourcing and decreasing numbers of suppliers (Malone et al. 1987, Clemons et al. 1993) as the use of market contracting does not necessarily imply application of price coordination.

Finally, by distinguishing between types of interdependencies, the hypotheses stated by Malone et al. and Clemons et al. can be specified more generally without increasing the number of variables accordingly. In contrast, Clemons et al. (1994) constructed a model to generalize and consolidate both hypotheses which required nine additional variables (i.e., in addition to IT’s ability to process and exchange more information per unit of resource and time).

5. Validating the framework

Up to now, empirical work related to the ”move to the market” hypothesis has been directed towards demonstrating a statistical relationship between IT spending and governance structures. The result of this work is mainly supportive of the ”move to the market hypothesis”, i.e. such a relationship has indeed been demonstrated. Specifically, IT spending is related to decreasing firm sizes and, what is more important, to decreasing degrees of vertical integration (Brynjolfsson et al. 1994). However, it has also been demonstrated that the number of suppliers tends to decrease as firms spend more on IT (Bakos/Brynjolfsson 1993).

However, demonstrating a statistical relationship between IT spending and outsourcing or decreasing degrees of vertical integration is not sufficient to prove the ”move to the market” hypothesis since other interpretations are possible. For example, the same relationship could be explained by increased degrees of process standardization implied in the application of IT to automating business processes. This, in turn, would enable an increased portion of these processes to be ”outsourced” as the interfaces between succeeding tasks are clearly specified. This interpretation is supported by the fact that the data used by Brynjoflsson et al. cover the period from 1976 to 1989, i.e. a period in which IT has been applied to internal processes but, as a rule, not to coordination between firms (which would be implied if a direct impact of IT on a shift between coordination mechanisms were invoked).

To validate the framework proposed in this paper, a two-pronged approach is suggested, namely a separate test for IT’s impact on coordination mechanisms and on forms of governance. Thus, the causal structure of relationships between variables can be better approximated by statistical analysis because fewer intermediating variables need to be controlled. For example, globalization, regulation, and consumer behavior may all affect the organization of economic activity such as the degree of vertical integration.

Assessing IT’s impact on coordination mechanisms could be done by relating IT spending with the type of coordination process being predominantly used. However, such an approach might be flawed because, first, the type of interdependency could change while IT spending is increasing thus triggering a replacement of coordination mechanisms which cannot be attributed to IT spending. Moreover, IT spending does not have to coincide with using IT for coordinating economic activity. Also, appropriate deflators used for gauging IT’s increasing capabilities while prices remain constant or are falling are a chronic source of debate (cf. Baily/Gordon 1988). Thus, a more sophisticated approach is required.

One possibility consists of studying actual replacement patterns of information systems. As new generations of information systems are implemented, new capabilities can be assumed to exist which, according to Hypotheses 1 through 3, should then enable replacements of coordination mechanisms as well. Possible changes in the underlying type of interdependencies could be controlled by collecting data about the production processes which are controlled by the information systems investigated. The problem, however, clearly consists of defining ”new generation”

information systems since replacement investments which do not expand IT's capabilities would not trigger a substitution of coordination mechanisms.

Regarding the hypotheses related to shifts in governance structures, separate studies are required for each replacement pattern.

With respect to hierarchical coordination being replaced by bilateral market coordination in situations of flow interdependencies, data about cases of cross-functional integration projects within hierarchies and markets can be collected. The Null-Hypothesis then would be that efforts at cross-functional integration do not fail more often within hierarchical arrangements than in market arrangements. The problem here is to control the type of interdependency being considered. Ideally, the same underlying production processes are involved.

Regarding use of associative forms of governance for automating price mechanisms, abundant anecdotal evidence can be found in popular IT journals as new so-called electronic market places are mushrooming in almost every industry. Moreover, some first tentative results regarding the impact of the Internet on electronic auctions have been published (Klein/O'Keefe 1999). However, the reasons for choosing this governance form when setting up electronic markets are less clear. To study these, it might be useful to analyze sources of failures of establishing electronic markets for different governance forms. Due to the nascent stage of the evolution of electronic markets, the number of cases is probably still too small for performing statistical analysis; therefore, a case study approach seems indicated here.

Regarding use of associative forms of governance for automating mutual adjustment, the evolution of governance forms is still less advanced than that for electronic markets. One indication of the validity of this hypothesis can be seen in the observation that consulting firms often choose the legal form of a partnership which, similar to professional organizations, largely eliminates hierarchical characteristics (at least with regard to those organizational members which are elevated to partner status). Since consulting firms heavily depend upon team work, this is supportive of the hypothesis that hierarchical governance structures pose barriers to the use of mutual adjustment as a coordination mechanism as Hypothesis 4 suggests. However, it still needs to be established if this barrier would be sufficiently high to render hierarchical governance less efficient than associative governance forms for team-based forms of coordination. Again, a promising approach is to study the reasons of failed efforts to automate the coordination mechanism of mutual adjustment in both, hierarchical and associative forms of governance.

6. Conclusion

In this paper, I have argued that current approaches towards predicting IT's impact on the organization of economic activity are flawed because they do not clearly separate between coordination mechanisms and forms of governance. Making this distinction explicit, I have developed six hypotheses about IT's impact on coordination mechanisms on the one hand and on governance forms on the other hand. Specifically, I have hypothesized that IT has a direct impact on coordination mechanisms by reducing coordination costs and an indirect impact on governance forms by implying new or changed governance requirements.

The result of this analysis is, in a nutshell, that more complex coordination mechanisms are substituted for less complex ones as coordination mechanisms are automated. However, these replacement patterns are constrained by types of coordination situations as defined by underlying types of interdependencies. Thus, only those coordination mechanisms are linked by replacement patterns which can be considered as functional equivalents for each type of coordination situation. Specifically, it has been hypothesized that mutual adjustment will dominate for coordination situations characterized by fit interdependencies, that flexible programming will dominate for coordination situations characterized by flow interdependencies, and that price coordination will

dominate for coordination situations characterized by sharing interdependencies.

With regard to governance forms, the ”move to the market” hypothesis has been generalized. Specifically, it has been demonstrated that there are three distinct ”component moves”, namely a move from hierarchical governance to associative forms of governance for coordination situations characterized by fit interdependencies; a move from hierarchical governance towards bilateral market governance for coordination situations characterized by flow interdependencies; and a move from bilateral market governance to associative forms of governance for coordination situations characterized by sharing interdependencies.

Some tentative suggestions as to how to validate these hypotheses have been made. If indeed it turns out that these hypotheses cannot be rejected by empirical investigation, the implications for management and regulation would be far-reaching.

Concerning shifts among coordination mechanisms, new skills are required of individuals involved in economic activities. As has long been argued, team skills will increase in importance relative to leadership and professional skills (cf. Drucker 1988). Also, the cognitive and decision making abilities implied in flexible programming are much more demanding than those required for fixed programming and direct supervision. Finally, increasing use of price coordination will increase the number of instances in which judgments about the economic value of products and services have to be made.

Concerning shifts among governance forms, new challenges for management and regulation are posed. I will try to briefly highlight these challenges with regard to the three governance forms which, according to Hypotheses 4 to 6, are expected to increase in importance.

Maybe the managerial implications of integrated supply chains are best understood among the three forms or governance described above. The concept of the *value system* proposed by Michael Porter helps to understand competitive issues posed for members of integrated supply chains (cf. Porter/Millar 1985). However, it is less clear how supply chain members should work out agreements on sharing the value created by a whole supply chain. For example, should supply chain members try to reach a general agreement on equal profit sharing resulting from improvements of processes crossing firm boundaries? This, however, implies that costs are distributed equally as well which might not be the case. Also, as electronic integration proceeds along the supply chain, integrated processes might well span more than two adjacent firms in the supply chain so that multilateral agreements would be required.

From a regulatory point of view, such agreements could pose challenges as well. Competition, according to Porter’s value system concept, does not only exist between firms on the same production stage, but also between firms along the supply chain, i.e. between customers and suppliers. Would these agreements then have to be considered as a threat to competition? More generally, how to define competition in integrated supply chains and, accordingly, threats to it?

Electronic marketplaces governed by associations pose entirely new managerial challenges whereas the regulatory issues are much better understood. For example, should electronic marketplaces be financed by members or by outside investors? If outside investors supply the required capital, how much influence should they have upon the rules governing trading procedures and trade objects on these marketplaces? This issue seems to be important since the automation of price coordination requires huge investments in information systems and data exchange networks which could probably only be financed by going to the capital markets themselves. Should the development and operation of automated price discovery systems then be separated from the governance structure regulating trading procedures and trade objects?

From a regulatory point of view, the main difficulty seems to be to trade off the advantages of having an integrated, highly liquid market against the threat of having one organization controlling this one market.

With regard to the emergence of associative forms governing automated systems for mutual adjustment, even more open questions are looming. What will be the role of ”the firm” in such

arrangements? Will it draw an a pool of skills and teams as required in order to continuously create new products and services and to manage their production and distribution or will these teams themselves take charge of these roles? How can a firm maintain its competitive advantage which ultimately resides in its members' skills and abilities if its members keep changing their employers, possibly working for the competitor the next day after having finished the one job assigned to them. How will this affect a firm's industrial relations policy?

Other questions relate to the compensation of individuals working in teams. Basing compensation on team performance would be a measure rather in opposition to popular beliefs about linking compensation to individual performance. And how to evaluate the long term effects of a team's performance if the team only exists for a short period of time?

From a regulatory point of view, the issue at stake is labor law in its entirety. Malone and Laubacher (1997) have shown how the role of the "job" has changed over the last two hundred years or so. Increasingly, the job became a bundle of rights and responsibilities not only with regard to labor and wages, but also with regard to security, health, personal development and social equality. As we are moving towards an "e-lance" economy (Malone/Laubacher 1998) in which teams are assembled temporarily for specific projects, it is likely that this traditional view of the job will have to change dramatically. But who will be there to take over the functions now performed by the governance structure which we call a firm?[23] The idea of Malone and Laubacher (1997), who have suggested that a rejuvenated version of medieval guilds could take over these functions, certainly merits further discussion.

Clearly, these issues are important and require further analytical study. A sound understanding of the mechanisms by which information technology changes the organization of economic activity is the first step towards answering these questions. In this paper, I have tried to develop an analytical framework which can serve as such a starting point. The main purpose of this framework is not to predict the future of economic organization but to create an analytical tool which will help to tackle the issues which are posed by the advent of information technology in the realm of coordinating economic activity. As such, it is of utmost importance that this tool can stand empirical validation. Thus, it is less important to test whether or not predictions about the future of economic organization coincide with actual developments (which are influenced by a plethora of factors apart from information technology), but to validate the elements of the analytical framework which can then be used as a basis for developing possible solutions to the managerial and regulatory issues created by information technology's impact upon the organization of economic activity.

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[23] Cf. Orts 1998 for a detailed description of the complex legal arrangements underlying the modern concept of the firm.

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