Managing Information Technology in the Transnational Organization: The Potential of Multifactor Productivity

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Abstract

The paper sets out with considering increased decision interdependencies in the Transnational Organization due to autonomous IT deployment in national subsidiaries. It proceeds by proposing Multifactor Productivity as a controlling instrument for managing the increased level of decision interdependence in the area of IT deployment. It is demonstrated how Multifactor Productivity supports the twofold task of (1) capturing IT-induced decision interdependencies and (2) deriving IT policies to cope with them. Possible ways of using Multifactor Productivity are discussed as well a potential pitfalls in applying this concept. Finally, a proposal is made as to how this instrument could be implemented by IT Management in companies considering the transition to the Transnational Organization.

1. The changing context for corporate IT Management

Traditionally, there are two distinct organizational types of companies acting on a global scale: the multinational and the global organization. The multinational organization sets up several "clones" of itself representing it in different regions or countries. These are autonomous as regards their operational activities. They regularly have their own procurement procedures, production sites and marketing systems. Bartlett terms this configuration the *Decentralized Federation Model* ([1], p. 374). US-based multinationals are often said to display this characteristic in their organizational structure.

At the other extreme, one finds the global organization which controls most value adding activities centrally, locating them in one country and using national subsidiaries only as a distribution and marketing facility. Thus, national subsidiaries are nearly totally dependent outlets of the headquarters. Bartlett calls this the *Central Hub Model* ([1], p. 375). Typically, Japanese export-oriented companies used to implement this strategy.[1]

Current changes in national and supra-national regulatory regimes, technology, and consumer preferences are triggering a process which impacts on both, the Decentralized Federation and the Central Hub Model. The ideal result of this process is in either case what Bartlett calls the *Transnational Organization* with national or regional subsidiaries specializing along functional lines and with each adopting a global perspective ([1], p. 377).

In the first case - Decentralized Federation Model - "transnationalization" implies that national subsidiaries try to identify comparative advantages due to their geographic location, specialize on these, and offer their service on a global scale, thus realizing additional economies of scale in the activity they are specializing in. In the second case - Central Hub Model - becoming a Transnational Organization requires upgrading national subsidiaries with the same objective as in the first case: building national competence centers on the basis of comparative advantages which supply their service in their specialized area worldwide.

The process of building the Transnational Organization, however, seems not to be one of simply re-allocating responsibilities and of re-defining the organizational structure, but one of carefully adjusting the balance between the need of local adaptation ("insiderization", as Ohmae puts it), and global integration ([16]). For this purpose, the most crucial issue might turn out to be corporate ability to dismantle established institutional structures (i.e. incentive schemes based on reporting and performance measurement procedures) and to encourage autonomous organizational units to co-operate with a global focus in mind ([16], see also [2]).

In terms of coordination requirements, the Transnational Organization has a further important implication: whereas in both other cases national subsidiaries act independently from one another, the Transnational Organization "becomes a truly integrated network of *distributed and interdependent resources and capabilities.*" ([1], p. 382, italics by this author). The coordination requirements of this configuration are different from those in the two originating organizational

[1] Konsynski and Karimi identify a third form which is the organizational structure emanating from an *international strategy* ([11], p. 84-85). Since this form is either more centralized than the multinational or more decentralized than the global organization it is only gradually different from both types.

types by orders of magnitude. In the decentralized federate form, headquarters demand regular financial reports focusing on profits/losses and control national subsidiaries through negotiated financial flows (capital and dividends, [1], p. 374). In the central hub organization, coordination implies "tight central control of product development, procurement, and manufacturing" ([1], p. 373). In contrast, the Transnational Organization must coordinate partially autonomous national subsidiaries which are heavily dependent on one another for their inputs and outputs.

Considering the relationship between these greatly increased coordination requirements in the latter scenario on the one hand and the deployment of information technology (IT) on the other hand, there are two possible perspectives. (1) IT could be viewed as a means of coordinating corporate activities, i.e. as instrumental with regard to the increased coordination requirements in the Transnational Organization. (2) IT deployment could also be viewed as an area of corporate activity which in itself considerably contributes to increased interdependence of activities and thus provides an objective of coordination rather than a means to it.

The first perspective implies studying global information systems such as corporate communications networks or corporate customer data bases and analyzing how they could be used to improve corporate coordination levels and how they consequently should be developed, implemented and operated ([14], [8], [17]). IT is seen as *coordination technology* ([13]) providing an infrastructure for global coordination requirements ([11], p. 88; see also [18] for a compilation of important contributions in this stream of research).

The second perspective focuses on new organizational interdependencies between national subsidiaries due to autonomous IT deployment in the Transnational Organization.

This paper adopts the latter perspective. Specifically, I will ask under which conditions so-called Multifactor Productivity could guide global IT management in identifying new coordination requirements and adequate policy measures in the Transnational Organization. Multifactor Productivity has been successfully applied in the area of operations management by Hayes and Clark ([7]).[2] The main hypothesis of this paper is that the concept of Multifactor Productivity could significantly improve the quality of global IT-Management in the Transnational Organization.

The argument sets out with describing potential new coordination requirements as a result of "transnationalization". For this purpose the notion of decision interdepence will be elaborated which lies at the heart of new coordination requirements. After that, some forms of decision interdependence will be illustrated for the case of IT deployment (section 2.).

In section 3. the concept of Multifactor Productivity will be introduced and its potential to cope with IT-induced decision interdependence will be discussed. Section 4. points out how Multifactor Productivity can be actually used by global IT-Management and how it should not be used. Section 5. deals with the problem of data collection and possible incentive distortions resulting from that problem. The concluding section summarizes the discussion pesented thus far with respect to (1) the conditions under which Multifactor Productivity can yield significant improvements for global IT-Management and (2) the possible impact its application will have on global IT-Management. Moreover, a (learning) method for deriving managerial measures based on Multifactor Productivity will be suggested.

2. New coordination requirements

2.1. Decision interdependencies

Considering the two traditional forms of global organization, the Decentralized Federate and the Central Hub Model, one finds only simple forms of input/output relationships. Whereas some minimal flows of information (financial reporting) and cash are to be maintained in the decentralized federate organization, flows of materials among subsidiaries or between subsidiaries and headquarters are virtually absent.

Since globally centralized firms typically concentrate manufacturing, design and procurement in the home country, a significant flow of materials, information and cash between the center and subsidiaries exists. Thompson calls this kind of input/output relationship *sequential interdependence*, meaning that one organizational unit depends on the input of another and delivers its own output to a third ([20], p. 54).

Coordination in the first case is done through allocating budgets, outlining broad product and marketing strategies and negotiating profit targets. In the second case, coordination becomes a more complex process. Due to sequential materials flows coordination proceeds sequentially, starting, for example, with customer needs, translating them into products or expected sales volumes, deriving new products or production plans and specifying necessary production capacities and procurement requirements. As Thompson points out, this type of coordination is typically done by centralized *planning* ([20], p. 56). If the environment is relatively stable, coordination can also be achieved by the more rigid mechanism of *standardization* (ibid.).

In contrast, subsidiaries in the Transnational Organization develop their own products and production capabilities which they are offering to one another on the ground of comparative advantages. Thus, organizational

[2] Hayes and Clark use the term *Total Factor Productivity* in their study. Nevertheless, it seems appropriate to refer to their study in terms of Multifactor Productivity since the actual construction of their measure precisely reflects that of Multifactor Productivity (see section 3.).

units (i.e. subsidiaries) are linked by partially reciprocal flows of materials, information and cash. Thompson recommends *mutual adjustment* for the task of coordinating reciprocal interdependencies (ibid.).

However, mutual adjustment points to a new form of interdependence which shall be coined *decision* interdependence and thus contrasted with Thompson's notion of interdependence which then might be termed *resource* interdependence. Decision interdependence results from underlying input/output relationships.

Consider, for example, the case referred to by Thompson's notion of reciprocal resource interdependence: Two units supply each other with some required input. The point which I want to make by the notion of decision interdependence is that these two units not only mutually specify requirements concerning their required inputs but that what they are willing to supply depends on what the other is willing to deliver. Thus, in a situation of reciprocal resource interdependence, a subtle balance of mutual expectations as regards the economic characteristics of input/output specification may emerge which will be disturbed if patterns of input/output relationships are altered.

Other, more complex forms of decision interdependence may occur when there are indirect input-output linkages among organisational units. If, for example, one unit supplies more than one other units with a certain required input, the supplying unit will specify its output contingent upon the degree of coordination among requirements of the units using this input. Thus, what one unit consuming the input in question gets may depend upon what the other consuming unit requires and vice versa.

To summarize, as soon as the company departs from the Decentralized Federation Model, competition among organizational units is always constrained by some overriding strategic concerns, i.e. units cannot decide totally on the basis of product quality and price but will have to make a range of vastly more complicated trade-offs in order to specify their mutual input/output relationships (provided they have, at least to some extent, discretion about specifying their inputs and outputs).

Thus, the notion of decision interdependencies refers to a situation where imbalances in input/output relationships cannot be compensated by cash side-payments (as in a market setting). Therefore, decision interdependencies can result from input/output relationships with respect to materials flow and data flow.

Accordingly, "transnationalization" can have two different effects on decision interdependencies. The first stems from increased cross-linking of materials flows. The Transnational Organization typically has several plants producing identical items dispersed over the globe. Whereas under the regime of a multinational strategy manufacturing plants are independent from one another, serving national or regional markets, transition to the Transnational Organization will produce significant decision interdependencies through cross shipping. The coordination requirements of this effect and potential management techniques to deal with them are described in great detail by Flaherty ([6]). She also demonstrates how existing reward systems must be temporarily suspended in order to effectively manage decision interdependencies in the Transnational Organization resulting from cross shipping. However, decision interdependencies could still be dealt with through individual cost accounting systems which will associate any cross-shipped product with its costs and thus provide information on how cross-shipping will influence profit and loss statements.

The focus of this paper, however, is on decision interdependencies due to data flows. Since data flows are much more complex than materials flows, cutting through the organization in virtually every direction, the amount of potential decision interdependencies due to data flows is greater by orders of magnitude than that due to materials flows ([5]). Thus, economizing on data flows through IT deployment will surface a significant amount of additional decision interdependencies which cannot be made explicit by cost accounting systems, i.e. which cost accounting systems will capture only as an overall increase in overhead expenses.

It is important to note that these increased overhead expenses do not necessarily or even probably only consist of direct IT related expenses (e.g. cash outlays for hardware, software and IT services). Rather, decision interdependencies will result in, for example, additional labour consumption through data capturing activities. In the MIS literature, this kind of effect is generally termed hidden costs (see for example [10]).

2.2. An illustration

To illustrate decision interdependencies resulting from autonomous IT deployment in the Transnational Organization it is helpful to distinguish between two cases: (1) Data flows overlay materials flows. (2) Data flows and materials flows do not overlap. Both cases are crucial for the case of the Transnational Organization.

To illustrate the first case assume that two organizational units were receiving materials input from a third one, and all were operating on a profit basis. Thus, both receiving units will be invoiced for the third's service in one way or another. Since the receiving units are independent from one another as is especially likely in the case of firms formerly operating in the context of a multinational strategy, they might have different accounts payable processing systems requiring different data inputs. If economic pressure is exerted on the receiving units the supplying one might be asked to send electronic invoices in two different formats (data formats) which would rationalize invoice processing in the receiving units but also increase the supplying unit's overhead expenses. Thus, the latter may have sufficient incentives to demand that the receiving units harmonize

their required data formats creating decision interdependencies among them.

An illustration for the second possibility (data flows do not overlay materials flows) could be the exchange of data between the R&D unit and several production facilities for the purpose of feeding data into CNC machines (Computerized Numerical Control machines). As in the first case, production plants in formerly multinational organizations are likely to have equipment from different vendors and thus require different data input. Again, decision interdependencies might surface because the R&D unit may require that the production plants harmonize their data interfaces. This case also demonstrates how functional specialization of formerly autonomous national subsidiaries might add new decision interdependencies, since one or two national subsidiaries may focus on product development and thus establish new information links with all other national subsidiaries.

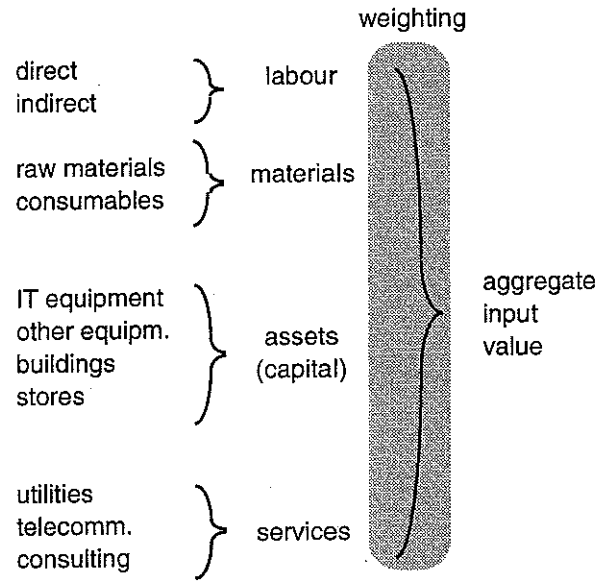
3. Multifactor Productivity: The concept and its potential

If one accepts that the building of the Transnational Organization implies a strong increase in the level of decision interdependence especially in the area of IT deployment due to multi-directional data flows and highly autonomous decision making, it seems plausible to look for a controlling instrument with which this increased level of decision interdependence can be coordinated. I suggest that the main tasks of this controlling instrument are (1) to capture IT-induced decision interdependencies and (2) to support management in identifying measures to cope with them.

In order to demonstrate how Multifactor Productivity can support this twofold task I want to briefly outline the concept.

The calculation of Multifactor Productivity is demonstrated in figure 1.[3] The crucial step consists of the weighting of inputs ([19], [12]). Therefore, this problem shall be addressed here in more detail.

Weighting of input and output factors is necessary in order to be able to add up different kinds of inputs and outputs. Since the measure is used in an economic context, weighting with *prices* serves to link internal allocation processes to the external system of existing relative prices. Moreover, using *constant* prices will isolate internal effects from external inflationary price movements which are not attributable to managerial decisions. Constant prices are calculated using price indexes which reflect average increases in price levels for different kinds of input and output factors of a given quality. Thus, if a company manages to increase its product prices by bigger an increment than the industry as a whole, this will be counted as increased output reflecting relatively higher product quality.



$$P_M = \frac{\sum_{j=1}^{m} O_j}{\sum_{i=1}^{n} g_i I_i} = \frac{\text{aggregate output value}}{\text{aggregate input value}}$$

P_M = Multifactor Productivity

O_j = Quantity of the j th output component sold x const. price

I_i = Quantitiy of the i th input factor used x const. price

g_i = weight of the i th input factor

Figure 1: Construction and calculation of Multifactor Productivity

Additionally, in a global context, exchange rate fluctuations must be dealt with. Since exchange rate fluctuations may also include over or under valuations of currencies, i.e. inflationary effects due to speculation and hedging activities in foreign exchange markets, purchasing power parities, which are the equivalent of price indexes for foreign currency, should be used for

[3] This type of productivity index is a variant among several other possibilities. Sometimes, the term *Total Productivity* is used instead. This is to be distinguished from Total Factor Productivity which is a concept based on neoclassical theory. In essence, Total Factor Productivity assumes identity of total input value and total output value, i.e. specifies output value as a function of input value (the so-called *production function*). Total Factor Productivity has been applied to productivity studies in the context of the so-called productivity paradox by, for example, Bynjolfsson and Hitt ([4]).

weighting input and output factors bought or sold on foreign markets.

A special problem which has received much attention consists of the calculation of capital input ([19], p. 6). This problem arises because the denominator of the Multifactor Productivity ratio, i.e. the aggregate input value, is a compound of factors which have different life spans with respect to the period for which economic figures are calculated (typically months or years). Essentially, these are investment versus expense related factors. Whereas investment related factors are intended for use over several periods, expense related factors will be used up within one period, for example purchase of machines versus materials.

Therefore, it is generally proposed to calculate the spread of investment-related factor usage over the expected life span, thus portioning the whole expense for investments among business periods. Practically, this will be done be adding up depreciation figures for different kinds of equipment and plants as well as costs for acquiring necessary funds, typically in the form of interest rates.[4]

Since Multifactor Productivity treats the firm as a black box into which flows a number of input factors and out comes a number of products, any kind of internal effect will be captured by it, inclusive of decision interdependencies. The concept serves to isolate internal from external effects which are due to changes in the system of relative prices. Thus, the concept also takes into account any kind of decision interdependencies which might result from autonomous IT deployment decisions in national subsidiaries.

On the other hand, it only gives few hints as to any causal relationship between inputs and outputs. In contrast, cost accounting attributes any consumption of input factors to one unit of output thus linking inputs and outputs in a causal way.[5] Some information about causality might be derived from analyzing input substitution. If, for example, increased capital inputs and decreased labour inputs go hand in hand with increased output, it might be concluded that investment has increased productivity. However, those are only tentative assumptions which cannot be validated on the basis of the figure itself.

4 The capital input, according to this proposal, will be conceptualized as "capital service" which has two components. (1) the real wear and tear of equipment and plants and the costs of providing the necessary funds for these assets. Both components could be expressed in costs per hour by calculating depreciation rates per hour and dividing total funding costs through the total of machine hours (or "building hours" and "land hours" for this purpose) ([19], p. 15). However, it should be noted that "estimation of capital services inevitably requires imputation of non-market transactions" ([19], p. 12). Therefore, calculating capital input according to this procedure is not totally satisfactory. Further research seems necessary to eliminate the bias involved by imputation of non-market transactions.

5 This is only valid for full absorption costing. Contribution costing, in contrast, only attributes direct costs to individual units of output and any other cost (overhead expenses) to different bundles of output.

Instead, further analysis drawing upon additional information sources is necessary to identify causal relationships attributable to changes in Multifactor Productivity. However, since Multifactor Productivity in itself does not imply any kind of causality, it offers much more flexibility in analyzing a vast range of potential causes or influencing factors which could serve IT Management as a guide in selecting appropriate measures. How this could be done will be explored in more detail in the following section. This section has demonstrated in which way Multifactor Productivity does take into account decision interdependencies accruing to decentralized IT deployment in globalized companies. As such, it is a truly global figure which, however, can only be the basis for further analysis and has no value in itself.

4. The applicability of Multifactor Productivity

There are two possible ways in which Multifactor Productivity could be used for further analysis. First, Multifactor Productivity may serve to control the effectiveness of managerial measures *ex post*, i.e. Multifactor Productivity would support feedback coordination. Second, Multifactor Productivity could also be used to identify *ex ante* areas which are available to managerial measures and which are most likely to have a strong or long-term effect on Multifactor Productivity; in this case, Multifactor Productivity would be used for forward coordination ([15], p. 160).

4.1. Using Multifactor Productivity for ex post control of IT Management activities

Using Multifactor Productivity to control the effectiveness of managerial measures ex post requires that each instance of increasing or decreasing input factor consumption or output production be imputed to managerial measures. Examples for IT related managerial measures are introduction of standards for computer interfaces, data formats or codes, training programmes or reduction of the number of allowed suppliers for hard- and software.

This could be done either by assuming causal relationships among input factors or between input and output factors on the one hand or by directly linking changing input and/or output quantities to managerial measures. This implies anticipating possible decision interdependence resulting from managerial measures which would render detection of unanticipated decision interdependencies impossible. This, however, is the whole purpose of using Multifactor Productivity, since every form of anticipated decision interdependency could be dealt with directly. If, for example, the number of allowed hardware suppliers were reduced in order to cut maintenance costs, it might be anticipated that costs for

additional training programmes necessary to make those users, who formerly used hardware which is not allowed under the new regime, familiar with the new systems. These additional anticipated costs could be offset against potential cuts in maintenance costs. If these effects were detected ex post, a cause/effect relationship between reduced maintenance costs and increased training costs must also be imputed ex post. Thus, in any case, Multifactor Productivity would offer no additional information.

Instead of assuming causal relationships among input and/or output quantities one could also try to directly link managerial measures to changing input/output quantities. This would imply associating each manager's activities with an area of changes in input/output quantities, i.e. defining areas of responsibility according to whether or not elements within this area are thought to be under this manager's sole influence. Thus, for example, responsibility areas could be delimited for local managers of national subsidiaries. All changes in IT related input/output quantities not attributable to local managers' areas of influence would then be attributed to central IT management measures.

Again, this implies imputing cause/effect relationships which could be anticipated. Therefore, Multifactor Productivity could not actually add any information to existing accounting systems such as contribution costing already in use for controlling purposes. Every ex post analysis for feedback coordination of Multifactor Productivity would have to rely on imputed cause/effect relationships between managerial measures and changes in input/output quantities. It would be impossible trying to calculate real or actual effects apart from that.

4.2. Using Multifactor Productivity for identifying the appropriate IT policy

Using Multifactor Productivity for identifying the "appropriate" IT policy requires the definition of *policy variables*. IT policy variables are IT-related objects which are accessible to managerial measures and which are supposed to have a direct effect on Multifactor Productivity. Possible examples are number and kind of computer interfaces, size of data bases, number of IT suppliers, and number of application programmes. These are accessible to central IT management through, for example, so-called information systems architectures which specify a number of interfaces between information systems aggregates under the authority of local IT managers ([9]), or simply through central directives (listing of suppliers, for example). As described above, it is also reasonable to assume a direct effect on Multifactor Productivity. For example, reducing the number of interfaces will decrease the amount of programming of converters or number of manual operating activities, although, it should be noted, offsetting effects are likely. Therefore, net effects are important which, however, are taken into account by Multifactor Productivity.

If a number of policy variables have been defined and data have been collected accordingly, statistical correlations between policy variables and Multifactor Productivity could be tried. If some policy variables turn out to have a statistically significant impact on Multifactor Productivity, IT Management will be provided with information about which policy, i.e. managerial action related to a specific policy variable, might have a significant impact on Multifactor Productivity. On the one hand, IT Management will be warned off futile efforts, on the other hand, a ranking of policies will result which indicates which policies are expected to have the strongest effect on Multifactor Productivity. Thus, taking into account scarce managerial capacity, Multifactor Productivity could be used to determine expected *efficiency* of possible IT policies. However, it is important to keep in mind that there is no way in determining ex post the actual effects of individual IT policies on Multifactor Productivity, i.e. their *effectiveness*, as demonstrated above.

Although statistical correlation does not indicate a cause/effect relationship, together with reasonable assumptions about cause/effect relationships a positive result, i.e. a significant correlation between a policy variable and Multifactor Productivity, provides a better basis for selecting IT policies than the simple imputation of cause/effect relationships without further analysis. However, the nature of the correlation between policy variables and Multifactor Productivity deserves more attention since this may also be a source of applying the concept in a wrong way, which will be done in the following section. This section has demonstrated that Multifactor Productivity could be used to support IT Management in identifying appropriate measures to cope with IT related decision interdependencies in the Transnational Organization.

5. Pitfalls in applying the concept

The main problem in using Multifactor Productivity to identify worthwhile IT policies consists of collecting data about potential IT related policy variables. Whereas data necessary for calculating Multifactor Productivity are readily available from existing accounting systems, data concerning possible IT related policy variables typically are not systematically collected. Thus, for this analysis it is necessary to decide about which possible policy variables data shall be collected.

There are principally two ways in doing this ([7]). First, time series could be analyzed for individual firms. Second, cross sectional analysis could be performed for a number of firms. The first method implies that there is some statistical material available which can be used for deriving policy variables since otherwise it would obviously take too much time to perform the analysis.

This will be the case rather for large than for small firms. The second method requires that a systematic study be performed for a number of companies since data collected individually typically will not be comparable.

The general dilemma concerning both methods of data collection is that since it is so expensive and time consuming to get these data there will be strong incentives to make use of the first positive results available. If, for example, it could be demonstrated for a particular company that the number of computer interfaces used between national subsidiaries has a significant negative correlation with Multifactor Productivity, it might seem reasonable to centrally limit the number of allowed interfaces and/or specify allowed interfaces between national subsidiaries.

However, there might be further, yet undiscovered but connected policy variables offsetting the expected increase in Multifactor Productivity. For example, a diverse set of internationally used computer interfaces may have served to exchange a vast range of data (construction, billing, ordering, planning, budgeting etc.). The computerized exchange of these data may have been regarded as economical because specialized computer interfaces existed, probably several ones for presumably identical purposes which, however, from a national perspective had significant differences. If some of these are not allowed any longer, automatic data exchange might seem, from a national perspective, too expensive.

One reason could be that under the former regime two national subsidiaries were exchanging data such that data capturing related costs were equally distributed among them. Under the new regime, some interfaces may not be allowed thus reducing the spectrum of economical automatic data exchanges which might lead to an imbalance in the costs attributable to automatic data exchange. Therefore, one party might refuse to carry the costs of automatic data exchange the main benefit of which may accrue to the other party. This, in turn, might increase the size of stored data, leading to redundant data bases, since both subsidiaries will have to manually re-enter some data which both are using. Thus, the costs associated with redundant data may offset gains in reduced numbers of interfaces.

Although the problem of connected policy variables is not limited to Multifactor Productivity analysis it seems especially serious in this context since Multifactor Productivity analysis may be regarded as an "objective" method in identifying appropriate policies. Thus, there is a serious danger that policies are adopted which have a strong negative effect on Multifactor Productivity. This is all the more important to keep in mind since, as demonstrated above, there is no way of determining ex post the effects of certain policies on Multifactor Productivity.

6. Simple and complex IT policies

The argument presented in this paper has demonstrated that it is plausible to expect a huge increase in the level of decision interdepence as companies try to build the Transnational Organization. The notion of decision interdependence has been set out against that of Thompson's resource interdependence. It has been argued that increased decision interdependence is especially likely in the area of IT deployment due to (1) highly autonomous decision making in this area and (2) the emergence of a dense multi-directional pattern of data flows in the Transnational Organization. I have suggested to employ Multifactor Productivity as a new controlling instrument for global IT Management because it (1) captures any kind of decision interdependence and (2) can be used to identify worthwhile IT policies.

From this follows that the concept will be a useful controlling instrument only in a company which has made the transition to the Transnational Organization. However, successfully employing this instrument requires the creation of a considerable body of knowledge and experience as will be indicated below. Thus, it is advisable to start experimenting with the concept and collecting data in an early stage if the company intends to make the transition to the Transnational Organization.

As regards possible effects of employing the concept, only some speculative comments can be offered. According to the two possible points of departure to the Transnational Organization, two different effects can be expected. If the company departs from the Central Hub Model, the most likely outcome initially is a significant reduction in the number of implemented IT policies. Whereas in highly centralized organizations currently IT Management desperately tries to keep pace with the seemingly never ending stream of new technology triggering constant change in usage patterns and organizational structure, adoption of Multifactor Productivity as a new controlling instrument could demonstrate that there are but few policies which will significantly impact on Multifactor Productivity.

In companies trying to build the Transnational Organization from a Decentralized Federation Model, the concept will be a useful instrument in supporting an emerging central IT Management function. However, since the company has no prior data available about the impact of autonomous IT deployment on Multifactor Productivity (because initially national subsidiaries are not linked by a multi-directional flow of data), a data base has to be built up in the course of the organizational transformation process. Thus, initially it must rely on cross-sectional data. However, since the level of decision interdependence only gradually rises as the Company makes progress in building the Transnational Organization, learning how to use the concept can be expected to keep pace with this process.

As a limiting factor of applying Multifactor Productivity it has been shown that this concept, although supporting the identification of worthwhile IT policies, cannot reasonably be used for determining the effectiveness of IT Management. This points to a possible serious pitfall in applying the concept if premature IT policies are selected: since Multifactor Productivity cannot be used to determine the effectiveness of IT policies, premature implementation of IT policies might go undetected.

Given the considerable danger associated with premature IT Management measures it seems necessary to collect data about several policy variables which are likely to be interconnected. As long as this has not been accomplished, strong IT Management measures should not be considered. To help IT Management evaluating the risk of taking the false measure, I think it useful to introduce the distinction between simple and complex policies.

Simple policies are based on single policy variables such as number of interfaces or number of IT suppliers. Since only one variable is taken into account, the respective policy will tend to directly control this variable, for example by centrally limiting the number and kind of allowed interfaces or suppliers.

Complex policies, in contrast, are formulated on the basis of an analysis of several, supposedly interconnected, policy variables. For example, if a link between *number of interfaces* and *degree of data redundancy* is detected for an individual company, complex policies will try to influence the target variable *number of interfaces* without negatively influencing the connected variable *degree of data redundancy*. Obviously, this cannot be done by centrally prescribing the kind and number of allowed interfaces but rather by initiating a standardization process in which all parties concerned will negotiate standards for company-wide data exchange, possibly moderated by corporate IT Management.

Thus, simple policies should only be adopted if IT Management is quite sure that there are no strongly interconnected yet undetected policy variables which will probably only be the case after considerable experience with Multifactor Productivity analysis in a firm has been gained. However, if the company starts its development process towards the Transnational Organization from the Decentralized Federation Model, initially only a low level of decision interdependence between formerly unconnected national subsidiaries can be expected to exist. Thus, the danger of existing but yet undetected offsetting variables is initially significantly lower than in the second case in which the company departs from the Central Hub Model.

To summarize, the main task for global IT Management will consist of cyclically going through the following four steps:

- Defining possible policy variables
- Deciding for which of these data should be collected
- Performing Multifactor Productivity analysis
- Developing tentative policies

Only if this cycle has been performed several times, actual policies should be implemented. Gradually, however, a body of knowledge and expertise will develop as a result of a learning process in IT Management.

There is a fair chance for such an approach in companies considering the transition to the Transnational Organisation because (1) no other functioning intelligence systems for global IT Management are in place ([3]) thus keeping opportunity costs of implementing this approach on a low level and (2) because the process of building the Transnational Organization is an ongoing organizational process stimulating demand for a new controlling instrument for corporate IT Management on a global scale.

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