*Measuring Social "Informatization": A Factor Analytic Approach**

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Some scholars have argued that we are witnessing a new social revolution—social "informatization"—that is comparable in scope and impact to that of the Industrial Revolution of the eighteenth century. Others have argued that it is a much more modest phase in the ongoing development of communication and information-processing technology. While there are a number of reasons for disagreement about what exactly "informatization" is, and what its impact will be, two are paramount: (1) conceptual imprecision, and (2) issues of measurement. Using factor analysis, this study aims to clarify its conceptualization, and, then, rather than focusing on a single dimension (e.g., technological or economic), it will develop a comprehensive multiple-indicator measure that captures the economic, technological, and size (stock) dimensions of social informatization. We find that this measure of social informatization strongly correlates with the general level of socioeconomic development. This result implies that social informatization may be a more continuous and cumulative process than a disjunctive or discontinuous "revolution."

Social change has been and will remain one of the perennial topics of study for sociologists, as well as other social scientists. It is not an overstatement to say that sociology as an independent discipline emerged in large part from study of the changes that swept through European societies during the eighteenth and nineteenth centuries. The drastic changes and the social instability, which the Industrial Revolution had brought into being, overwhelmed contemporary scholars, and made them diligent in seeking laws of social change and development. For instance, Auguste Comte specified overcoming this instability as the purpose of sociology, which he dubbed "the queen of the sciences" (Marshall 1994).

It is often said that we are witnessing a new social revolution, perhaps even comparable to the Industrial Revolution in the eighteenth century. The essential aspect of the current social change is what we choose to call "social informatization." Social informatization can be defined as the process by which the social capacity to generate, process, and transmit information increases. We prefer the term "social informatization" to "information society," in part because the latter implies a dichotomy of societies as being either informational or noninformational. For this dichotomy to work, one would be able to identify a specific threshold, or Rubicon which objectively marks the dividing line, and this appears neither possible nor desirable. Rather, we agree with Webster (1994:17) when he states that "quantitative measures cannot of themselves

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identify a break with previous systems." Thus, a more productive way to conceptualize the term, we believe, is to view and operationalize it as a continuous process varying in degree rather than as categorical and binary.

This process affects the everyday life of individuals, including the way to produce goods and services, to interact with each other, and to gain socioeconomic power. Since the pioneering work of Fritz Machlup, *The Production and Distribution of Knowledge in the United States* in 1962, this theme has been taken up and elaborated by many authors; to name a few, Bell (1973), Castells (1996, 1997, 1998), Dordick and Wang (1993), Lyon (1988), Porat (1976), Stonier (1983), and Webster (1995).

The thesis of social informatization, however, has been criticized as much as it has been applauded. While there are many reasons for the disagreements and confusion about social informatization, two appear more important; conceptual imprecision and the lack of empirical measurement. Researchers of social informatization operate with undeveloped and/or imprecise definitions of their subject (Webster 1994). Without clear definitions of concepts, scientific discourse is difficult if not impossible, and any resulting theory will lack clarity and precision. This conceptual imprecision may be responsible, to some extent, for the subjective interpretation, implicit value judgment, and/or ideological claims, which we often find in the literature on the process of social informatization (Lyon 1988).

Moreover, efforts to empirically measure social informatization have been problematic. A few recent measures, such as the Information Society Index (ISI) from the IDC/World Times and the Digital Access Index (DAI) from the International Telecommunication Union (ITU), however, mainly focus on a particular (i.e., technological) aspect, while neglecting other important dimensions, such as the economic and the stock aspect. The lack of empirical measurement or improper measurement hinders systematic and objective research on the effects of social informatization, and generates only anecdotal cases and a limited body of empirical research.

For the investigation of social informatization to have a more scientific basis, therefore, there is a pressing need for a clear, cogent conceptualization of the phenomenon and an objective empirical measure of it. To address this need, we will propose and develop a composite measure of social informatization. It is composite in order to encompass the various aspects of social informatization, including the size and relative importance of the information economy, the overall volume of information (stock), and the availability of information technology. We will use factor analysis to construct a composite measure from these multiple aspects of informatization. This will provide a better overall representation of the concept and will reduce the error or bias that is inherent in each aspect taken individually (Singleton, Straits, and Straits 1993).

Approaches to the Study of Social Informatization

There have been several approaches to the study of social informatization (see Duff 2000; Webster 1995). They can be classified into three general categories: the economic, the technological, and the stock approach. Simply put, the economic approach focuses on the growing dominance of the economy by its information sector, while the technological approach focuses on how efficient the production and distribution of information is. Finally, the information stock approach focuses on the size of the stock of information accumulated in a society.

The Economic Approach

In a sense, it was the economists who initiated the study of social informatization particularly in the 1960s and 1970s (e.g., Drucker 1969; Machlup 1962; Porat 1976). The main focus of their approach was on structural changes in the economy, especially industrial output and employment. They argued that the essential difference between an "industrial" and an "information" society was that in an information society the locus of economic activity had shifted away from manufacturing *objects* and toward the handling of *information and symbols* (Porat 1978a). Thus, social informatization was identified with growing dominance of the information sector of the economy.

This approach, however, has been criticized for the number of subjective interpretations, value judgments, and conventions it required and made (Ricci 2000; Webster 1994). In practice it turns out that it is very difficult, if not impossible, to identify and distinguish industries and occupations that are *exclusively* informational. Thus, researchers were forced to make a number of questionable assumptions to separate out an information sector. A further complication is posed by the fact that the information sectors of two countries may differ greatly in their internal structure and characteristics, even though they may comprise similar proportions of the workforce (Katz 1986).

The Technological Approach

The technological approach has gained popularity in recent years, and, in fact, now appears to dominate contemporary discourse on social informatization. It focuses on the fact that, since the 1970s, information and communication technologies (ICTs) have developed at an amazing pace, and have dramatically reduced the costs of generating, storing, and transmitting information. Some even view this development of ICT as being epoch-making, that is, having effects on informatizing societies comparable in sweep and magnitude to those the steam engine had on industrializing societies during the Industrial Revolution (Castells 1997; Masuda 1981). Reflecting the central role accorded to computers in this process, authors with this perspective frequently equate informatization with "computerization."

This approach, however, is prone to a simplistic technological determinism. Neglecting the role that social organization and culture play in the shaping and directing of technology, this approach "misconceives social change because it desocializes key elements of social change" (Webster 1995:219). Interestingly, despite its strong determinism, this view has often led to an excessively optimistic or even a utopian expectation for future change (Ricci 2000).

But, while it clearly affects society, it is widely acknowledged that technology is socially shaped as well. Technology is not some neutral, autonomous agent over which we have no control (Bannon 1997). Research and development are a case in point. The decision of how much time, energy, and money are to be directed to develop which technology, is basically a social decision. Thus it embodies and reflects to varying degrees social, political, and economic values (Webster 1994). Furthermore, the accommodation or adaptation to the resulting technology is also socially conditioned.

The Information Stock Approach

This approach has been present in some forms for a long time,[1] although it may be the least discussed in recent literature. This approach, simply put, states that being informatized is related to having a greater amount of information. For example, Lane (1966), developing the idea of a "knowledgeable society" in the 1960s, argued that a knowledgeable society would be one where there is a large inventory of knowledge, and where many people go about the business of producing knowledge in a proper (i.e., scientific) fashion. The stock of information is defined as "the sum of total things known to members of [a] society, regardless of the number of knowers; some things are known to many, other things to only a few, perhaps only to one living person" (Machlup 1962:122).

Rather than having to decide among these approaches and measures, it seems prudent to first consider whether, rather than being *alternatives*, they actually represent different dimensions or aspects of a single process of social informatization. In other words, is social informatization a uni- or multi-dimensional concept? Regarding this issue, it is useful to note the distinction between effect indicators and causal indicators that Bollen and Lennox (1991) make. Conventionally, we see indicators as dependent on a latent variable (effect indicators). As the latent variable determines its indicators, the causal direction flows from the latent variables to the effect indicators. Thus, any change in the latent variable would necessarily lead to a corresponding change in "all" effect indicators. In this case, the latent variable is viewed as a unidimensional concept. Moreover, because they are determined by a single latent variable, the effect indicators should be highly correlated with one another.

On the other hand, it is also possible that indicators “cause” the latent construct (causal indicators). Contrary to the former case, each indicator here represents a distinctive dimension of the construct, indicating that the construct must be a multidimensional concept. This implies, first, that the correlations among the indicators are not necessarily high. Second, a change in the latent variable may result from a change in any one of the indicators, while the others remain unchanged. Moreover, removing one indicator from the model would lead to dire repercussions, because it “changes the composition of the latent variable” (Bollen and Lenox 1991:308).

It seems to us that the process of social informatization is best viewed as a unidimensional construct. For instance, a growing volume of information will generally be expected to lead to increasing specialization and division of labor in the information workforce, and thus result in greater demand for information workers. This growing information sector, in turn, will have a positive feedback effect on the stock of information. Moreover, having a large number of information workers may contribute to the development and use of ICTs, because they are the primary users of such technologies.[2] Finally, the development of ICTs, by increasing the efficiency of information production and the speed of distribution, may well spur the production of new information. Therefore, all these aspects of informatization can be seen to interact and to reinforce each other, rather than being isolated or independent. In fact, none of them can be expected to progress very far without corresponding increases in, and support from, the others.

Figure 1 shows our hypothesized measurement model of social informatization. Again, the observed indicators are posited to be dependent variables of a single underlying construct, social informatization.

Measuring Social Informatization

Measuring social informatization, as noted above, has proven to be a very thorny problem. Measurement has frequently been controversial and subject to obvious shortcomings and errors. A good example of this is found in, but not limited to, the economic approach. Most researchers have measured the information economy by defining the information sector as an independent sector of an economy. However, a moment’s reflection makes it obvious that information is present in *all* economic activity. Separating out the information sector is, thus, far from easy, as it spans, to varying degree, all the traditional economic sectors, including agriculture, manufacturing, and service (Lyon 1988; Porat 1978b). What one must attempt, then, is to focus on information intensity, but that is difficult to quantify and measure, especially cross-nationally.

The two most common approaches to the measurement of the “information” economy are the occupation-oriented and the output-oriented approach.

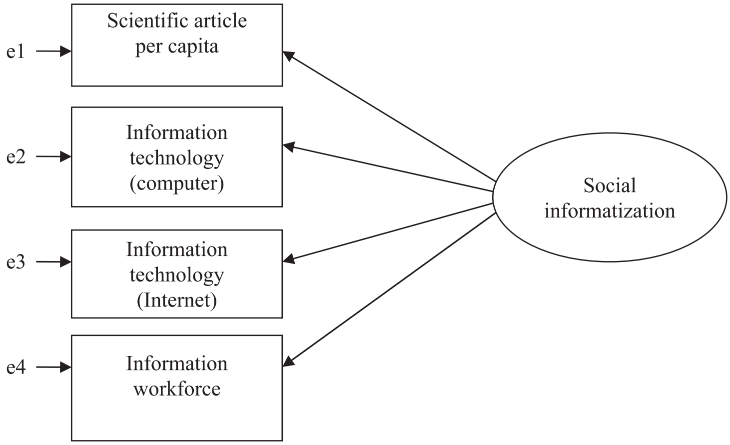

Figure 1
Hypothesized Measurement Model of Social Informatization.

The former usually measures the ratio of information workers to the total labor force, whereas the latter measures the contribution of the information sector to total economic output. These measures may have their own relevance and uses. Informatization should be reflected in the kind of work people do to earn a living (occupation) and/or in the commercial production and the sale of goods (output).

Nonetheless, each of these measures is problematic in its own way. A key problem facing the industry approach is that information is often intangible, so that it is difficult to measure its output. Possibly foreseeing his controversial results, Machlup (1962:44) grumbles:

> There is no physical output. Indeed, for most parts of the production of knowledge no possible measure of output can be conceived that would be logically separate from a measure of input; and those relatively rare kinds of knowledge for which independent indices of output could be concocted cannot in any meaningful way be compared, let alone aggregated, with other kinds of knowledge.

Since it is easier to measure the relative size of the information workforce than it is to measure its informational output, we will utilize the occupational approach in this study. Yet, there is no agreed-upon criterion for precisely delineating informational and noninformational work. At present, there appear to be three basic definitions of the information workforce. One, which we term the broad definition, is that proposed by Machlup (1962) and Porat (1976). As he believed that the production of information could not be separated from its dissemination, Machlup included information producers and distributors. Thus he considered postal employees to be information workers, because they were information distributors. As a result, this classification overlaps greatly with the service sector. Porat (1978b) also considers information machine operators, such as telephone installers and television repairers, to be information workers.

Criticizing this approach, Bell (1973:212–13) offered a much narrower definition of information work, focusing more heavily on the "production" of information. He asserts that:

> Any meaningful figure about the "knowledge society" would be much smaller [than that of Machlup's]. The calculation would have to be restricted largely to research, higher education, and the production of knowledge, as I have defined it, or as intellectual property, which involves valid new knowledge and its dissemination.

Then, he specifies that information work is constituted by scientific, technological, administrative, and cultural estates (p. 375). It should be noted that clerical and sales workers were not included in Bell's classification.

An intermediary definition of information occupation could be developed by adding clerical workers to the knowledge workers of Bell. For example, Uno (1982) defines knowledge workers as those participating in the development of knowledge or utilizing knowledge. Unlike Machlup and Porat, Uno considers those primarily involved in distribution of information as not being different from simple manual laborers. On the other hand, unlike Bell, he emphasizes information utilization, as well as its production.

Consequently, Uno includes clerical workers with something very close to Bell's "knowledge workers" (i.e., scientific specialists, educators, medical specialists, artists, and managers). In an attempt to increase the robustness of the measure, we will use all three of the definitions to see if they produce systematic and significant differences in the results.

To capture the technological dimension of informatization, we will use the number of computers per thousand persons and the proportion of Internet users in the total population. It is without doubt that the essence of the contemporary technological revolution lies in the development and the widespread use of computers. To see the important role of computers in the informatization process, one only need imagine how much of the information that we possess today would exist or be accessible if it were not for computers. The information-processing power of computers has grown exponentially, while the cost has plummeted. Moore's observation in 1965 that the amount of information storable on a given amount of silicon had doubled every year since it was invented seems still to hold today.

Nonetheless, the computer remained simply a machine for information processing and generation, however, until it was connected to other computers all over the world. The Internet, the worldwide network of computers, has become the most powerful and efficient means of information transmission. Moreover, the Internet is a point-to-point communication medium, which, contrary to point-to-mass media, is largely beyond central control. For this reason, its development has often been associated with political democratization (Hill and Hughes 1998), facilitating the division of labor, and increasing productivity (Porat 1982).

Finally, to measure the information stock aspect of social informatization, we will use the annual number of scientific and technical journal articles published per million persons. The stock of information is hard to measure because of its intangibility, and, even if measured, it is hard to compare across different societies because of its variety and variation in quality (see, for example, Machlup 1962). Nonetheless, scientific and theoretical information must take the central position in any measure of informatization (Bell 1973). Given this, a relevant indicator will be the count of articles published in scientific journals per capita (Bell 1973, citing Derek Price 1961).

One will find, however, upon reflection that this actually measures the production of certain kinds of information, rather than the stock of information. But, we would argue that the production of scientific information is almost certainly connected to the already existing stock of information. Information by its nature is "cumulative" in that new information builds upon the stock that has been generated previously. Thus, the number of published scientific articles can be a useful, if indirect, measure of the stock of information.

In fact, there are some distinct advantages to this measure. One is that it allows one to consider qualitative aspects of social informatization. There have been a number of critiques that the quantitative measure of information (such as in the information workforce and in the information technology penetration) did not "distinguish more strategically significant information activity from that which was routine and low level" (Webster 1994:17). Another advantage of this measure is that it allows one to quantify "original" information. This is an advantage, considering the fact that much of information in society is redundant, so that simple quantitative measures are likely to overestimate the stock of unique information.

Data and Method

Data on the number of scientific and technical journal articles, the number of personal computers, and the number of Internet users are all drawn from the *World Development Indicators* (WDI),[3] the World Bank's annual compilation of data about development, containing approximately 800 indicators (World Bank 2001). Published journal articles and Internet users are reported in absolute values. To make them more comparable, we divided them by the corresponding population size.

The data on information workers (i.e., their proportion to the total labor force) are taken from the *Yearbook of Labor Statistics*, published annually by International Labour Organization (ILO) of the United Nations (ILO 2000). The *Yearbook* contains internationally comparable and reliable, if aggregate level, information on the distribution of workers by occupations.[4] The ILO has developed a series of classification schemes of the International Standard Classification of Occupations (ISCO). The latest is the ISCO-88, used from 1988. It consists of 10 major groups, divided into 116 minor groups. While most countries report their statistics based on the ISCO-88, several of them still adhere to the 1968 version (ISCO-68), which differs slightly from the ISCO-88.

The data on the information workforce greatly limits the sample size, because the *Yearbook* contains many missing cases. To relieve this constraint, we had to compromise, to some extent, on the exactness of the measurement. For example, in cases where the data on the information workforce were not available for the reference year (1998), we used the 1997 and even the 1994 (e.g., Ecuador and Paraguay) data, if available. Unlike such rapidly changing data as computer penetration and the proportion of Internet users, the information workforce, we believe, is relatively stable over such short periods of time. Although the resulting sample size is still relatively small ($N = 58$), it is larger, and allows more controls, than those used in previous empirical studies (e.g., Dordick and Wang 1993; Katz 1986).

Another potential problem facing this study is the fact that missing cases are not random. Less developed countries, especially in sub-Saharan Africa, are more likely to be missing cases. One might object that for this and other reasons, our measure will be "biased" toward, or only of relevance for, more developed nations. While, at first glance this might seem to be a serious flaw, we believe it is not necessarily. Given the fact that all technological development and productivity results from, and embodies, *information* (e.g., Lenski 1970), we can ask how could it be otherwise? How could economic development and informational resources not be correlated so?

A more relevant question, we believe, is whether or not such a measure can help us to understand economic differences among the more developed societies for which we have data. Therefore, although we caution our readers to remain aware of the limitations we face with respect to the reliability and generalizability of our results, we think it well worth the effort to attempt the construction of a composite measure of informatization.

As we discussed earlier in some detail, various authors have presented a variety of classification schemes regarding information occupations. Thus, we will operationalize our measure in three ways. First, using the narrow definition of information occupations we include the first three major groups of the ISCO-88: legislators, senior officials and managers; professionals; and technicians and associate professionals. For the ISCO-68, it includes the first two major groups: (1) professional, technical, and related workers; and (2) administrative and managerial workers. Second, following the intermediary definition we add the fourth major group (clerks) to the narrow definition; for the ISCO-68, we add the third group, Clerical and related workers. Finally, in keeping with the broad definition, we add the fifth major group, Service workers and shop and market sales workers. For the ISCO-68, we add the fourth and fifth groups, Sales workers and Service workers, respectively.

We do not claim that any of the above operationalizations is without its problems. In fact, all are subject to the common critique that nearly all occupations involve, to some extent, information processing and cognition. Thus, the distinction between information and noninformation occupations is not especially precise. And, as Porat (1978b) notes, such distinctions are always risky. Another shortcoming is the fact that, given the data available, we have to include all service occupations in our broad operationalization of information occupations. Clearly, neither Machlup nor Porat would argue that their (broad) definitions would include *every* service occupation. However, it is simply not possible to single out specific occupations from all the service occupations in order to exactly match Machlup’s or Porat’s definition with our *Yearbook* data. Nonetheless, despite these limitations, we believe that the *Yearbook* of the ILO is the best cross-national data source available for this topic.

As there are multiple aspects or dimensions of social informatization, and because each is at best a partial or imperfect indicator of the underlying theoretical concept, factor analysis is an appropriate tool for our project. Factor analysis will allow us to determine if there is a common factor underlying our indicators. And, if there is, its results can provide us with a single composite measure (latent construct) that not only better measures our theoretical concept, but will enable us, and other researchers, to use this measure in future analyses of its causes and consequences.

Results

Table 1 presents the correlation matrix for our indicators of social informatization. As discussed earlier, the information workforce is operationalized in three different ways: (1) the narrow definition, (2) the intermediary, and (3) the broad definition. Despite the differences in operationalization, it turns out that all of these measures are substantially and significantly intercorrelated. For example, the correlation between the narrow and the intermediary definition is as high as .95, while it is .69 between the narrow and the broad definition.

The correlation analysis above, however, suggests that the information workforce may be less correlated with the other indicators of social informatization. This is particularly true for the broad measure of the information

Table 1
Correlation Coefficients among the Indicators of Social Informatization (*N*)

	1	2	3	4	5	6
1. Information workforce (*N*)[a]	1.00	.95**(62)	.69**(62)	.63**(58)	.64**(60)	.74**(60)
2. Information workforce (I)[b]		1.00	.82**(62)	.72**(58)	.71**(60)	.79**(60)
3. Information workforce (B)[c]			1.00	.63**(58)	.60**(60)	.63**(60)
4. Computer per 1,000 people				1.00	.88**(91)	.87**(90)
5. Internet users (%)					1.00	.84**(98)
6. Articles per million						1.00

[a]The narrow definition of information workforce.
[b]The intermediary definition of information workforce.
[c]The broad definition of information workforce.
**Significant at the .01 level (two-tailed).
Source: International Labour Organization (2000) and World Bank (2001).

workforce; its correlation with scientific journal articles, computers, and Internet users is .63, .63, and .60, respectively. These relatively low correlations may be explained by the "hypertrophy" of the information sector in some developing countries. For example, a closer look reveals that former communist nations (such as Croatia, Czechoslovakia, Hungary, Poland, Slovak Republic, Slovenia, and Ukraine) and Egypt have a relatively high proportion of their workforce in information occupations, compared to other societies at similar levels of development.

This hypertrophy may result from the different definitions each country makes in classifying occupations, or more plausibly, from the fact that the quality and quantity of the work being performed by information workers varies substantially from country to country (Rai and Lal 2000). A number of authors have observed that the (service sector or) information sector may be larger in developing countries than it is in more developed countries at a similar stage in their development (e.g., Bairoch 1975; Katz 1988), while the quality of its work is low.[5]

Similarly, Katz (1988) argues that the relative hypertrophy of the information sector in developing countries is caused not only by indigenous development but also by "external distortions in the industrialization process itself" (Katz 1988:30). In other words, the information sector has grown in developing countries due, at least partly, to noneconomic reasons, such as expansion of governments and a dysfunctional education system (e.g., producing an oversupply of educated workers). In the case of Egypt, Katz (1988:40) concluded, that "at lower levels of development, the expansion of government is the main contributor to the growth of the information sector."

The same reasoning may explain the relatively large information workforce in the former communist countries. According to a recent survey, the average total government civilian employment is about 6.9 percent of population among the former communist countries (Eastern Europe and Central Asia), whereas the world average is only 4.7 percent (Schiavo-Campo, Tommaso, and Mukherjee 1997).[6] And, in countries such as Hungary and Ukraine, it accounts for over 8 percent of the population. Most of the government employment is accounted for by education and health, with central government administration at a modest size.

We used SAS's PROC CALIS procedure and maximum likelihood for our analyses. We first tested how many factors could be extracted from the data. As the independence model did not fit the data ($\chi^2 = 208.09$, $df = 6$), we then ran a two-factor model where computers and internet users constitute one factor, and the information stock and information workforce constitute the other. This model did not fit very well either ($\chi^2 = 80.30$, $df = 2$).

How well does our hypothesized single-factor model fit the observed data? The goodness-of-fit indexes (GFI) of the hypothesized model are .95, .96, and 1.00, respectively, when the narrow, the intermediary, and the broad definition of

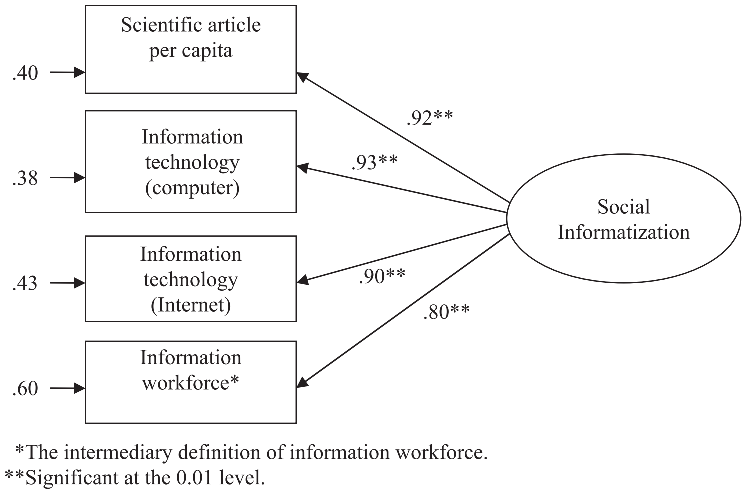

Figure 2
Maximum Likelihood (Standardized) Estimates of Social Informatization Model ($N = 58$).

information workforce are employed. The corresponding adjusted goodness-of-fit indexes (AGFI), which adjust the GFI for loss of degrees of freedom, are .74, .82, and .98. Finally, the χ^2 values, where $df = 2$, are 5.87 ($p = 0.05$), 3.93 ($p = 0.14$), and 0.53 ($p = 0.77$). These results indicate that the model, employing the narrow definition of information workforce, does not fit the data very well, while the model using the broad definition of information workforce fits the data best.

All four variables seem to be reasonable indicators of the latent construct—social informatization. As Figure 2 shows, the standardized factor loadings (and standard errors) are .92 (.10) for the publication of journal articles, .80 (.11) for the intermediary operationalization of information workforce, .93 (.10) for personal computers, and .90 (.10) for Internet users. When the broad operationalization of information workforce is employed, the loadings are .90 (.10) for articles, .68 (.12) for the information workforce, .94 (.10) for computers, and .91 (.10) for Internet users. As anticipated from the correlation matrix, the information workforce has a somewhat lower loading than the other indicators, and this is especially true for the broad definition of information workforce (.68). Thus, of the three different definitions of information workforce, the intermediary appears most effective. It provides both an acceptable level of model fit and has a substantial factor loading (.80). While the broad definition of information workforce did provide a somewhat better fit, its lower factor loading on the underlying construct (.68), made it less suitable in our opinion.[7]

Before proceeding, it should be noted that all the fit indices make certain assumptions. For example, it is assumed that the sample is reasonably large, and that the observed variables have a multivariate normal distribution. The fact that our sample is relatively small ($N = 58$), and that our data are not multivariate normal (Mardia's multivariate kurtosis value is 9.5 and the relative multivariate kurtosis is 1.4, when the intermediary definition of information workforce is used), suggest that our estimates of model fit may be biased, and that the results from maximum likelihood estimation must be viewed with a caution.[8]

Partial Least Squares (PLS), however, is a useful alternative, as it makes no distributional assumptions regarding the data, and requires a much smaller sample size[9] than covariance-based modeling techniques, such as Maximum Likelihood (ML) and Generalized Least Squares (GLS). Unlike the latter procedures which employ common factor analysis, PLS utilizes a component analysis. Thus, high communality, which is present in our data set, is a desirable property. Although PLS estimates are to some extent less optimal regarding bias and consistency, variance-based PLS and other covariance fitting procedures should be considered complementary rather than competitive in nature (Chin, Marcolin, and Newsted 1996).

The factor loadings from the PLS estimation method (Chin and Frye 1998) are presented in Table 2. As it shows, the results are very similar to the previous ones. All indicators have high loadings on the latent construct, which implies good convergent validity.[10] Moreover, internal consistency reliability[11] is .96, when the intermediary definition of information workforce is used. This is well

Table 2

Partial Least Squares (PLS) Estimates of Social Informatization Model ($N = 58$)

Indicator	Narrow[a]	Intermediary[b]	Broad[c]
Published article	.94	.94	.93
Personal computer	.93	.93	.94
Internet users	.92	.92	.92
Information workforce	.82	.87	.79
Internal consistency reliability	.95	.96	.94

[a]Narrow definition of information workforce is used.
[b]Intermediary definition of information workforce is used.
[c]Broad definition of information workforce is used.

above the adequate level of .70 (see Yi and Davis 2003). Therefore, it seems reasonable to conclude that all the variables are reliable and robust indicators of our latent construct—social informatization.

Informatization scores for the 58 sample countries are presented in Table 3. These estimates were calculated by using the PLS procedure. Among the sample,

Table 3

Rank-Ordered Score of Informatization by Country, and Its Comparison with the Digital Access Index (DAI) 2002 from the International Telecommunication Union (ITU)

Country	Informatization Score*	DAI Score (Rank)
Sweden	2.152	.85 (1)
Switzerland	1.910	.76 (13)
Finland	1.831	.79 (8)
Norway	1.707	.79 (5)
Denmark	1.670	.83 (2)
Australia	1.627	.74 (19)
Canada	1.619	.78 (10)
United States	1.543	.78 (11)
Netherlands	1.406	.79 (6)
Singapore	1.303	.75 (14)
United Kingdom	1.202	.77 (12)
New Zealand	1.133	.72 (21)
Hong Kong	1.101	.79 (7)
Israel	1.097	.70 (25)
Germany	.933	.74 (18)
Austria	.816	.75 (17)
Ireland	.662	.69 (26)
Japan	.531	.75 (15)
Slovak Republic	.292	.59 (41)
Slovenia	.273	.72 (24)
Italy	.177	.72 (22)
Spain	.124	.67 (29)
Korea	.109	.82 (4)
Czech Republic	−.084	.66 (31)
Estonia	−.095	.67 (28)
Greece	−.197	.66

(*continued*)

Table 3
(*continued*)

Country	Informatization Score*	DAI Score (Rank)
Hungary	–.292	.63
Croatia	–.363	.59
Brazil	–.400	.50
Russia	–.432	.50
Poland	–.432	.59
Portugal	–.433	.65
Uruguay	–.549	.54
Latvia	–.553	.54
Ukraine	–.598	.43
Chile	–.611	.58
Costa Rica	–.634	.52
Egypt	–.652	.40
Malaysia	–.670	.57
Trinidad and Tobago	–.681	.53
Mauritius	–.741	.50
Panama	–.756	.47
Venezuela	–.783	.47
Honduras	–.815	.29
Colombia	–.836	.45
Mexico	–.860	.50
Peru	–.876	.44
Ecuador	–.900	.41
Romania	–.912	.48
Bolivia	–.947	.38
Turkey	–1.027	.48
El Salvador	–1.055	.38
Sri Lanka	–1.105	.38
Thailand	–1.111	.48
Philippines	–1.136	.43
Lithuania	–1.222	.56
Pakistan	–1.233	.24
Bangladesh	–1.305	.18

*The intermediary definition of information workforce was used to calculate the factor scores.

European countries, particularly the Scandinavian and Nordic countries (e.g., Sweden, Finland, Norway, and Denmark) have the highest scores, while less-developed Asian countries such as Bangladesh, Pakistan, Philippines, and Thailand, have the lowest. Given the fact that most of the least-developed countries (such as the sub-Saharan African ones) are missing, however, one should not conclude that these Asian countries are the least informatized in the world.

While there is four-year difference in time, this index may be compared with the Digital Access Index (DAI) 2002 from the International Telecommunication Union (ITU), the oldest index available, which mainly focuses on ICT access (ITU 2003). Generally speaking, these two indices largely overlap each other. According to the DAI-2002, the 10 most informatized countries are exclusively European (6) and Asian (3), except for Canada. While European countries dominate in our index, the Asian Tigers (e.g., South Korea and Hong Kong) are not very high. For example, South Korea, ranked 4th in the DAI-2002, is 23rd here, and Hong Kong drops from 7th to 13th. One possible explanation for this is that the newly industrialized Asian countries are highly informatized with regard to ICT access, but that they are not as prominent with regard to other aspects of informatization, such as information stock and the information workforce.

The reason that the Scandinavian and the Nordic countries are found to be the most informatized may have to do with their general lack of natural resources needed to sustain industry. For example, explaining the high level of informatization in Finland, Shifflet (2001) argues that industrialization was not a viable long-term option for this country because of its lack of natural endowment. If true, this explanation might be extended to neighboring countries in the region.

Summary and Discussion

The goal of this study was to better specify and to better measure the concept of social informatization. To do so, social informatization was conceptualized as a composite variable, encompassing a number of dimensions. The dimensions of social informatization include (1) the information workforce, (2) information technology, and (3) the stock of information available in a society. While each of them had significantly high loadings on the latent construct, the information workforce had a lower loading than the others. As we indicated above, this may have to do with the relative hypertrophy of the information sector in currently developing countries.

Of the three alternative definitions of the information workforce examined here, the intermediary definition of information workforce was found to be better than the narrow and broad definition. The narrow definition of information workforce did not produce a satisfactory model fit. The broad definition, while producing the best model fit, led to an unacceptably low factor loading (.68). Thus, in our opinion, the most effective way to conceptualize the information workforce is to include clerical workers together with professional, managerial, and technical workers, while excluding sales and other service workers.

We have also concluded that social informatization is best seen as a unidimensional concept. In other words, the different aspects, rather than representing distinctive and independent dimensions of social informatization, appear to be driven by the single latent construct. All aspects of social informatization appear to interact and reinforce each other, rather than being independent.

The resulting factor score enables us to assess the extent to which a society is informatized. Because it is a continuous measure, one does not have to depend on an unrealistic dichotomy between an information society and a noninformation society. In addition, this measure covers multiple aspects of social informatization, and therefore, is more comprehensive than previous measures, which mainly focused on a single (technological) aspect of social informatization.

As can be seen in Table 3, the informatization scores generally correlate with level of socioeconomic development. In fact, we find a strong linear (positive) correlation between the level of informatization and gross domestic product (GDP) per capita (see Figure 3). Simply put, advanced countries tend to be more informatized than their less-developed counterparts. This finding implies that social informatization may be more of an evolutionary and continuous, than a revolutionary and discrete process. Thus, social informatization may be better seen as a continuous and cumulative process than as a disjunctive or discontinuous revolution.

This goes against what Miles (1996) calls “transformism,” which stresses that the information society is something different and fundamentally new. As Woodall (1982:9) notes, the mistake that transformists make “lies in [their] failure to grasp the continuity of the industrialization process.” Social informatization, whether or not it constitutes a significant social change, cannot be detached from its socioeconomic context and its precursors.

Thus, although it may not be strictly impossible, it appears highly unlikely that less-developed countries, as some have argued, can “leapfrog” or bypass an “industrial” phase of development, and move directly into becoming an information society. Simply importing more ICTs into them will not be sufficient in our opinion. And, thus, the thought that developing countries have tremendous opportunities to develop and catch up with developed countries, as the world becomes informatized, seem overly optimistic to us. A more realistic conclusion may be that their existing shortcomings with regard to informatization will cause them to fall even further behind their more advanced competitors in coming decades. As Lenski and Nolan (1984, 2005) have shown, the technoeconomic

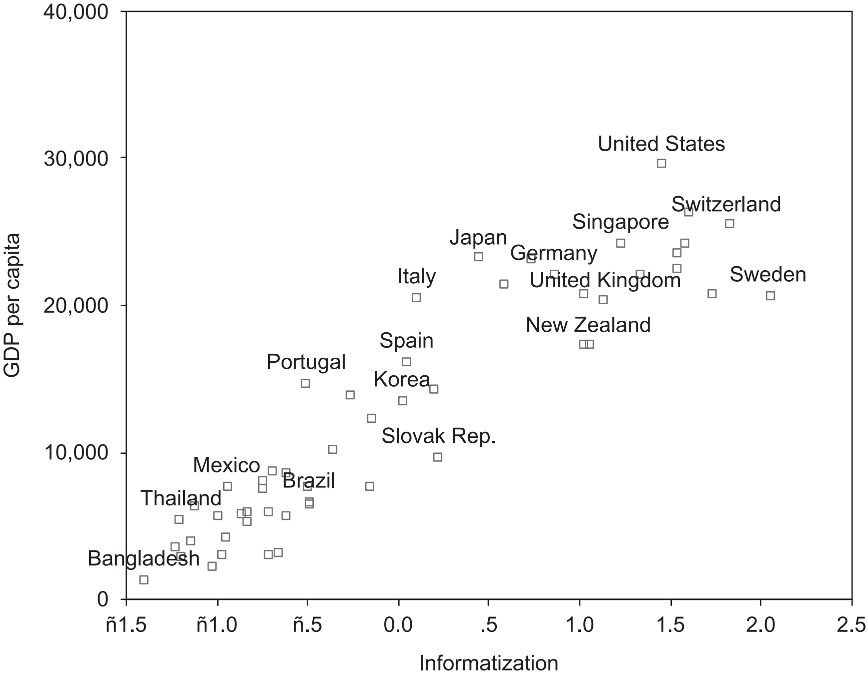

Figure 3

Scatter Plot of the Informatization Scores by Gross Domestic Product (GDP) per Capita.

heritage of the distant past continues to affect the current level and pace of development in currently developing societies. Thus, past experience continues to cast a long shadow over the present, and might be expected to continue to do so far into the future.

ENDNOTES

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[1]The information stock approach traces the epistemic root of social informatization back to the Enlightenment in the eighteenth century. According to Mokyr, the amount of (particularly scientific)

information increased after the Enlightenment, and the ensuing "Industrial Revolution constitutes a stage in which the weight of the knowledge-induced component of economic growth experienced a marked increase" (Mokyr 2000:12).

[2]The service sector accounts for about 80 percent of IT investment (Brynjolfsson and Yang 1996).

[3]The World Bank does not directly collect the data. The data on scientific and technical journal articles are from the National Science Foundation's *Science and Engineering Indicators*. The data on computer and Internet users are from the International Telecommunication Union's *World Telecommunication Development Report* (ITU 2003).

[4]For the reliability of the data, see Katz (1986).

[5]Bairoch (1975:161) argues, "The high level of tertiary employment can be explained by the excessive development of commercial activity and public services in most of the countries concerned and by the impossibility of absorbing in the secondary sector all the surplus labor from agriculture."

[6]Relative to total employment, government employment accounts on average for about 16.0 percent, while the world average is 11.0 percent.

[7]It is worth noting that, if a loading is below .707, the communality of the indicator is less than .5, meaning that less than a half of the variance in the indicator is explained by the latent construct.

[8]"Nonnormality, especially high kurtosis, can produce poor estimates and grossly incorrect standard errors and hypothesis tests" (SAS Institute 1999:437).

[9]The sample size requirement would be equal to the larger of the following: (1) ten times the scale with the largest number of formative (i.e., causal) indicators, or (2) ten times the largest number of structural paths directed at a particular construct in the structural model.

[10]The average variance extracted, calculated from the formula:

$$\text{AVE} = \sum\lambda_i^2/[\sum\lambda_i^2 + \sum(1 - \lambda_i^2)]$$

where λ_i is the standardized component loading of a manifest indicator of a latent construct (Yi and Davis 2003), is .84, which is fairly high.

[11]Internal consistency reliability is computed as,

$$\text{ICR} = (\sum\lambda_i)^2/[(\sum\lambda_i)^2 + \sum(1 - \lambda_i^2)],$$

where λ_i is the standardized component loading of a manifest indicator of a latent construct (Yi and Davis 2003).

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