*Analyses of Information and Energy Segments of the Iranian and Indian Economies**

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Abstract

This paper analyses the interdependence between information and energy segments of the Iranian and Indian economies. The Iranian economy is an energy-based resource exporting economy and the Indian economy is a non-resource energy importing economy. Despite the diversified structure, informatization of the two economies appears to be a common goal for structural changes in the two countries. The main objective of this paper is to quantify the informatization of the two economies. The informatization is considered in terms of structural changes with respect to trend substitution between information and energy segments using macroeconomic approach. For this purpose we use two sets of IOTS: 1991-2001 for Iran and 1994-1999 for India.

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Introduction

The central issue of this paper is to analyse an empirical relationship between information and energy segments of the Iranian and the Indian economies. The Iranian economy is characterized as an energy- based resource exporting economy and the Indian economy is known as a non-resource energy importing economy. Despite the diversified structures, the informatization[1] of the two economies appears. to be a common goal for the transformation or structural changes of the two countries. For the first time, the importance of informatization with "Knowledge based economy" and/or "Knowledge based and management" appears to be one of the long-term objectives of the long-term perspective plan of Iran (2005-2025)[2]. Broadly, such an objective has two main characteristics: One is to revive the continuing issue of long term structural change from a resource-based (oil-based) mono-economy to an industrial-resource-based poly economy which had been initiated after the quadrupling of oil revenues in the seventies (Banouei, 1992a, Banouei, 1992b, Prasad, Banouei and Swaminathan, 1992) and the second is a long term transformation of a resource-based (more precisely energy-based) to a knowledge-based economy (Banouei and Mohagheghi, 2007). The dividing line of the long term economic policies between the two above mentioned characteristics is that, the former has not visualized the nature of resources to be used for production of goods and services for the structural changes whereas the latter had endorsed such structural changes from a resource-energy based to a knowledge based economy. Therefore the substitution between information and energy appears to be the main concern of planners as well as policy makers in Iran.

Recognizing the impressive growth that India has achieved since the mid-eighties, India planners and policy makers have given due importance to the versatility of knowledge-based economy in the formulation of the Tenth Five Year Plan (2002-

2007) (Planning Commission, 2003). It states that "Telecommunication is a crucial component of infrastructure and one that is becoming increasingly important, given the trend of globalization and the shift to a knowledge-based economy" (Planning Commission, 2003, p.21). The shift to knowledge based economy will lead to energy saving as well as reduce the burden of the adverse balance of payments for the Indian economy (Mukopadhyay and Charkaborty, 2003).

Considering the crucial role of information and informatization for the structural changes of the two diversified economies, the main focus of this paper is to empirically investigate the following two questions: Being developing countries which are of them have successfully experienced the structural changes with respect to trend substitution between information and energy segments? How far does the relationship between information and energy contribute positively (in the case of substitution) and negatively (in the case of complementarity) for the two economies under consideration?

The contents of this paper with respect to the above question are structured as follows: In Section 1 we briefly overview the relevant literature. The basic definition, classification and units of measurement of three segments of two economies are given in Section 2. In Section 3, we briefly explore the methodology of the paper. Data base and adjustments are covered in Section 4. In Section 5, we present the empirical results and analysis. In the last section, we end with the summary and conclusions.

1- Brief Review of Relevant literature [3]

Machado and Miller in their seminal article posed a challenging question: "Is information able to substitute for energy in the economy?" (Machado and Miller, 1997, p.913). The origin of this question is based on the old challenge of the statistical interpretation of the second law of thermodynamics that had been initiated by Maxwell in 1871. Maxwell's work inspired an enormous amount of research into the relationships between energy and information in Physics. The Maxwell's demon which performs the role of information (or knowledge), was supposed to be able to violate the second law of thermodymics and generate free energy starting from a state of maximum entropy. Therefore, if the ability of information to produce free energy is a challenge to Science, there is a similar and less problematic question from a theoretical point of view, still with strong practical implications to the question posed. In other words, if information is able to substitute for energy, then this may signify that more economic value can be created using less energy. Using less energy may reduce the environmental impact of energy usage. In economic jargon, the substitution of information for energy means putting more information into an economic activity in order to reduce the quantity of energy required.

Considering the above explanations, we observed that few studies examine the relationship between energy and information activities at the economic level (Spreng, 1993, Chen, 1994, Machado & Miller, 1997, Mukopadhyay & Chakraborty, 2003).

Spreng (1993) discusses the possibilities for substitution between energy, time and information in the economy and considers the influence of new information technology (NIT) on energy demand and shows that NIT is used and could be used much more to conserve energy. However, NIT serves more often to speed up processes rather than to make them more energy efficient. Chen(1994) indicates that the substitution of information for energy is a dominant phenomenon in economic activities. But this substitution is very particular compared to the substitution among factors of production, because information does not have the properties of a factor of production [4]. He considers only direct energy expenditures and does not provide empirical evidence on substitution at a global economic level.

The core of analysing an empirical relationship between information in general and information activities or sectors in particular is, first of all ,to present the conceptual definition and measurement of information activities. Fritz Machlup (1962), followed by Porat who was latter joined by Rubins(1977) are considered to be the first classical studies in this area (Apte and Nath, 2004, Machado and Miller, 1977).

The main objective of these studies were not only to conceptualize knowledge and information activities but also to measure the size of these activities for the informatization of US economy over time. As compared to Machlup, Porat's work has since then been widely quoted and cited as the first major use of the term "information economy". For example, the OECD has adopted Porat's definition in its studies on the nature, size, and growth of economies(Ambrosi, and others, 2005). Similar studies have been carried out in India, South Africa, and other countries (Kelkar and other, 1991).

One of the more recent efforts to estimate the size of the US information economy was done by Apte and Nath (2004), who found that the US information sector's share of the total GNP grew from about 46 percent in 1967 to about 56 percent in 1992, and to 63 percent in 1997 which revealed further informatization of US economy. But how does the informatization of the US economy relate to energy use? and how does it contribute to energy saving? Recently Machado and Miller (1977) have tried to answer the above questions and empirically tested the old challenge made by Maxwell's demon. Using input-Output approach for the years 1963-1987, results show an increasing presence of information activities in all segments of the economy and strong evidence for their contribution to energy saving. Similarly, using input-output approach for the years 1973-1974, 1996-1997, for the Indian economy, Mukopadhyay and Chakraborty (2003), observed that the share of information activities is found to have increased gradually, and these activities are less energy-intensive than other economic activities. Thus, the above sequence highlights that the information sectors partially reduce energy consumption or they save energy indirectly.

2- Definition, Classification and Units of Measurement of Three Segments

In this paper, we have aggregated all the economic activities of the two countries in to three segments: information segment, energy segment and non-information segment. The word "segment" is used throughout this paper to mean a set of economic sectors. The selection of information sectors was broadly based on the suggestions made by Porat (1977), but their classification schemes had to be adjusted to the classification schemes already employed in the four Input-output tables of Iran and India. This will be elaborated in the next section. The criterion employed to select a sector as being an information sector was to verify the relative number of information or energy subsectors it contained. When most (nearly all) of its sub sectors were information or energy activities, the entire sector was included in the information or in the energy segment. This criteria cannot reveal and in fact underestimates the concepts and definitions of the second domain of information economy adopted by Porat[5]. The notion of information economy rests on the concepts of "information" and "information activities" Porat defines information as the data that have been organized and communicated, while his operational definition of information activities encompasses all workers, machinery, goods and services that are employed in processing, manipulating and transmitting information. He then divides the information into two broad categories: Primary information sectors and secondary information sectors. Primary information sectors are defined as the outputs of information sectors that are directly delivered to markets as opposed to the secondary information sectors)[6]. Secondary information sectors, according to Porat include all information services produced for internal consumption by government and non-information sectors. They comprise most of the public bureaucracy and all the private bureaucracy which are out of the domain of the market mechanism [7]. On account of the aggregation schemes of Input-output tables of the two countries, primary and secondary information sectors of the Porat's type are not considered here, and therefore a conservative definition of information activities which resemble Machado and Miller's and Mukopadhyay and Chakraborty's schemes is used in this paper. With respect to the units of measurement, two points are needed to be clarified. One is that due to the well known difficulties in the measurement of non-commercial forms of energy and information, we consider only commercial energy and information in our analysis. We thus neglect the share of energy from environment or from humans employed in economic activities, such as the sun's radiation in agriculture or human physical labour in manufacturing. Also many aspects of information in society such as information content of cultural system or cultural traits, level of organization of the economic system or even the information processing activities directly derived from human labour are not considered here[8]. We are aware that the use of such conservative definitions, decreases the explanatory potential of the study but they could be useful for the feasibility and precision of the empirical analyses.

In theory the best way to measure energy, information and non- information would be to respectively use thermodynamic (calories, Joules), information theory (bits) and monetary (Rials or Rupees) units. But in order to compare shares of energy, information, and production outputs in the two economies at the same points in time and to examine the evolution of these shares over time, we opt to use the same monetary units to measure the outputs of all three segments of the two economies.

This also has the possible additional advantage of reflecting more closely the situation faced by decision makers who usually must deal with monetary trade-offs, taking into account price and costs, not amount of energy calories or information bits.

3- Methodology of the Paper

A conventional input-output technique with the following objectives is used to sharpen the structural changes of the two countries based on trends substitution and / or Complementarity between information and energy segments.

3.1- Trends based on data contained in input-output accounts of the two economies

3.2- Trends based on the direct effects as measured in the input-output model technical coefficient matrices.

3.3- Trends based on total effects (direct plus indirect) captured in Leontief inverse matrices from the input-output model.

4- Sources of Data

The basic data are the four input-output tables. The two input-output tables of the Iranian economy for the years 1991 and 2001 prepared by the Statistical Centre of Iran (Statistical Centre of Iran, 1996, 2006). The two other tables of Indian economy are for the fiscal years 1993-1994 and 1993-1998 constructed by the Central Statistical Organization of India (Central statistical organization, 2000 and 2005).

The original 1991 and 2001 IOTS of Iran which contain 78 and 99 sectors respectively, are aggregated to 3×3 tables made up of the information, energy and non-information segments. Based on definition, classification and the units of measurement, the information sectors chosen are as follows: printing and publishing, radio, TV and communication equipment, miscellaneous manufacturing products (including office, computing and accounting machines, electric lighting and wiring equipment, scientific and controlling instruments, optical, ophthalmic and photographic equipments), communication services, financial services, insurance services, business services, amusements, health, educational and social services, coal mining, crude petroleum and natural gas, petroleum refineries and related industries, electricity, gas and water are included in energy segment. The remaining sectors of the economy are included in the non-information segment. The following sectors are considered as information sectors and accommodated in information segment of the Indian economy: Printing and publishing, office-computing machines, electrical wire and cables, communication equipment, electronic equipment including Radio and TV, banking, insurance education and research, communication services, medical and health services. The activities in energy segment are: coal mining, crude petroleum and natural gas, petroleum refineries and related products, water, electricity and gas. The remaining sectors are considered as non-information segments.

5- EMPIRICAL RESULTS AND ANALYSIS

5-1- Trends Based on Input-output Accounts

Tables 1 and 2 show non-information, information and energy shares in intermediate, final demand and total output respectively during 1991-2001 for Iran and 1993-94, 1998-99 for India. Looking across the non-information row in Table 1, we observe that all the three intermediate, final demand and total output shares of the non-information segment of the Iranian economy are increasing during 1991-2001. The percentage increase in intermediate share is highest (24%). Average increase of non-information segment is 15.25%. The information segment in all three intermediate, final demand and total output are decreasing with highest decrease (74.18%) of intermediate share of information segment of the Iranian economy. The average decrease is about 58%. All the three components of the energy segment of the Iranian economy during 1991-2001 show increasing trends where, intermediate share of energy segment records the highest share, i.e. 144%. The average increase of energy segment during the abovementioned period is about 113%. The results do not confirm the informatization process of the Iranian economy, and therefore, do not reflect the structuralchanges of the economy.

Table 1: Non-information(NI), Information (I) and Energy (E) shares in intermediate output(IN), final demand (FD) and total output (TO), respectively in 1991 and 2001 of Iran.

		1991	2001	Percentage change (1991-2001)
NI	**IN**	**0.700**	**0.868**	**24.00**
	FD	**0.627**	**0.715**	**14.03**
	TO	**0.699**	**0.753**	**7.72**
I	**IN**	**0.275**	**0.071**	**-74.18**
	FD	**0.306**	**0.144**	**-52.94**
	TO	**0.236**	**0.124**	**-47.46**
E	**IN**	**0.025**	**0.061**	**144.00**
	FD	**0.068**	**0.141**	**107.35**
	TO	**0.065**	**0.123**	**89.23**

Table 2: Non-information(NI), Information (I) and Energy (E) shares in intermediate output(IN), final demand (FD) and total output (TO), respectively in 1993-94 and 1998-99 of India.

		1993-94	1998-99	Percentage change (1993-94__1998-99)
NI	**IN**	**0.836**	**0.807**	**-3.47**
	FD	**0.894**	**0.854**	**-4.47**
	TO	**0.827**	**0.803**	**-2.90**
I	**IN**	**0.077**	**0.104**	**35.06**
	FD	**0.090**	**0.129**	**43.33**
	TO	**0.099**	**0.123**	**24.24**
E	**IN**	**0.087**	**0.089**	**2.29**
	FD	**0.016**	**0.018**	**12.5**
	TO	**0.074**	**0.075**	**1.35**

Under structural changes, one would expect that the information segment should grow in importance and non- information segment increase in importance. On the contrary, the results reveal the importance of energy and non-information segments of the Iranian economy which means that the non-information segment requires more energy than information. Considering Table 2, we observe that a clear process of informatization of the Indian economy between 1993-94 and 1998-99, reflecting a structural change in the economy. Based on the results of Table 2, we observe that the non-information segment on an average decreased around 4% with the highest decrease in intermediate share of non-information segment (4.47%) whereas information segment on an average reveals an increasing trend of 34.21% with highest final demand share of information segment (43.33%).

Therefore, as compared to the Iranian situation, the information segment of the Indian economy plays an important role in informatization process and hence is responsible for the structural change of economy. Based on the results, we can observe that the process of informatization is especially strong in final demand and intermediate output shares (43.33% and 35.06%) respectively.

5.2- Trends Based on Input-Output Technical Coefficients Matrices: Direct Effects.

So far we have examined simple macroeconomic trends. In order to have a sharper picture of the changes in the two economies under consideration over time, we shall try to show quantitatively, how the output of the three segments of the two economies behave as inputs in the process of the same three segments. How much direct input of non-information, information and energy were needed in 1991 for Iran and 1993-1994 for India to generate one unit of output of non-information, information and energy segments? How much were needed in 2001 and 1998-1999 for Iran and India respectively. How did these amounts (which are expressed in technical coefficients) change over time for the two economies? Do the figures indicate any substitutability or complementarity between energy and information segments as factors of production? (see note 4 regarding the difficulties of economic theory to deal with the information as a factor of production). In order to answer these kinds of questions, which are directly relevant to the overall objective of this paper, we have to compute the technical coefficients or direct requirements matrix (A) for each year for the two economies. The technical coefficients show a picture of the production process in terms of the direct requirements for one unit of output. Traditionally, all inter industry transaction and output are measured in monetary terms. Therefore, for the Iranian and Indian economies an a_{ij} depicts the value of input of i^{th} segment per one billion rials worth of output of j^{th} segment in the case of Iran and one million rupees worth of j^{th} segment in the case of India. Tables 3 and 4 show the technical coefficients matrices of Iran for the years 1991 and 2001, and India for the years 1993-1994 and 1998-1999 respectively.

Table 3. Technical coefficient Matrices of Iran: 1991 and 2001

Technical coefficient: 1991			
Segments	**NI**	**I**	**E**
NI	**0.273**	**0.317**	**0.053**
I	**0.029**	**0.041**	**0.010**
E	**0.019**	**0.008**	**0.057**

Technical coefficients: 2001			
Segments	**NI**	**I**	**E**
NI	**0.3416**	**0.0878**	**0.0531**
I	**0.0200**	**0.0883**	**0.0143**
E	**0.0198**	**0.0132**	**0.0967**

Table 4. Technical coefficient Matrices of India: 1993-1994 and 1998-1999

Technical coefficient: 1993-94			
Segments	**NI**	**I**	**E**
NI	**0.339**	**0.163**	**0.155**
I	**0.038**	**0.139**	**0.020**
E	**0.047**	**0.024**	**0.319**

Technical coefficients: 1998-1999			
Segments	**NI**	**I**	**E**
NI	**0.3286**	**0.2079**	**0.1396**
I	**0.0362**	**0.1209**	**0.0380**
E	**0.0479**	**0.0193**	**0.3132**

Each column in an A matrix for a given year of the Tables 3 and 4 for the two economies under consideration, represents the direct intermediate requirements of the corresponding segment in that year. Based on the figures of Tables 3 and 4, we derived the percentage change in the technical coefficients from 1991 to 2001 for Iran and from 1993-94 to 1993-99 for India as shown in Tables 5 and 6.

Table 5. Percentage changes in A coefficients from 1991 to 2001 of the Iranian Economy*

Segments	NI	I	E
NI	25.29	-72.31	0.39
I	-11.16	115.32	45.30
E	3.22	72.82	68.30

* **This table was obtained as** $[(A^{2001} - A^{1991} / A^{1991}] \times 100$. A^{2001} **and** A^{1991} **represent 3×3 technical coefficients matrices of table 3.**

Table 6. Percentage changes in A coefficients from 1993-94 to 1998-99 of the Indian Economy*

Segments	NI	I	E
NI	-3.12	27.62	-9.71
I	-4.23	-13.29	94.88
E	2.58	-20.33	-1.77

* **This table was obtained as** $[(A^{1998-99} - A^{1993-94} / A^{1993-94}] \times 100$. $A^{1998-99}$ **and** $A^{1993-94}$ **represent technical coefficients matrices of table 4.**

From Table 5, we observe that, there exists a complementary relationship between information and energy segments of the Iranian economy. This observation does not confirm the informatization process and thus does not reflect structural change of the economy. Because the direct input requirement of energy to produce one unit of information output in 2001, has increased to about 73% from 1991 to 2001, and the direct requirement of information to produce one unit of energy output in 2001 has also gone up to 45.30%. This means that direct inputs of energy and of information do have the same directions which reveal a "complementarily" and not "substitutability" between energy and information segments of Iranian economy. With regard to the Indian situation (Table 6), the results show a substitutability between information and energy segments. This confirms the informatization process and hence reflects the structural change of the economy. On the basis of Table 6, we observe that the change in the direct energy input required per unit of information output is approximately 20% less in 1998-99 than 1993-94. On the other hand, the direct information input required to deliver one unit of energy output increased by more than 95% from 1993-94 to 1998-99. That is, direct inputs of energy and of information evolved in opposite directions which is contrary to what had been observed in the Iranian experience. Therefore, if less energy per unit of information was needed in 1998-99 than in 1993-94, and if information was increasing required (not for all three segments, but for energy segment), would at least indicate that information was substituting for energy in the Indian economy and reflecting structural change.

5.3- Trends Based on the Input-Output Model: Leontief Inverse Matrices

When a technical coefficients matrix is used in an I-O model, one of the most useful results is a total requirements (Leontief inverse) matrix $L=(I-A)^{-1}$.

A typical elements, α_{ij} shows the total (direct plus indirect) requirements from i^{th} segment per unit (billion rials and or million rupees worth) of final demand for j^{th} segment. Based on the Tables 3 and 4, we have estimated the Leontief inverse matrices for each year of the two economies. The results are given in Tables 7 and 8. The figures in Tables 7 and 8 represent the total requirements from non-information, information and energy segments needed to satisfy one unit of final demand for non-information, information and energy respectively. From these tables, we could derive the percentage changes in the Leontief inverse elements between 1991 and 2001 for Iran and 1993-94 and 1998-99 for India as shown in Tables 9 and 10 respectively.

Table 7: Leontief Inverse Matrices of Iran: 1991 and 2001

Leontief Inverse Matrix: 1991			
Segments	**NI**	**I**	**E**
NI	**1.391**	**0.461**	**0.083**
I	**0.033**	**1.054**	**0.013**
E	**0.029**	**0.018**	**1.063**

Leontief Inverse Matrix: 2001			
Segments	**NI**	**I**	**E**
NI	**1.526**	**0.148**	**0.092**
I	**0.034**	**1.100**	**0.019**
E	**0.034**	**0.019**	**1.109**

Table 8: Leontief Inverse Matrices of India: 1993-94 and 1998-99

Leontief Inverse Matrix: 1993-94			
Segments	**NI**	**I**	**E**
NI	**1.556**	**0.305**	**0.362**
I	**0.071**	**1.177**	**0.050**
E	**0.109**	**0.063**	**1.495**

Leontief Inverse Matrix: 2001			
Segments	**NI**	**I**	**E**
NI	**1.533**	**0.370**	**0.332**
I	**0.068**	**1.155**	**0.078**
E	**0.109**	**0.058**	**1.481**

*Table 9- Percentage changes in Leontief Inverse Elements from 1991 to 2001 of the Iranian Economy**

Segments	NI	I	E
NI	**9.7**	**-67.89**	**10.84**
I	**3.03**	**4.36**	**46.15**
E	**17.24**	**5.55**	**4.33**

* **This table was obtained as** $[(L^{2001} - L^{1991} / L^{1991}] \times 100$. L^{2001} **and** L^{1991} **represent 3×3 Leontief Inverse matrices for the respective years.**

*Table 10- Percentage changes in Leontief Inverse Elements from 1993-94 to 1998-99 of the Indian Economy**

Segments	NI	I	E
NI	**-1.48**	**21.31**	**-8.28**
I	**-4.22**	**-1.83**	**56.17**
E	**-0.35**	**-7.14**	**-0.88**

* **This table was obtained as** $[(L^{1998-99} - L^{1993-94} / L^{1993-94}] \times 100$. $L^{1998-99}$ **and** $L^{1993-94}$ **represent 3×3 Leontief inverse matrices for the respective years.**

From Table 9, we can see that changes in the total requirements from information segment to satisfy one unit of final demand for non-information, energy and information are all positive. Similar to the previous observation, the same is true for energy. We note that there is a complementary relationship between the information and energy segments of the Iranian economy which does not confirm the structural change of the economy. Because from Table 9 we observe that the total requirement from energy segment for a unit of final demand of information segment, increased nearly 6% and total requirement from information segment to satisfy a unit of final demand of energy segment increased by more than 46%. Therefore, direct plus indirect effects of information segment on energy segment and direct and indirect effects of energy segment on information segment do have the same direction which confirms the observation made in the previous section, and hence reflecting a complementarity and not substitutability between energy and information segments.

Table 10 which portrays the Indian scene, gives a different picture. On the one hand we observe that the direct and indirect energy requirements for one unit of final demand of information was 7.14 less whereas direct and indirect requirements of information to satisfy one unit of final demand of energy increased by more than 56%. These figures confirm the observation made in the previous section and in fact suggest that information was substituting for energy in the Indian economy which is an indication of structural change of Indian economy.

The above empirical results and analysis clearly clarify the two main questions posed in the introductory section of this paper. With respect to the first question, we observed that an energy importing economy like India was experiencing structural changes whereas results for energy exporting economy like Iran did not reveal similar changes. With respect to the second question, we noted that the relationships between information and energy segments of Iran did contribute negatively in the complementary sense, which means absence of energy saving. Such relationships in India appeared to be positive in the substitutability sense which means the existence of energy saving.

6- Summary and Conclusions

In this paper, we have tried to empirically explore the relationship between information and energy segments of the two diversified economies with respect to the following two questions. One: being developing countries which one of them has successfully experienced structural changes with respect to trend substitution between information and energy segments? And two, how far has such relationships between two segments contributed negatively (in the case of complementarity), and positively (in the case of substitution) for the two economies? In order to answer these questions, we have used a conventional input-output technique with the following three main objectives: trends based on the macro-input-output accounts, trends based on the technical coefficients matrices and trends based on Leontief inverse matrices. For quantification purposes, we have used four IOTs of the countries under considerations: 1991 and 2001 IOTs of Iran and 1993-94 and 1998-99 IOTs of Indian. All the economic activities (in four original tables) of the two countries are aggregated in three segments: non-information, information and energy segments. The results with respect to the first question show that an energy importing economy like India was experiencing structural changes whereas results for energy exporting economy like Iran did not show similar changes. With respect to the second question, the results for India showed that the relationship between information and energy segments did contribute positively (in the substitutability sense) which means the existence of energy saving in India. In this case Mukopadhyay and Chakrobarty (2003) applying same approach with IOTs of 1973-74 to 1996-97 reached the following conclusions "on the basis of the above facts, we can predict that if the trend of informatization process continues, then the India economy would be partially free from the energy crisis. These findings have also an implication for CO_2 emissions". In the case of Iran, the results indicated that the relationships between information and energy segments did contribute negatively (in the case of complementarity) which means the absence of energy saving. Such results for Iran supports findings in our previous attempts in which four Iranian Input-Output tables from two different statistical organizations (i.e. 1988-1999 IOTs of Bank Markazi of Iran, and 1986-1991 IOTs of Statistical Centre of Iran) had been used (Banouei and Mohaghaghi, 2007).

Notes

[1] By the word "Informatization" in this paper, we mean the process of development of information activities over time and the increasing share occupied by them in the economy system.

[2] For more information, see four workshops on Iranian economy and Management organized by Institute for Management and planning Studies in 2005 and 2006.

[3] This literature review is based on the following three articles: Mukopadhyoy and Chakroborty, 2003, Machado and Miller, 1997, and Banouei and Mohaghaghi, 2007.

[4] In this case, Chen shows the difficulties of economic theory in dealing with information as a factor of production, suggesting that information does not satisfy the requirements of a production factor: One of the reasons for this is the pervasiveness of information, which "flows" in a multitude of forms within and outside the production context, making it impossible for one to measure the amount of information that goes into a particular production process. Taken rigidly this point would imply that energy also cannot be considered as a factor of production, because forms of energy in the biosphere, other than commercial energy, also participate in the economic processes. These restrictions to energy and information as factors of production , however are not relevant here. Later on, we shall point out that we are considering only commercial energy and information.

[5] Porat divides the economy into two distinct but inseparable domains: one involved in the transformation of matter and energy from one form to another form and the other is transforming information from one pattern into another (Apte and Nath,2004).

[6] The sub-categories of primary information sectors are: (1) knowledge

production and invention: private R & D and private information services; (2) information distribution and communication: education, public information services, telecommunication etc.;(3) risk management: insurance, finance industries and others; (4) search and coordination: brokerage industries, advertising etc.; (5) information processing and transmission services: computer based information processing telecommunication infrastructure etc.; (6) information goods: calculators, semiconductors, computers; (7) selected government activities: education and postal service; (8) support facilities; buildings, office furniture etc.; (9) wholesale and retail trade in information goods and services (Apte & Nath, 2004).

[7] The sub-categories of secondary information sectors are: The costs of organizing firms, maintaining and regulating markets, developing and transmitting prices, monitoring the firm's behavior and making and enforcing rules, the public bureaucracy comprises all the information functions of the federal, state and local governments such as: governments performance planning, coordinating, decision making, monitoring, regulating and evaluating activities (Apte & Nath, 2004).

[8] It would be difficult to include the information associated with human labour unless we use the monetary values of salaries and wages, for example if the energy from human labour (also measured in terms of wages and salaries) are also included to preserve the symmetry of the study, the energy and the information contributions of higher paid intellectual labour would be weighted much more heavily than the energy and information associated with physical labour. It is not clear if this higher contribution would derive from human labour per se, or from the instruments and system of action controlled by human labour, which might be accounted for outside the measurement of human labour. Because of these and other conceptual and measurement difficulties, we opted for a simpler approach in

which both energy and information are measured in monetary units and in terms of economic contribution of the energy and information sectors.

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