

Swedish Information Economy

A preliminary account

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Abstract

The recent developments and adoptions of digital technologies give rise to the growth of information economies, understood as an aggregate of economic activities that produce informational outputs. Several key characteristics of an information economy differ to the conventional economic wisdom derived from the industrial age, which may impose governmental policy implications and therefore constitutes a key question: how to govern the newly emerged information economy with the thinking of the industrial age economy. Resolving this problem requires, among others, comprehensive understanding of information economies. To that end, Sweden is among the most advanced adopters of digital technologies and represents therefore a suitable empirical base for the investigation of an information economy. This paper offers preliminary results from a first ever account of the Swedish information economy in terms of its value created, jobs and wages; this account shows that the Swedish economy is dominated by its information economy, which requires a careful attention of policy makers.

Keywords: information, digitalization, information products, information services, work substitution effects, information-material decomposition

Introduction

An *information economy* is constituted by workers, in public and private organizations, who produce informational outputs (goods and/or services), for internal and external consumption (Porat, 1977). Examples of information workers are teachers, film and music producers, accountants, lawyers, physicians, engineers, architects, scientists, marketers, managers, and financial analysts. When the execution of information producing work includes digital technologies, an information economy tends to manifest somewhat different characteristics compared to the conventional economic wisdom as derived from the industrial age where material products are manufactured (Varian et al., 2004; Wolff, 2005; 2006; Apte et al., 2012). Examples of these peculiarities of information economy include the elimination of marginal costs (Varial et al., 2004), the realization of strong network effects (ibid.), radical reduction of transaction costs (ibid.), alternative revenue sources (Benkler, 2006) and the emergence of informal markets (ibid.).

By derivation, this suggests that the economic principles and theoretical bodies developed for industrial economy, as induced from empirical studies in the post WWII period, do not fully account for an information economy, as industrial age economy did not use advanced digital technologies and could not manifest the listed peculiarities of an information economy. This constitutes a problem for policymakers in developed countries, when faced with economic and societal challenges, as founding policy decisions in industrial age thinking may produce more harm than benefits. The problem has two parts; one is that the mentioned principles of economic conduct differ radically in some respects; the second is that the very conception, understanding and measurement of an economy differ between information age and industrial age – the secondly mentioned is the subject matter of the present paper.

In light of these peculiarities and the consequent problem, the analysis of a nation's information economy becomes crucial as its results may offer an understanding of economic structures and dynamics that may require careful attention from various kinds of policy makers, both in public and private sectors; this may include employment and education policies formulated by governments and corporate strategies pursued by firms.

Somewhat surprisingly few accounts of an information economy have been advanced to this date, with an exception of the US economy (e.g. Machlup, 1962, 1980; Porat, 1977; Karunaratne, 1986; Apte & Nath, 2004; Apte et al., 2008; 2012; Wolff, 2005; 2006; Nath, 2009; 2011). To remedy that gap, the present paper offers preliminary results from the first ever identification of the Swedish information economy, which shows that Sweden is presently indeed dominated by its information economy. This is highly interesting as Sweden is regarded as a leading nation in terms of the adoption of digital technologies (ITU, 2014) and simultaneously regarded as a leading innovation economy (EU, 2016). The here uncovered characteristics of the Swedish information economy may inform vari-



ous policy makers, both corporate and governmental – such as education, taxation, or copy rights.

The next section offers an analytical framework for the conception of an information economy. Preliminary results of the first ever account of the Swedish information economy are given thereafter. The paper ends with some key conclusions.

Conceptual Research Framework

The development, introduction and use of various kinds of information and communication technologies, also labelled as digital technologies, have attracted a significant amount of research aimed at an examination of the economic and social consequences that its use gives rise to (e.g. Kraemer & Danziger, 1990; Brynjolfsson & Hitt, 1996; 2003; Autor et al., 2003; Fisher, 2006; Kowalkowski, 2008; OECD, 2011; Gershuny & Fisher, 2014; Haftor & Mirijamdotter, 2010; Bradley, 2011). Yet, for the numerous studies, very little attention has been put into the understanding of an information economy. A chief reason to that limitation is the difficulty to measure and quantify national economies at the macro level with regard to information activities and their economic value creation. The number of recent studies that attempt to quantify the size, structure and dynamics of an information economy at macro level has therefore been relatively limited (Karunaratne, 1986; Apte & Nath, 2004; Apte et al., 2008; 2012; Wolff, 2005; 2006; Nath, 2009; 2011). The key message delivered by these studies is that the US information economy accounts now for more than half of the total US economy, measured in terms of GNP and the share of workers; and that the information economy is continuing to grow. However, very little is known about other nations' information economies.

Porat's study (1977) provides a major and comprehensive attempt to define and measure the place of information activity (or information sector) within a national economy. In addition, it operationalised the structure and quantity of information-related work places. Porat divided information activities into primary information sector (PRIS) and secondary information sector (SIS), where the firstly mentioned include all industries that produce information goods and services while SIS accounts for all information services produced by public organisations and information products consumed internally by those firms whose main output is not information.

Porat (1977) studied the U.S. labour force for the period 1860-1980, dividing it into two-sectors: information products vs. material, or non-information, products. His analysis showed a rapid emergence of information workforce and the relative decline of the traditional occupations (e.g. agriculture, manufacturing). Apte and Nath (2004) provided a critical assessment of Porat's methodology and suggested specific improvements that may be made to obtain a more plausible measure of the size and structure of an information economy. Menou and Taylor



(2006) pointed that analysis of the metrics of the ‘information society’ are still far from optimal and continue to suffer from measurement challenges; the present investigation attempts to incorporate these remarks in its conceptual approach.

Following Porat (1977), a fundamental distinction within an economy may be made in terms of the content of a product. The binary distinction between material products vs. information products constitutes one conceptualization assumed here which is combined with the binary distinction of a product’s form: good vs. service. Combining the two binary dimensions of a product – content and form – offers four categories of products: information services, information goods, material services, and material goods; see Figure 1 for examples of their instances. This two-by-two conception of products constitutes a starting point for the present investigation, where each type of product can be provided to both an external market and an internal market. Each product can be produced by human or machine agents or a combination thereof. This in turn offers a reference point for conception of information workers vs. material workers, the firstly mentioned are those workers that process mainly information (e.g. architect and engineer, secretary and manager, teacher and physician) while the secondly mentioned are those that process mainly materials (e.g. painter, carpenter, mechanic, peasant).

Content \ Product	Goods	Services
Material	<i>Car</i>	<i>Repair of a car</i>
Information	<i>Film</i>	<i>Visit to a movie theatre</i>

FIG 1. Information-material conception of products

Economic value analysis of an information economy

Identification of the size of PRIS in an economy is made here through a calculation of the value added, which measures the contribution of each private industry and of public organizations to the nation’s Gross Domestic Product (GDP).

Identification of the size of SIS in an economy, on the other hand, is made through a calculation of three components of the value added: wages of information workers employed in a sector, net operating surplus due to information activities, and depreciation of information capital (mainly ICT hardware and software).

A challenge to this approach of information economy identification is that most of macro data is typically collected and published at aggregate levels of industrial and occupational classifications; this in turn makes it difficult to identify each separate information activity. Therefore, a conventional macroeconomic measurement approach is utilized here with aggregated classifications (e.g. publishing, consultancy activities, teachers, physicians).



Employment and wage patterns in the information economy

A number of scholars emphasize the fact that technological change in the modern workplace is broadly skill biased (Freeman, 2002; Mithas and Whitaker, 2007). The main idea is to determine the extent to which employee involvement in the workplace and ICT promote the use of higher order cognitive and interactive skills (self-planning, problem-solving, communicative skills etc.). In this regard, classification of information activities and information processing jobs is central.

Porat (1977) developed a conceptual scheme for information workers classification. This scheme divides occupations into three major classes, which are further divided into several subcategories. We have adapted Porat's somewhat outdated classification of information jobs so as to match contemporary job markets.

Next, and following Apte et al. (2012), we apply indicator of information intensity, defined as a job's fraction of time spent in dealing with information-intensive tasks. An occupation is classified according to five levels of information intensity (100%; 75%; 50%; 25%; 0%). We use the following equations for estimation of information and material employment in industry i :

$$IE_i = \sum_{j=1}^n v_j E_{ji} \quad \text{and} \quad NE_i = \sum_{j=1}^n (1 - v_j) E_{ji} \quad (1)$$

where:

- IE_i and NE_i are the information and non-information employment, respectively, in industry i ;
- v_j is the weight that represents information-intensity applied to the j^{th} occupation and $v_j \in [0; 0.25; 0.50; 0.75; 1]$
- and E_{ji} is the number of workers employed in occupation j in industry i .

To measure the total wage bill, we use the employment statistics data and corresponding data of wages (average or median salaries and wages).

Firstly, we classify the occupations into several categories according to level of information intensity described above. Further we apply the corresponding weights to total employment and total annual wage bills in each industry. We can calculate information and non-information wage bills for all occupational categories within industries and sum them up for each industry applying equation (1).

Findings: Sweden's Information Economy

We obtained macro data from the Swedish Statistical Office (www.scb.se); that data was analysed as specified above. The results of the analysis are presented in Tables 1 – 6, as follows: the distribution of GNP in terms of value added in the Swedish economy (Tables 1, 2 and 3); the distribution of employment in the here



conceived sectors in the Swedish economy (Table 4); the distribution of Swedish wage bill in those sectors (Tables 5 and 6).

Tables 1 and 2 show that 60 percent of the Swedish economy is generated by information production, and that there is a trend of slow growth of the information economy as a share of the total Swedish economy. In this, the overwhelming largest sector is the information services production, which accounts for just more than half of the total Swedish economy; that sector also shows the fastest growth. The current growth trends suggest the Swedish information economy will generate some 65 percent of the total economy by 2030, where information services production will continue to increase as a share of the total economy while goods production will decrease.

Table 3 shows that the primary information sector (PRIS) is circa three times the size of the secondary information sector (SIS), with the trends of an increasing PRIS and decreasing SIS.

Table 4 shows that the Swedish economy had nearly 51 percent of workforce occupied with information production in 2012, where the largest employment sector is the information services with app. 42 percentages and it shows a clear growth trend.

Tables 5 and 6 manifest wage polarization within four sectors. The earnings of skilled information services workers are higher relatively to material workers, with a trend where both information and material services wages increase while material goods and services production wages decrease.

Conclusions

This paper reports preliminary findings from the first ever attempt to identify the Swedish information economy. The findings show that Swedish economy as a whole is dominated by its information economy, the latter representing well above half of the GNP, with a slow growth mainly from information services. More than half of the Swedish workforce is employed in information products provision, again information services being the dominant sector with a clear growth. This domination of information services has given rise to sharp polarization of wages, where professionals within information services have gained major wage increases while producers of good have lost relatively to the overall growth. An overall conclusion is that the Swedish economy is rapidly transforming into a full-blown information economy.

Elaboration of potential consequences of the here identified Swedish information economy require dedicated efforts, hence is outside the scope of the present paper. We point only shortly to some key areas of governmental policy formulation.

To start with, the numbers presented here show that the single largest and fastest growing sector of the Swedish information economy is the information services provision, which requires highly professional workers, such as engineers,



managers, physicians, and teachers. This indicates the particular importance of various educational and training policies that need to be adopted to support and facilitate the ongoing transformation of the Swedish economy into a full-blown information economy.

Secondly, the identified structure of the Swedish economy offers major opportunities for the introduction of new digital technologies aimed at automation of tasks and also whole jobs (Wolff, 2005, 2006) – this is particularly relevant for well-structured jobs, e.g. call-center agents. Such ongoing substitutions need to be met with governmental policies that facilitate the flow of workforce into new jobs, typically through various educational and training efforts but also motivated by various incentives.

Thirdly, a sensitive domain for public policy intervention is the ongoing wages polarization, as driven by the growth of information services production. The sensitiveness is peculiar as Sweden has a long standing tradition of equality, including wages, on the one hand, yet it is important not to de-incentivize the various self-employed entrepreneurs who initiate new information services firms, by increasing taxation.

Fourthly, as the use of digital technologies enables significant reduction of firm's transaction costs (i.e. to scan for external partners, establish contracts and control mechanism etc.; Varian et al., (2004)), it in turn incentivizes the firm to reduce its staffing and instead hire the needed competencies on a project bases; this in turn provides with more flexibility to the firm's attempts to adapt to the changing business environment.

Fifthly, to facilitate a further growth of the Swedish information economy, governmental bodies need to secure that the nation has the needed digital infrastructure, such as wireless broadband with the required capacities, and more challenging and important that the many governmental organizations in the country, such as municipalities, schools, healthcare centers, and various authorities, do digitalize their operations so as to enable a smooth interaction with each other and current and new firms.

Sixthly, the fact that the primary information sector is circa three times the size of the secondary information sector, shows that most of information products are produced for the free market rather than for internal needs in organizations. This is supported by the radical decrease of transaction costs due to the use of digital technologies (Varian et al., 2004), and the massive outsourcing trends of many traditionally internal functions, such as finance, human resource, and IT-services. This trend has produced a general decrease of the size of firms (Brynjolfsson et al., 1994) which is likely to continue and thus to the increase of the number of firms. The above suggested policy measures need to facilitate this transformation.



Also other nation's policy-makers may learn from Sweden, which is often considered among the leading nations with regard to such indicators as industrial innovation, digitalization, economic growth and equality.

Finally, there are a number of domains that deserve additional investigations, including further analysis of the Swedish information economy using additional time series data, correlation tests with other factors such as investments in education, innovation practices, and new firm establishments, and then comparisons between the Swedish and other information economies, such as the US and the Nordic countries – such compression may unearth some cause and effect relationships which in turn may offer more precise instruments for policy makers to govern information economies.

TABLE 1. 2 x 2 Decomposition of the Swedish GNP, 2001, percentage shares

Content Product	Goods	Services	Total
Material	19.9	20.3	40.2
Information	11.4	48.4	59.8
Total	31.3	68.7	100.0

TABLE 2. 2 x 2 Decomposition of the Swedish GNP, 2012, percentage shares

Content Product	Goods	Services	Total
Material	19.0	20.6	39.6
Information	9.0	51.4	60.4
Total	28.0	72.0	100.0

TABLE 3. Structure of the Swedish information economy in terms of value added, 2001-2012

Sector	2001	2012
Primary information sector (PRIS)	42.0	44.6
Secondary information sector (SIS)	17.8	15.8
Total information	59.8	60.4
Total material	40.2	39.6
Gross national product (GNP)	100.0	100.0

TABLE 4. Distribution of employment in the Swedish economy, percentage shares

Worker type Year	1960	1970	1980	1990	2001	2005	2008	2012
Material workers in goods	45.3	37.4	29.5	25.2	19.5	17.7	15.4	14.3
Material workers in services	17.7	22.5	27.1	30.1	34.0	34.5	34.1	34.8
Information workers in goods	14.2	11.1	9.7	8.2	8.6	8.6	9.0	8.5



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Information workers in services	22.8	29.0	33.6	36.3	37.9	39.2	41.5	42.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 5. 2 x 2 Decomposition of the Swedish wage bill, 2001, percentage shares

Content / Product	Goods	Services	Total
Material	19.2	29.9	49.1
Information	8.8	42.1	50.9
Total	28.0	72.0	100.0

TABLE 6. 2 x 2 Decomposition of the Swedish wage bill, 2012, percentage shares

Content / Product	Goods	Services	Total
Material	15.4	33.8	49.2
Information	7.9	42.9	50.8
Total	23.3	76.7	100.0

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