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The Evolution of a "Digital Economy": Research Issues and Policy Challenges

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Introduction

Proponents of the "New Economy" claim that the rapid spread of digital information and communication systems (DIS) has provoked a fundamental change toward "…higher sustainable growth due to faster improvement in labor productivity" (Department of Commerce, 2000, chapter VII, p.60). This contrasts with earlier concerns about a "productivity paradox"[1]. There is more than a kernel of truth to this claim. For instance, Brynjolfson & Hitt (2000: 36) demonstrate that, during the second half of the 1990s, DIS in the U.S. have had an impact on productivity and growth that is disproportionately large compared to its share of capital stock or investment. But is there a "new economy" that follows different rules from the "old economy" based on industrial manufacturing? Which transformations are critical? What are the drivers? And what are the consequences?

The claim that a "New Economy" has emerged is correct insofar as we are witnessing fundamental transformations in economic structures and institutions. But this is only new to neo-classical economists. From an evolutionary perspective, "punctuated equilibria" (Mokyr, 1990) are the essence of economic growth. Rather than talking about a "New Economy", research should focus on the evolution of a "Digital Economy". Following Lazonick (2000), we first argue that history needs to be brought back into the economic analysis. We then discuss challenges for economic research in three areas that can be identified as: co-evolution of DIS and organization, measurement, and an agenda for economic research. We conclude by highlighting two challenges for policy-making, neglected by the proponents of the "New Economy": the "global digital divide", and international aspects of innovation systems. Like any selection of priority issues, this list is of course subjective and tentative. It draws on what I have learned over 3o years through research, teaching, policy advice and consultant work in information industries.

1. Historical Perspective

A historical perspective is necessary to assess current debates. After all, transformations imposed by information and communication technologies on economic structures, social relationships and political boundaries have a long history. For instance, nation states became the most efficient geographic units for organizing markets only once transportation and communication links were sufficiently interconnected to exchange market information (Braudel, 1992). But while new technologies created opportunities to transcend the barriers of time and space, national markets did not emerge automatically. Social and political structures that remained from the feudal era had to be eliminated, which "required the intervention of the state, and the imposition of new rules governing economic activities - such as the laws of enclosure and the poor laws - as well as the establishment of a stable currency as a means of exchange." (Garcia, 2000, p.10)[2].

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[1] See Robert Solow`s widely quoted observation, in a review article in the New York Times Book Review (July 12, 1987:36): "(Y)ou can see the computer age everywhere except in the productivity statistics."

[2] Polanyi (1957) provides the classical account of the state´s role in establishing the English market.

Similar examples that show that not much is new about the "New Economy" abound in the great works of economic historians like Landes, Chandler, North and Lazonick. As for digital information and communication systems (DIS), the study of their economic impact has gone through various phases since the 1950s. While originally the focus has been on "automation", and its impact on employment in the factory and the office, we now need to deal with a much broader and more complex set of issues.

Following Brynjolfsson and Hitt (2000), we know that the impact of DIS on economic performance is mediated by a combination of intangible inputs as well as intangible outputs that act as powerful catalysts for organizational innovations. Intangible inputs include, for instance, the development of new software and databases; the adjustment of existing business processes; the recruitment of specialized human resources and their continuous upgrading; and, induced by all of this, the transformation of existing organizational structures and business strategies. After a while, these induced organizational changes may lead to productivity growth, by reducing the cost of coordination, communications and information processing. Of equal importance are intangible outputs that would not exist without DIS, like speed of delivery, flexible customization, the transition to a built-to-order (BTO) production model, and improved customer-relations management (CRM).

In short, we are talking about a complex process that involves a set of inter-related ("systemic") changes (Milgrom and Roberts, 1990): by combining DIS with changes in work practices, strategies, and products and services, a firm transforms its organization as well as its relations with suppliers, partners and customers.

2. Coevolution of DIS and Organization

The challenge is to match and fit organizational structure to the performance features of DIS, making the transition to an IT-intensive production system. By definition, this transition requires time. Note however that the IT management literature rejects the old idea of a "fit" between organization and IT management as naïve. Empirical research has shown that the fit, which is an intuitively appealing concept, is expensive to implement and hardly ever works (e.g., Ciborra et al, 2000; Hagstrøm, 2000: 204). Technology, competition and strategy change, so "fit" becomes a moving target. Striving to achieve a fit can easily be a recipe for introducing tomorrow`s legacy systems. In many cases it can become a straitjacket. According to a manager of Ericsson, "… it is easier to organise the company around the system (he is refering to the implementation of an "enterprise resource planning" (ERP) system) rather than to adapt the system to the organization" (Hagstrøm, 2000: 204).

The key to success are creative combinations that build on complementary information and communications technologies ("digital convergence", e.g. Chandler and Cortada, 2000), enabling the same infrastructure to accommodate manipulation and transmission of voice, video, and data. Combined with the availability of cheaper and more powerful technologies (e.g., Sichel, 1997 and Flamm, 1999), this has fundamentally changed the way firms use DIS as a management tool (Nolan, 2000**)**. From a machine to

automate transaction processing, the focus has shifted to the extraction of value from information resources, and then further to the establishment of Internet-enabled flexible information infrastructures that can support the extraction and exchange of knowledge across firm boundaries and national borders. Compared to earlier generations of DIS, the Internet appears to provide much greater opportunities to share knowledge with a much greater number of people faster, more accurately, and in greater detail, even if they are not permanently co-located (Ernst, 2000, 2001a, and 2001b)[3].

In short, the use of DIS as a management tool has experienced two important transformations: from automation to information resource management, and then on to knowledge management. In turn, these transformations keep redefining the requirements for transforming business organization, and for the development of DIS . The transition to computer networking has been driven by a combination of technological and economic developments. On the technology side, the move towards "open standards" in DIS architecture (UNIX, Linux, and HTML) and protocols (TCP/IP) enabled firms to integrate their existing intranets and extranets[4] on the Internet, which, by reducing cost and by multiplying connectivity, dramatically extended their reach across firm boundaries and national borders.

On the economic side, increasingly complex information requirements resulted from the long-standing trend toward vertical specialization (Mowery and Macher, 2001). As firms now have to deal with constantly changing, large numbers of specialized suppliers, they need flexible and adaptive information systems to support these diverse linkages. These requirements became ever more demanding, as global corporations (or what I call the "network flagships") attempt to integrate their dispersed production, knowledge and customer bases into global and regional flagship networks (GFN) (Ernst, 2001c, 2001d; Ernst, Guerrieri, et al, 2001).

Second, far-reaching changes in work organization have fundamentally increased the requirements for information management and for the exchange of knowledge. The transition from Fordist "mass production" to "mass customization" requires a capacity to constantly adapt products or services to changing customer requirements, "sensing and responding" to individual customer needs in real time (Bradley and Nolan, 1998)[5]. This necessitates dynamic, interactive information systems, and a capacity to rapidly adjust GFN to disruptive changes in markets and technology.

Third, real-time resource allocation, performance monitoring and accounting became necessary, due to the short-term pressures of the financial system (quarterly

[3] While such forms of interactive learning across borders are still exceptional, they illustrate nevertheless a huge potential for reorganizing the global chain of knowledge creation. Once these developments gather momentum, they will have dramatic implications for established localized clusters. But when this happens, it may be too late to start research on this topic.

[4] An "intranet" is defined as a private network contained within an organization (a firm) that consists of many inter-linked LANs (= local-area networks). Its main purpose is to share company information and computer resources among employees. An "extranet" in turn is a private network that links the flagship via conventional telecommunications networks with preferred suppliers, customers and strategic partners.

[5] For good reason, this has given rise to concern about invasion of data privacy.

reports) and due to the shortening life cycles of products and technologies. Fourth, to cope with ever more demanding competitive requirements, firms have to continuously adapt their organization and strategy. Internet-enabled computer networking thus can act as a powerful catalyst for organizational change.

3. Measurement

We still need to integrate this complex story of an evolving digital economy into a consistent conceptual framework that can guide policy-oriented empirical research. Economic theory can help, but may not be sufficient. Most economic research on the impact of DIS and the Internet has focused on cost reduction and productivity improvements (as measured by such indicators as TFP or Y/L). That research has produced mixed results (see overview in Department of Commerce, 2000: chapter 4). Studies that are based on macro-economic and firm-level data conclude that DIS contribute significantly to productivity growth (e.g., Jorgenson and Stiroh, 2000; and Brynjolfsson and Hitt, 2000). Yet, studies at the industry level, continue to raise doubt. A typical example of the latter type of study is Robert Gordon´s widely quoted study for the NBER (2000), entitled "Does the `New Economy´ Measure Up to the Great Inventions of the Past?". The term ´New Economy´ is used as a shorthand for "the Internet and the accompanying acceleration of technical change in computers and telecommunications". Gordon argues that "…outside of durable manufacturing, the New Economy has been remarkably unfruitful as a creator of productivity growth." (p.46)

An exclusive focus on productivity improvements is not very helpful. Findings like the one proposed by Robert Gordon are in fact almost tautological. This reflects a fundamental logic flaw of the underlying theory that Dick Lipsey has eloquently exposed in the following sentence: "To study the circumstances under which rapid technological … change will and will not be accompanied by rapid productivity growth, we cannot employ a model that equates technological change with productivity growth." (Lipsey, 2001 :page 28). This insight provides a powerful wake-up call: it is time to cast the net wider to capture a broader range of possible impacts that extend beyond measurable productivity gains[6]. We need to develop a conceptual framework that allows us to explore the co-evolution of DIS, industry structure and firm organization. This requires an interdisciplinary research agenda that combines, among others, insights from economic theories of the firm and industrial organization, innovation theory, industrial sociology, strategic management, economic geography, with research on the international dimension of business networks.

4. Agenda for Economic Research

While much research exists on the impact of DIS on economic performance, this is paradoxically still an area where we know very little. Research is required on three inter-related levels: appreciative theories, case studies, and large-sample econometric

[6] This is in line with Brynjolfsson and Hitt (2000) who argue that "the greatest benefit of computers appears to be realized when computer investment is coupled with other complementary investments; new strategies, new business processes, and new organisations all appear to be important."

analysis. Attempts to develop formal theories need to wait till we have better insights into the nature of these changes and more informed hypotheses through appreciative theories and case studies. An excellent analysis of issues related to large-scale econometric analysis can be found in Brynjolfson and Hitt (2000). I will discuss appreciative theories and case studies.

Appreciative theories

To move from pure conjecture to empirically testable propositions, we need "appreciative theories", as defined in Richard Nelson´s thought-provoking review of economic growth theory (1995)[7]. In contrast to formal growth theories, appreciative theories do not attempt to compress stylized facts into rigorous formulations. Rather, an attempt is made to include more of the observed empirical richness of DIS and transformations in business organization than formal theories. This of course comes at the cost of being unable to model these relationships mathematically. Hence the need for formal theories. But for the latter to be fruitful, they need to be based on appreciative theories, and on the findings of case studies and econometric analysis[8].

Specifically, we need appreciative theories that explore possible causal linkages between DIS and transformations in business organization. We know very little about how DIS and business organization co-evolve. Brynjolfson and Hitt (2000: 24) argue that "…much work remains to be done in categorizing and measuring the relevant changes in organization and work practices, and relating them to IT and productivity." Such theories should help to enrich the research agenda for both case studies and econometric analysis; they should also help moving formal theories more closely to real-world issues.

Case studies

Complementary to appreciative theory, we need a broad set of comparative case studies that provide qualitative insights into the nature of these changes. Given the scarce knowledge that we have of this phenomenon, it is appropriate at this stage to pursue an "interpretative" approach to case study research (Walsham, 1993: 4-5): the main purpose is to understand the context and the drivers of digital information systems, and the process whereby DIS interact with the organization of firms and GFN. A case-based qualitative study is suitable for descriptive purposes and appreciative theory-building (Eisenhardt, 1989), where how and why questions are the most urgent ones to answer (Yin, 1989).

Over the last decade, case studies have highlighted the diversity and evolutionary nature of interactions between DIS, business organization, and economic performance. It is now well-established, for instance, that matching organizational structure and strategy to the performance features of DIS is a time-consuming process of trial-and-error.

[7] For an extremely stimulating application of this concept, see Lipsey, Bekar and Carlaw, 1998 a and 1998b.

[8] This is in line with the perception of sophisticated econometricians. Geroski (1998), for instance, emphasizes a plurality of methodological approaches: without descriptive appreciative theories, modelling and abstract theoretical reasoning can easily go astray.

Making the transition to an IT-intensive production process requires time, substantial financial and human resources and persistence. Only very few large corporations can do this on their own. But even they, the dominant global network flagships, face an increasing need for collective organizational innovations.

This raises an important question for future case study research: To what degree can the spread of Internet-enabled changes in business organization reduce these barriers? Surprisingly, the impact of the Internet on business organization is still a largely neglected research topic. Until recently, important contributions to information management neglect and hardly mention the Internet and the world-wide web[9]. Very little research exists on how the Internet reshapes business strategy and organization, and how this affects industry structure[10]. Even less research exists on how the Internet transforms international aspects of business networks[11].

While case studies have provided important insights, we need to broaden further their scope. Most importantly, we need cross-national comparative case studies that explore how DIS transforms cross-border forms of business organization, especially the international aspects of business networks. There has been a forceful debate about new forms of business organization in an international context, "as the dissatisfaction with traditional models grew" (Birkinshaw and Hagstrøm, 2000: 211). There is a new divide in industrial organization: a transition is under way from "multinational corporations", with their focus on stand-alone overseas investment projects, to "global network flagships" that integrate their geographically dispersed supply, knowledge and customer bases into global (and regional) networks (GFN) (Ernst, 2001d).

In addition, five important weaknesses need to be corrected. First, it is time to extend this research beyond the US and a few countries in Europe. Second, research needs to move beyond a "flagship bias", to understand how these developments affect the economic performance of smaller firms, especially local suppliers to GFN. Third, we need to explore differential patterns based on a taxonomy of industry sectors. Fourth, research needs to move beyond a hardware bias to include software, and knowledge-intensive support services.

Finally, we need to address a fundamental limitation of firm-specific case studies. On the basis of firm data, it is difficult if not impossible to distinguish productivity gains (due to better product and service quality) from rents (due to market power). Brynjolfsson and Hitt (2000: 35) rightly argue: "When price differences are due to differences in market power that are not related to consumer preferences, then firm-level

[9] An important book like Strategic Planning for Information Systems (Ward and Griffiths, 1996) mentions the Internet just once, but then as a synonym for the information super highway. And the edited volume Global Information Technology and Systems Management (Palvia et al, 1996) mentions the Internet briefly three times on its more than 600 pages, but fails to provide an explicit analysis.

[10] Noteworthy exceptions are Nolan (2000), Hagstrøm (2000), Brynjolfsson and Hitt (2000), and Evans and Wurster (2000).

[11] On the impact of the Internet on GFN, see Mowery and Macher (2001), Luethje (2001) and Ernst (2000, 2001a, and 2001b). On Internet-enabled knowledge exchange, see Lerner and Tirole (2000), and Weber (2001).

data will lead to inaccurate estimates of the productivity effects of IT." This brings us to an additional unresolved issue: How to distinguish between rents that network flagships can extract from suppliers, and real improvements in economic performance (including productivity)?

5. Global digital divide

Let us now turn to the policy challenges. The first of these is the issue of inequality. Most research on the "digital divide" has focused on the exclusion, in the U.S. and other industrialized countries, of lower-tier income groups, women and ethnic minorities Of equal importance however is unequal geographic dispersion that indicates a *global* digital divide: a few highly IT-enabled regions in the U.S., Europe and Japan are separated from the so-called RoW (= rest of the world) that is caught in a "low-access trap". Take Internet access: almost 90% is concentrated in the industrial heartlands of North America, Western Europe and Japan. Developing Asia, despite its successful catching-up in industrial manufacturing, lags way behind: with almost two thirds of the world population, the region accounts for a meager 7% share of the total Internet population, which is projected to increase to no more than 9% by 2003. Reported shares for Latin America and Africa are even more miserable. Even within developing Asia itself substantial disparities are now emerging. Most notably, Korea's e-business market is projected to be 2.5 times the size of China's by 2005, and larger than the combined markets of Singapore, the rest of Southeast Asia, India, and Hong Kong. Finally, almost 99% of the international Internet traffic in Asia is routed through the United States.

There is a need to document systematically the global divide of access to DIS and its impact on development and welfare. We also need to add another aspect of inequality: a gap between private and public sector applications that reduces the scope for public policy response. For instance, Internet applications in private business have grown much faster than in the public sector. The Internet initially started in the public sector, driven by the requirements of military R&D and Big Science (Naughton, 2000). Yet, the private sector (especially finance, but also global manufacturing industries) has clearly taken the lead since the mid-1990s. While important achievements have been reported, there is a huge and still largely untapped application potential in the public sector, covering health care, welfare systems management, research and the improvement of government functions ("digital government"). This gap may well reduce the capacity of public sector institutions to provide incentives, to orchestrate innovation and diffusion, and to sustain growth with equity.

This happens at the same time as requirements for public policy response increase to adapt economic structures and institutions to the relentless pace of change now taking place. The recent advancements in DIS will generate turmoil, growing uncertainties, and social dislocations. In one indication of the seriousness of this, the Organization for Economic Cooperation and Development (OECD) is now focusing its efforts on changes in policies and economic governance that will be necessary to respond to these dramatic changes. The severity of coming economic problems was captured in testimony before the U.S. Congress by Andy Grove, former chairman of Intel and one of the forces behind

these changes. The Internet, Grove observed, "is about to wipe out entire sections of the economy." Unless politicians start moving "at Internet rather than Washington speed," America may see "a repeat of the social disaster that followed the mechanization of agriculture". This warning to the world's richest country is even more ominous for developing countries and transformation economies, and highlights the need for concerted action.

6. International Aspects of Innovation Systems

To reap the benefits of DIS, the challenge of greatest importance is that of developing robust national, regional and sectoral innovation systems. Basic principles are now well established within the economics profession: a focus on learning and innovation as a major source of economic growth is no longer a minority position. Some key concepts are beginning to shape policy debates in the OECD, the World Bank, and the European Commission. It is time to move beyond the defense of basic principles to a policy-oriented research agenda. There is ample scope for complementary work to the systemic view of innovation dynamics and policy responses to technological change. Despite its impressive achievements, national innovation system (NIS) theory has two important weaknesses that frustrate an effective implementation of policies and firm strategies to reap the benefits of DIS: it fails to address the interaction between these technologies and globalization, and disruptive changes imposed by both on the geography of innovation systems; it also fails to identify potential benefits that particular regions ("industrial districts") could reap from international linkages.

An alternative research agenda may focus for instance on the following propositions (Ernst, 2001c). First, industrial districts need to blend diverse international and domestic sources of knowledge to compensate for initially weak national production and innovation systems. Second, a greater variety of international knowledge linkages is possible, as IT-enabled globalization reduces the spatial stickiness of innovation. Third, globalization has culminated in an important organizational innovation: the spread of GFN combines concentrated dispersion with systemic integration, creating new opportunities for international knowledge diffusion. Such a research agenda explores resultant challenges for public policy response. It also helps to define the new agenda for industrial upgrading, and to identify policies and support institutions that may help to reap the benefits from network participation.

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