A Schumpeterian Approach to Explaining Growth in the Digital Economy

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Abstract

This paper investigates the impact of electronic commerce on the economy and examines the following research questions. (1) Why has e-commerce been so successful? (2) Why is the digital economy booming so fast? and (3) whether the digital economy is fundamentally different from the physical economy, and if so, how is it different? The information systems literature has addressed e-commerce mostly from a firm-level or a particular market perspective and focused on the study of intra-organizational issues and the relationships between an organization and its business partners such as suppliers, customers, and other market players. E-commerce is emerging as the new business technology that allows the total integration of the entire value-adding chain and encompasses the procurement from suppliers, the design and execution of the internal business procedures that add value to the merchandise, the management of the distribution channels, and the interaction with the consumer. Recent research has thoroughly examined the effects of e-commerce technologies on organizational designs, business models, innovation, and business strategy with respect to cost-effectiveness, competitive advantage, product quality, and customer service. While this line of research has generated a better understanding of what makes particular organizations perform better than others, it has barely touched upon the macroeconomic effects of e-commerce. The current paper is concerned precisely with the macroeconomic effects of e-commerce, that is, how the economy as a whole is impacted by digital business. More specifically, we investigate the determining factors of aggregated economic growth and how they are related to the e-commerce framework

In this paper we develop an explanatory theory and suggest a Schumpeterian model of economic growth in the digital economy. Contrary to conventional economic growth theory, growth is not viewed as more output resulting from higher levels of physical factor inputs like capital and labor, but as a consequence of decisions made by risk-taking, profit-seeking entrepreneurs who carry out new combinations of business ideas and technological knowledge. New successful technologies and business models will replace old ones and hence, new industries (digital business) may arise and destroy old (physical) industries. We argue that Schumpeter's, at its time, controversially received theory of *constructive destruction* for explaining economic development provides a very current and accurate economic foundation for the explanation of growth in the recently emerging digital economy.

1. Introduction

It has taken only a few years for electronic commerce to evolve from a fringe novelty to the newly emerging mode of conducting business [1]. Initial skepticism about the economic significance of e-commerce has already now been proven wrong. Early critics misjudged several key elements of e-business. For example, they failed to recognize (1) that e-business would open up new possibilities to do business in fundamentally different ways rather than merely complementing existing business models *(impact)*; (2) that successful e-business would not be confined to niche markets *(scope)*; and (3) that the growth potential of the new, digital economy is uncannily strong, virtually unbounded, and for real *(scale)*. After just a few years of controversial debates on whether e-commerce is only a fad with little impact on economies and heated discussions on what is really so different about e-commerce, we can now, right at the turn of the century, watch as the digital revolution is changing everything around us, not only commerce but also, and more importantly, societies in their entirety.

This paper investigates the economic impact of electronic commerce and examines the following research questions. (1) Why has e-commerce been so successful? (2) Why is the digital economy booming so fast? and (3) is the digital

economy really fundamentally different from the physical economy, and if so, how is it different? Obviously, these or similar questions have been entertained before, but the information systems literature has addressed e-commerce mostly from a firm-level or market perspective and focused on the study of intra-organizational issues and the relationships between an organization and its business partners such as suppliers, customers, and other market players [2, 3, 4, 5]. E-commerce is emerging as the new business technology that allows the total integration of the entire value-adding chain and encompasses the procurement from suppliers, the design and execution of the internal business procedures that add value to the merchandise, the management of the distribution channels, and the interaction with the consumer. Recent research has thoroughly examined the effects of e-commerce technologies on organizational designs, business models, innovation, and business strategy with respect to cost-effectiveness, competitive advantage, product quality, and customer service. While this line of research has generated a better understanding of what makes particular organizations perform better than others, it has barely touched upon the macroeconomic effects of e-commerce. The current paper is concerned precisely with the macroeconomic effects of e-commerce, that is, how the economy as a whole is impacted by digital business. More specifically, we investigate the determining factors of aggregated economic growth and how they are related to the e-commerce framework

In this paper we develop an explanatory theory and suggest a Schumpeterian model of economic growth in the digital economy. Contrary to conventional economic growth theory, growth is not viewed as more output resulting from higher levels of physical factor inputs (like capital and labor) but as a consequence of decisions made by risk-taking, profit-seeking entrepreneurs who carry out new combinations of business ideas and technological knowledge. New successful technologies and business models will replace old ones and hence, new industries (eg. digital businesses) may arise and destroy old (physical) industries. We argue that Schumpeter's, theory of *constructive destruction* for explaining economic development, which was published by the eminent scholar nearly a century ago [6] and controversially received at the time, provides a very current and valid economic foundation for the explanation of growth in the recently emerging digital economy.

2. Schumpeter's Theory of Economic Development and Growth

This section summarizes Schumpeter's original theory of economic development with regard to growth based on the principle of constructive destruction, that is, the dismantling of an old economy and replacing it with a new economy through entrepreneurial innovation. Reviewing empirical data and macroeconomic statistics [7] we find several pieces of evidence that point to the emergence of a new techno-economic paradigm stimulating economic growth [8] and ultimately social welfare that are surprisingly consistent with classic Schumpeter ideas. We will, later in this paper, develop a growth model of the digital economy, drawing on the constructive destruction theory which Schumpeter put forth nearly a century ago [6]. We postulate that entrepreneurship in combination with new knowledge is the main driving force in the (digital) economy. Traditional factor inputs like physical capital and labor are no longer determinants of economic growth. This change also illustrates the idea that the digital economy (based on new technologies and ideas) is 'constructively' destroying or replacing the old physical economy. The following table 1 summarizes the original Schumpeter theory [6, p65ff]. It additionally provides – in the last column - a reinterpretation of its basic concepts that we propose in light of the changes that the digital age has brought to bear.

Table 1 The Principles of Schumpeter's Constructive Destruction Theory

Economic Variable	Original Schumpeter Theory (1909)	Adaptation in the era of the Digital Economy
Innovation	Introduction of new goods	Introduction of new digital products and digital services
Technology	New methods of production	Digitization of the production processes of knowledge- based goods
Customer-orientation	Opening of new markets	Creation of electronic markets and digital distribution channels
Coordination	Conquest of new supply sources	Implementation of B2B-EC to manage supply networks
Entrepreneur-ship	Reorganization of the firm; Risk-taking strategies; Profit-orientation	Development of new models to manage digital businesses; electronic markets; Dotcom companies and Internet startups

3. A Modern Economics Growth Perspective

The digital economy has ushered in a paradigm shift concerning technological change. In order to analyze the growth in the Internet economy, we need to understand what factors and forces are causing this growth. Earlier theories in growth tended to emphasize physical capital accumulation [9]. This cannot be the dominant paradigm in the digital society, given that most of today's companies depend crucially on information and knowledge management. The dominant consensus in growth literature has changed therefore to knowledge accumulation based the exploration of new combinations of ideas. Arrow's 'learning by doing' model [10] and Romer's analysis of endogenous growth theory [11] introduce the concept of new knowledge discovery through investments in research activities that gives rise to increasing returns in production. In this paper, an attempt has been made to understand the growth in the Internet sector. In order to keep the modeling task analytically tractable we will make a simplifiying assumption and disentangle the overall economy into two separate sectors, a physical sector and a digital sector. Hence, we do not focus on the transition from the physical economy to the digital economy but emphasize the expansion within the digital economy. The model of economic growth that we posit is a competitive equilibrium with externalities. The equilibrium that is calculated is not the result of a social planning problem but rather the maximization problem of an individual agent (entrepreneur) along an endogenous growth path. Our growth model is based on the following constructs that are derived from the Schumpeterian theory outlined in table 1 above.

(i) Economic growth in the Internet sector is a result of greater productivity and more efficient allocation of resources. This improvement in the way things are done is what drives economic growth (*coordination*).

(ii) This shift towards a more efficient system of production and distribution of goods is a result of the profit seeking actions of entrepreneurial market agents (*entrepreneuship*).

(iii) We also assume the existence of a disembodied technology, ie there is a body of knowledge that is available to all the participants in the market. There is a knowledge network that is a result of the knowledge investments of individual agents, which can be accessed by all market participants (*knowledge-based innovation and technology*).

Before we proceed with our discussion of the Internet economy, it is necessary to look at how knowledge can be classified. An economic good can be classified as nonrival if its use by one person or firm does not limit its use by another. A good is excludable if the owner of a good can prevent others from using it, either by legal means such as copyright protection or technical means such as encryption. Conventional economic goods are both rivalrous and excludable. Knowledge on the other hand, is nonrival and incompletely excludable. This characterization of knowledge makes it possible for us to talk about spillover effects in the production of knowledge. Also, nonrival goods can be accumulated without bound on a per capita basis. These two features - incomplete excludability as well as unbounded growth - are relevant for our discussion of endogenous growth with increasing returns.

This distinction between rival and nonrival inputs can extend to the workforce too. We can assume that a section of workforce spends its effort on generating new ideas and learning new knowledge forms, and this knowledge produced by the workforce is what contributes to the aggregate stock of disembodied knowledge about the Internet economy. Thus, the ideas produced by individuals have a life of their own, as it were, and contribute to the available stock of knowledge in the economy. Similarly non-internet capital can be separated from that invested in Internet knowledge. The rival inputs of labor and capital can be classified together as the total rival input needed for the production process.

Qualitatively, the implication of modeling knowledge would mean that we are concerned not simply with the technology, but with the existing state of know-how. This includes technical expertise, innovation in the way products are assembled, delivered and sold, and newer forms of transaction processing in the market. In the Schumpeterian analysis, this sort of a broad shift to a newer techno-economic system entails:

(i) introduction of new goods and services
(ii) new methods of production and coordination
(iii) opening up of new markets or creation of new ways of organizing markets
(iv) new sources of supply, new ways of executing market transactions
(v) new forms of industrial organization.

As a result of digital technologies, it is possible to package products to exactly match consumer demands. Readers of an

on-line newspaper could, for example, subscribe only to the financial news and sports, i.e. only the sections that interest them. This implies an entirely new way of producing and transporting products and services. Advances in technologies such as embedded software makes it possible to produce smarter products. New economic forms, such as an auction market powered by the web, adds another dimension to the emergent techno-economic sphere –newer forms of carrying out market transactions. B2B sites such as Ariba (www.ariba.com) make it possible for buyers and suppliers to coordinate more efficiently and thus usher in more efficient ways of production. In our modeling approach we subsume this entire state of know-how in the economy into one factor or variable called knowledge.

4. A Simple Two Period Model

In this section, we develop a simple two period model that represents the first wave of Internet entrepreneurs and how their economic activities and decisions lead to endogenous technological change and growth in the Internet economy. We try to look at an overlapping generations framework with two periods and no discounting. We characterize the economic system as consisting of an older system that relies on earlier technologies, and an Internet sector that relies on networking technologies for coordination and allocation of economic resources. Growth in the Internet economy implies a shift to a newer techno-economic system powered by the Internet. Let us consider a simple, closed economic system with two categories of firms. One category of firms has business processes that are purely physical and cannot be digitized. The other sector of the economy is capable of being digitized, i.e. the business processes can be conducted over the internet. It is not too hard to find an illustration of this concept. Industries such as mass media or entertainment deal with information, and this can be distributed almost free over the Internet. The Internet infrastructure enhances the productivity of those firms whose processes are most amenable to digitization [12]. The firms in the second sector of the economy experience gains in productivity by adding to the corpus of the Internet.

Our model is a discrete time model with two periods. For our purpose of analysis we can assume a single output good in the economy. The gains accrued by firms joining the Internet will be that of greater productivity, coordination, mobility, better search and access leading to more efficient allocation of resources. Let S of identical consumers have a twice continuously differentiable, strictly concave utility function U (c_1, c_2) over consumption of a single output in periods 1 and 2.

For our purpose of analysis, we look at the nascent Internet sector. This is the group of firms that can realize productivity gains from joining the Internet. Let us say there are N firms in the Internet sector. Based on our previous section, the assumptions we will make in our analysis are:

- There are increasing returns in the production of output- facilitated by the greater coordination and lesser search and transaction costs offered by the Internet.
- Decreasing returns to the production of new ideas on the internet
- Endogenous technological change as a result of the actions of profit maximizing agents

Production of consumption goods in period 2 is a function of the state of knowledge of internet technology of each individual firm, and a set of additional factors such as physical capital, labor, etc. denoted by the vector **x**. We assume that the stock of knowledge about the internet technologies can only be augmented. The factor represented by **x** is in fixed supply. Since there is a trade-off between consumption today and knowledge that can be used to produce more consumption tomorrow, we assume that the Internet technology produces knowledge from foregone consumption in period 1. Each firm invests an amount k in research and development of Internet technology. For the i^{th} firm (i = 1 to N), output in period two is a function of variables k_i, x_i and aggregate level of internet know-how, K .

The total stock of knowledge about the internet that is available in the economy functions as a public good that is accessible by all the firms in the market. K is the total stock of capital investment in the Internet economy at the aggregate economy, k_i is the firm level investment in Internet technology, and x_i is the sum of the rival inputs used by the typical firm. In keeping with economics tradition, we assume that for any fixed value of K, F (k_i, K, x_i) is concave as a function of k_i and x_i. Without loss of generality we can assume that F is homogeneous of degree one as a function of k_i and x_i.

The growth in the Internet economy is a result of the entrepreneurial vision of the Internet innovators. In the nascent stages of the Internet economy, the popularity and growth in the Internet economy were due to the intentional actions of

people responding to market incentives. The amazing success of the Internet start ups is not in the least because their founders could come up with marketable ideas and customer friendly ideas. The Internet may have started as an academic venture to enable researchers to exchange ideas, but the enormous Internet consumer base arose from the attempts of private firms to earn a profit. So, we conceptualize that for the Internet firms there is a knowledge production function that depends on the aggregate level of internet know-how and such a firm cannot survive as a price-taker. To illustrate this argument let us look at the production function. By the homogeneity if F in k_i and x_i and by the assumption that F is increasing in the aggregate stock of knowledge, K, it follows that F exhibits increasing returns to scale. Therefore, for any $\Psi > 1$,

$$F(\Psi k_i, \Psi K, \Psi \mathbf{x}_i) > F(\Psi k_i, K, \Psi \mathbf{x}_i) = \Psi F(k_i, K, \mathbf{x}_i)$$

Therefore F exhibits global increasing marginal productivity of knowledge from a social point of view. From the analysis it follows that the aggregate level of knowledge $K= \sum^{N}_{i=1} k_i$, where N is the total number of Internet firms. To simplify the analysis we assume N=S. The equilibrium now reduces to a standard competitive equilibrium with externalities. Each firm maximizes profit-taking K, the aggregate level of knowledge, as given. Because there is an externality effect from the aggregate level of knowledge, all firms could benefit from a collusive agreement to invest more in Internet know-how. However, each firm would also have an incentive to shirk, and not invest its share in the Internet infrastructure.

The constrained optimization model therefore is:

$P(K)$: $\max U(c_1, c_2)$

$k \in [0, \underline{e}]$

subject to $c_1 <= \underline{e}$

$c_2 <= F(k, K, x)$

$x <= \underline{x}$

Let us denote the Lagrangian for P(K*) by $\boldsymbol{L}$, with multipliers p1 and p2 and w:

$\boldsymbol{L} = U(c_1,c_2) + p_1(e – k- c_1) + p_2 [F(k, K, \mathbf{x}) – c2] + w(\underline{\mathbf{x}} – \mathbf{x})$

If we define a function $\Gamma : R \dashrightarrow R$ that maps K into S times k, the fixed points of Γ are candidates for an equilibrium. When an interior solution is assumed, the sufficient conditions for a concave maximization is that k* and x are the optimal choices for the firm. Therefore, for the concave maximization problem P(K*) the solution is $k^* = K^*/S$, $c1^* = e - k^*$ and $c2 = F(k^*, K^*, x)$. A fixed point of a mapping like Γ defined by a family of concave problems P (K) can be supported as a competitive equilibrium that is Pareto optimal.

In the above framework, marginal rate of substitution for consumers equals the private marginal rate of transformation perceived by firms. This, however, is different from the true marginal rate of transformation for the economy since each firm lacks incentives to invest in the optimal amount of Internet know-how. Therefore, the derived equilibrium solution is generally sub-optimal with regard to social welfare.

5. Conclusion

This paper extends previous research on the impacts of e-commerce on firm performance, organizational change and market efficiency to the overall macroeconomic effect that the Internet has brought to bear. We argue that the Internet has evolved into a new economic infrastructure that not only benefits individual firms, business model designs, or particular markets but has created a entirely new economy that is more efficient and more effective in terms of market coordination, innovation, and entepreneurship. The digital economy has by and large abandoned old productivity models based on physical assets and instead shifted to a knowledge-based economy. Triggered by technical change and recently accelerated by the information technology revolution an economy has emerged whose productivity, competitiveness, and growth all depend foremost on knowledge rather than physical resources. New communication technologies, better information management and coordination have enabled the creation of a networked economy that has been reorganizing all economic activities, including production, distribution, and consumption, on a global scale and has lead the new, so-called informational society [13].

Based on recent empirical findings and ideas from classic Schumpeterian economics and modern endogenous growth theory, we argue that the Internet provides an economic infrastructure that facilitates the synergies between entrepreneurship and knowledge generation and sharing, and henceforth leads to accelerated economic development and growth. We have also developed a theoretical, explanatory model of the digital economy that concludes, under the assumptions of profit-maximizing entrepreneurs, knowledge externalities, increasing returns to knowledge in the production of output, and decreasing return in the generation of new knowledge, a steady and basically unlimited economic growth path. This essentially presents the foundation wherefrom we can answer our original research question raised in the introduction. (1) E-commerce has been so successful because it takes advantage of a new economic infrastructure, the Internet, that is economically more efficient and effective, especially for producing, distributing and consuming information goods and knowledge-based products. (2) The continuously high growth rates of the US economy that have been recorded for more than a decade now, which represents the longest boom period in 20th century American history, may be the result of increasing returns to knowledge in the production function. While this process of growth-stimulating, knowledge-based endogenous technological change could have been ongoing for quite some time, we may just now observe a significant upturn with the Internet turning into a global economic infrastructure. (3) Yes, the new digital economy is indeed fundamentally different from the old physical economy. The main reason is again the shift from physical assets and factor inputs to the accumulation of knowledge stocks as the main driver of economic development and growth.

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