RATIONALIZING THE INFORMATION TECHNOLOGY REVOLUTION

Kanupriya Gupta*
Shishir Gupta**

ABSTRACT

The paper makes an attempt to unravel the dynamics of the much talked about Information Technology (IT) revolution. The central question that we address is whether IT represents a fundamental development or it a bubble. Analysis points to the fact that there is a demand and supply relationship between technology and the current IT boom was badly demanded by the economic system for its continual growth and development. A modest attempt is made in this paper to understand whether the Information Technology revolution, which gripped the entire world since the 90's represents a "Great Leap Forward" or merely a bubble, which is and will soon lose its sheen. Let us clear our stand on one critical aspect. Our endeavor in this paper would only be to analyze the productivity and hence growth aspects of the IT revolution. Its distributional ramifications, though important, fall outside our ambit.

Introduction

The world has been gripped by the IT mania. It has been frequently hailed as the 'Third Revolution' after the Agricultural and the Industrial revolutions. Its admirers never tire of talking about the dawn of a new – "Virtual World". They profess that the future belongs to 'mouse and click' and not to 'brick and mortar'. The evidence also seems to favor them hands-down. Ever since its emergence, barring for a short lull phase, US, the world's most IT intensive country, has been a star performer in terms of income growth. World's richest men are IT whiz kids for quite some time now.

As if it is not enough, we are frequently reminded that the best is yet to come. Digital networks and miniaturized electronics have started to alter our perception of time and space. These die-hard votaries vehemently deny the proposition that the current boom is just a flash-in-the-pan and will fizzle out sooner.

There has been so much talk and corroborative evidence provided by the supporters of the "New Economy" that its existence seems obvious, a well-entrenched reality. However, nothing is obvious. If anything seems so, it is because that phenomenon is backed by an unassailable principle, an absolute truth. Before

* Kanupriya Gupta, Pursuing M.Phil. in the Department of Economics, Delhi School of Economics, University of Delhi, Delhi

** Shishir Gupta, Visiting Faculty, Department of Commerce, Shri Ram College of Commerce, University of Delhi, Delhi

Newton, it was obvious that objects fell on Earth. However, he questioned the age-old obviousness and rationalized it in the form of "Gravitation". Therefore, our unwavering thought in this paper would be to unravel, if at all there exists any such obvious element, so far as IT revolution is concerned.

We propose to go the following way. We will first try to establish the rationality about the 'Timing' and 'Nature' of the IT revolution. We believe, a good way of analyzing the potentiality of any technological development is to try and seek its rightful place in the economic system. For the case at hand, it involves that we should know the following- why does the IT age represent a revolution. WHY?? What's so special about it? Why have information and communication assumed such a critical dimension? Unless we answer these questions satisfactorily, we doubt we can ever detect that 'Obvious' rationality.

Ever since Solow's (1957) seminal contribution, it's in the public domain that secular economic growth thrives on 'Technological Change'. However, this change is still one of the black box of economics. To extend, what to some may seem a bit far-fetched analogy, theorizing about technological change is similar to understanding the subconscious. Though we do not know what goes on in it, it guides us. So, we should continue making efforts trying to unravel its dynamics, however, slowly or incompletely. For a lot of things become clearer and we are in greater control of ourselves!

Economic agents respond to information signals. They form the nucleus of human actions. Ceteris Paribus (perceptions, etc.), lesser the information, greater is the level of uncertainty of the implications of our actions. Perfect and complete information is thus a pre-requisite for perfect competition – the most cherished economic state.

However, there is no *free-lunch* in economics. Consequently, information is a scarce resource and it is costly to be informed. As a result, the level of information expenditure is contingent on the sheer magnitude of its *potential benefits.* This suggests that the scale of information activity in the economy is *endogenously determined,* endogenous on the potential benefits and hence on economy's size. In economics jargon, it implies that the *'Transactions' cost structure is determined by the 'Transformation' cost structure.*

The above analysis points at an interesting and highly intuitive way of looking at the timing and evolution of different information and communication technologies. As suggested, the level of information is dependent on the stakes involved in terms of going awfully wrong in terms of production etc. Seen from this vantage point of view, picture (w.r.t. IT) started moving in the right earnest ever since the advent of the Industrial Revolution. Industrial revolution increased "... the speed of an entire social processing system, from extraction and production to distribution and consumption". For the first time in history by the mid 19th century, the social processing of material flows threatened to exceed in both volume and speed the system's capacity to contain them was born the crisis of control..." (Beniger).

That Industrial Revolution ushered in the control crisis could be easily been from the efforts expended in the mid 19th century to run the rail-road system efficiently. At one point of time, its expansion was constrained largely by the lack of any reliable control mechanism. Emile Durkheim noted the economic counterpart of the crisis. According to him, "industrialization tends to break down the barriers to transportation and communication that isolate local market, thereby extending distribution of goods and services to national and even global markets. This in turn, disrupts the market

equilibrium under which production is regulated by means of direct communication between producer and consumer". "This is nothing but a crisis of control at the national level, which had little practical relevance before the mass production and distribution of factory goods." Resolution of this crisis demanded better mode of information and communication to control the economy, which was shifting from local segmented markets to higher levels of organization. A few things are noticeable here. Firstly, during the early phase, since economy was largely national, control crisis remained within the confines of the national boundaries. Secondly, control is a generic term representing a binding mechanism. It has to be mutually compatible with the rest of the system *e.g.*, socialism is a centralized control mechanism. However, it failed because it needed tremendous information content. This example testifies that 'timing' of the control mechanism is endogenously determined. Thirdly, industrialization resulted in the emergence of the "Mass Production (M.P.) Paradigm".

We are in consonance with those who question the 'Mass Production' as destiny and blind decision. There was (is) nothing sacrosanct about the mass production paradigm. That is industrialization could as well have taken the craft-production route. Nevertheless, mass production is a reality. Mass production derives its validity from the economies of specialization. Growth in the M.P. paradigm critically hinges on the exploitation of these economies of specialization, and thereby, the consequent economic interdependence in the system. These terms – 'specialization' and 'interdependence' – are relative in the sense that they are dynamic. That is, overtime, economies are getting 'specialized' and consequently 'interdependent'. In such a densely intertwined system where everyone is interdependent on every one else, to keep the system growing smoothly a strong, reliable and swift mode of information and communication was a must.

The system can be envisioned as if continually increasing number of arguments is entering multiplicatively in the system and hence even a single argument's lower value (less development) can significantly reduce the aggregate output. The analysis is similar to Michael Kremer's O – ring theory of low productivity. According to that, in a long chain of arguments even a single weakling can become fatal.

The advent of industrialized and mass production economy turned the then prevalent control mechanism obsolete and it became the Achilles' heel of the system. That size – number of agents and value, stake involved – critically determines the mode of information and communication could be easily seen from the fact that had it been a Robinson Crusoe economy there would automatically have been complete and perfect information and thus no need for any coordinating medium. The above analysis clearly points that Industrial Revolution resulted in the crisis of control.

The system did adjust smartly to the challenges and continued to grow as a consequence. Quoting Beniger, "... as this crisis of control spread through the material economy from the 1840's to the 1880's, it inspired a stream of innovations in information processing, bureaucratic control and communications". It was this compelling need to prevent the system from falling asunder that resulted in a spate of information and communication technology developments in just a generation's time – Telegraphy (1830's), Transatlantic cable (1866), Telephone (1876), etc. That these developments in information and communication technology took place in response to the control crisis could be seen from the fact that since mid 19th century share of services in the national income has been growing. All these developments in information,

communication and organization techniques clubbed together can be called, THE CONTROL REVOUTION.

In this scheme of things, the onset of the current IT age merely represents the latest sequel in the control revolution, made necessary by the ongoing process of 'globalization' – on an unprecedented scale – which is intensifying the process of interdependence to dizzying heights. That the whole world today represents a highly interdependent system, can be gauged from the terms in vogue like – world as a conveyor belt, global village, etc. World trade constitutes 1/3 of global output and is continually increasing. Also as a result of increasing incomes, people are getting choosy. This has resulted in "Mass-customization", which wouldn't have been possible without the developments in IT

Not only trade in goods and services, other facets of the economy are also affected by globalization and hence warrant a better controlling mechanism. About $1.5 trillion worth of currency exchanges hands everyday. This "hot money" would at best have been 'lukewarm' without the current advancements. The WTO's annual report (1998) acknowledges the impact of the IT revolution in making globalization possible. That IT increases efficiency by cutting down the transactions cost can be clearly seen in it turning the Singapore as the most efficient port with turnaround time of only 8 hrs, down from 3-3 ½ days.

Galbraith, in his "The New Industrial State", staunchly advocates that 'big is beautiful'. Since IT is an aide in this process, it is filling a critical void in the system by enabling still greater economies of scale, still higher specialization and consequently still higher interdependence. What is interesting is to note that though IT emerged as a control technology to assist globalization, its benefits may well outweigh that of globalization itself.

Charles Babbage is widely claimed to have anticipated the modern computer technology in 1823. However, first computer, ENIAC by Von Neumann, was established only in the 1940's. On the other hand, Arkwright's water frame, invented in 1768 could be successfully exploited immediately because it appeared at a moment when conditions were opportune for it.

We view the invention and innovation activity in the economy as follows-

Economic structure influences the knowledge pool in terms of encouraging 'induced technological activities'. Also, there are independent R & D activities, largely for academic purposes that are not currently aimed at economic exploitation. They have been currently christened as autonomous technology. Nevertheless, it forms part of the society's knowledge pool (foreign technology can also be included here). Amongst them, there is continuous interaction.

At each point in time, the economy utilizes those techniques of its pool that are most apt. So, as economic structure changes, whatever technology was of academic interest earlier might become profitable for exploitation – like computers. Once autonomous knowledge becomes part of the aggregate knowledge pool, it also affects the economic structure. In nutshell we can say that existing techniques remain in hibernation and new techniques not developed unless the time is ripe for its profitable utilization.

The Counterarguments

However, some people have different perceptions about the IT revolution. Some of them try to draw connections between the ascendancy of the IT age in the 70's and the

contemporaneous lackluster performance of the US economy. Though we have no corroborative evidence, people must have questioned the reality of the industrial revolution also, and they should have. This escapism apart, what we find most discomforting is that in drawing conclusions about the IT prospects they an ad-hoc and piecemeal approach and hence their conclusions are based on a very weak wicket. We believe that time is just ripe for IT's optimal utilization.

The argument to drive home our point is the obsolescence of the methodologies used to quantify various variables - productivity growth, investment etc.

According to Prof. Simon Kuznet's "Six lectures on Modern Economic Growth", industrial revolution resulted in putting the manufacturing industries at the top in terms of proposition of workforce employed, contribution to GDP etc. **Machlup** and **Porat** have also contended that tertiarization of the presently developed economies started from the late 19th century.

However this 'Tertiarization' is in at least one fundamental sense different from 'Industrialization'- *services cannot be stored.* Also, production of services is largely skill intensive and hence the quintessential importance attached to physical capital, when we talk of production of goods, is being eroded. This has marginalized the importance of traditional saving and investment in economic growth. That the US economy is currently booming despite negative household savings might just be a pointer in this direction.

This is a profound change, services are skill-intensive and hence their development requires better education, health, parental care, etc. A number of these are regarded as consumption in National Income Accounts. This is misleading. As Frank P. Stafford has noted "The system is subject to the emerging complexities of valuing home time applied to IT activities. Is time spent by fathers in playing computer games with children entertainment (consumption) or part of early learning (investment)". All this suggests that 'tertiarization' is fundamentally different from industrialization and should not be treated alike. We intend to make the above point clear by way of an illustration below.

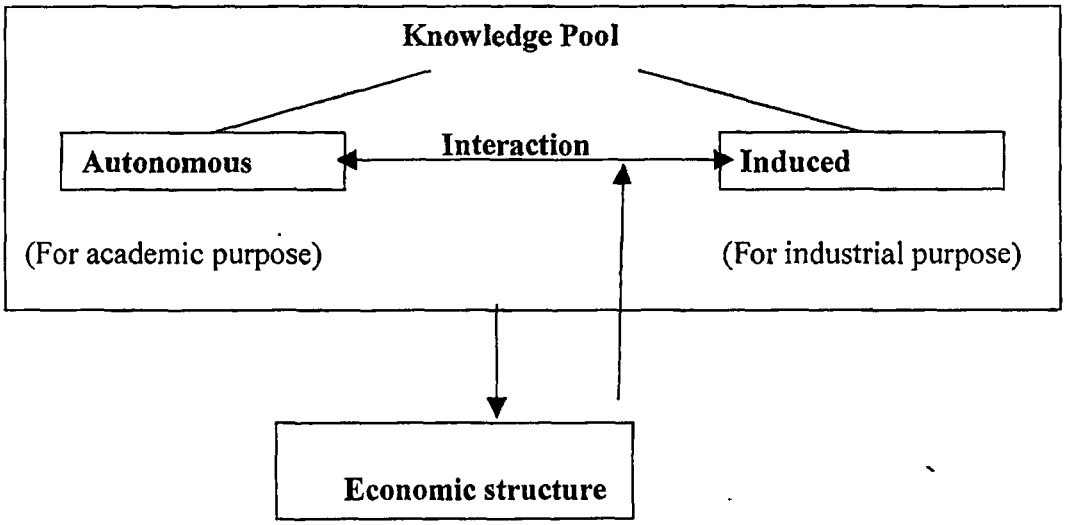

Illustration:

$Q = A(t)f(K,L)$, where Q is output, A is productivity coefficient, K and L represent standard capital and labor in the production function

Implies $\dot{Q}/Q = \dot{A}/A + W_L \dot{L}/L + W_K \dot{K}/K$

There can be three problems w.r.t. the above equation when applied for present purposes:-

- You cannot measure service output properly, so you underestimate $\dot{Q}/Q$ and byimplication $\dot{A}/A$
- Unless you redefine K, you will keep underestimating it and by consequence Q. These two bottlenecks lead to the underestimation of the economy's output.
- Further, any analysis lacks opportunity-cost sense. That is, what would have been the economic landscape had IT not happened!

The central point that we want to put forward is that if an economy is growing on the basis of its service constituent, who is not storable and is skill-intensive, we need to understand its dynamics closely to get the real picture.

In a recent paper by Jorgenson and Stiroh, they have tried to analyze the hollowness of the IT revolution by analyzing the US data national accounts since 1973.

a) According to them the US output growth declined from 4.02% during 1948-73 to 2.86% during 1973-90. They ascribed this decline in growth largely due to a decline in productivity ushered in by the simultaneous onset of the I.T age. We feel the basic problem with their argument lies in the year they choose to divide the two periods. 1973 is known for its oil shock and for a sudden (overnight) ascendancy of the I.T activities in the economy. Standard macroeconomics tells us that an increase in the price of 'Coorperant' factors like oil results in a negative aggregate supply shock and hence the consequent decline in aggregate productivity.

b) Then they analyzed the data for the period 1990-96. During this period growth rate of output was 2.37%, 0.5% lower than the immediately preceding period. This was due to the decline in the contribution of K-services in the economy. They offer no argument for this trend.

We think that again the choice of the dividing year was wrong. 1991 was the year of third oil shock. However, 1990's were the decade, which really heralded the I.T age. And as is commonplace in economics, herd-behavior overtook rationality. In their pursuit to secure the right niche, a lot of money started floating around. This rage must have resulted in a lot of sour investments-a possible explanation for the decline in K/K during 90-96.

NASSCOM chairman himself testified that even in the US only a few companies made money, the rest bombed. For the future, he claimed that 9 out of 10 start-ups would either merge or fail. However, being a service economy, we feel even its failures are not akin to industry failures.

Here, you don't have any intrinsic value. It's just like "Token currency" as opposed to "Full bodied". As a result, sour investment is a complete dead weight-loss in the present service economy regime. Along with these contextual

arguments we want to offer some general points:

(i) Rise of the I.T age and simultaneous lackluster US performance can merely be a spurious regression owing to the related but independent time series properties of the two variables.

(ii) The true measure of an economy's performance can be gauged through the contemporary performance by the comparable economies. If we compare this way, the U.S is a clear-cut star performer. US's performance seems to better when we notice that it's the biggest economy in the world accounting for a quarter of it's output.

(iii) Common sense guides us that greater is the scale of investment longer is the generation lag. This holds for an economic system also. If we accept the terminology-IT-revolution we must realize that it requires economy-wide reconstruction. Obviously this is a time consuming and costly (less immediate returns) exercise-birth pangs.

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