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Innovation Economics

Part I: An introduction to its birth and international context

By

Allan Næs Gjerding

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Aalborg University
Centre for International Studies
Fibigerstraede 2, 9220 Aalborg Ø, Denmark
Tel.: 45 96 35 80 80 Fax: 45 98 15 69 50

Allan Næs Gjerding
Ph.D., assistant professor
Department of Development and Planning
Aalborg University,
Fibigerstraede 2, DK-9220 Aalborg
Tel.: +45 9635 8395 Fax: +45 9815 6950
e-mail: gjerding@i4.auc.dk

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Contents

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1. Introduction

The present paper provides an introduction to the birth of innovation economics. It describes the birth of innovation economics as the outcome of a paradigmatical struggle on how to analyse technical change and to what extent technical change represents a deviation from the standard microeconomic assumptions of perfect competition. The paper argues that innovation economics represents a new way of perceiving the market both in a national and an international context, and in doing provides an introduction to modern trade theory.

Innovation, in the present paper, is often used in its technical sense as the introduction of new products and new processes. At some instances, the concept of innovation is enhanced to include the opening of new markets. However, this is primarily done in the sense that new products allow the firm to adopt new market positions. A conception like this is in accordance with the common use of innovation within innovation economics but does not, however, pay full credit to the most recent developments in the field. Recently, innovation economists have come to include organisational change as well, primarily based on the view that technical change in many instances require an adaptation of the organisational configuration of firms (Gjerding, 1996) and industries (Freeman & Perez, 1988; Lundvall, 1988). It has also been argued that the chain of causality is not unidirectional, since organisational change is important in order to enhance the ability of the firm to develop and exploit new products and processes (Christensen, J.F. 1992; Gjerding, 1992). Recent international case studies (Andreasen et al., 1995) and Danish survey studies (Lund & Gjerding, 1996; Gjerding, 1997) imply that the line of causality in many cases works both ways simultaneously. These issues are dealt with elsewhere in the series of working papers to which the present paper belong (Gjerding, 1998).[1]

Section 2 presents the main focus of classical economics and concludes that the analysis of innovation entered as part of an analysis of macrosocial changes. Section 3 describes how the opposition to the classical economics evolved into an economic analysis focused on the establishment of equilibrium within which innovation disintegrated into incremental, exogenous events. Section 4 argues that a growing interest in long term business cycles reintroduced innovation to economic analysis as a radical, endogenous force of change. Section 5 shows that the work of business cycle economists lead to a debate which resulted in an entirely new way of perceiving the market, and according to section 6 a similar theore-

1. Similarly, Gjerding (1998) discusses the concept of innovation. Two questions are addressed. First, in which cases may we define a change as an innovation? It is argued that three general cases exist, i.e. we may talk about innovation when the change is new to the firm, new to the economic environment, or new to the firm *and* that part of the economic environment in which the firm operates. Second, is it reasonable to talk about innovation if the change in question has detrimental effects on the firm, the industry or the society at large? It is argued that the definition of innovation and the evaluation of the innovation should be kept apart in order to provide analytical clarity.

tical development occurred in the field of international economics. Finally, section 7 suggests that the theoretical struggle between innovation and mainstream economics represents the emergence of a new paradigm.

2. Historical antecedents: From minor to major changes

Technical innovation, i.e. the renewal of products and production processes, has always been important to the long-term competitiveness of firms. However, analysing competitive changes as a result of technical innovation at the level of the firm is a recent phenomenon in the field of economics. Originally, the study of innovation focussed on production processes and was part of the analysis of the creation and distribution of wealth. In his work on *The Wealth of Nations*, Adam Smith (1776) associated technical change with the division of labour, and believed that technical change occurred because large-scale activities "enabled clever artisans to devise labor-saving tools and devices" (Abramovitz, 1989, p.4). Combining analytical reasoning at the macro level with case study insight, Smith argued that the division of labour would lead to improvements in the processes of work because those doing the handiwork became specialists:

> Men are much more likely to discover easier and readier methods of attaining any object, when the whole attention of their minds is directed towards that single object, than when it is dissipated among a great variety of things. But in consequence of the division of labour, the whole of every man's attention comes naturally to be directed towards some one very simple object. It is naturally to be expected, therefore, that some one or other of those who are employed in each particular branch of labour should soon find out easier and readier methods of performing their own particular work, wherever the nature of it admits such improvement. A great part of the machines made use of in those manufactures in which labour is most subdivided, were originally the inventions of common workmen...
>
> (Smith, 1776, p.20)

Thus, in the Smithian version, technical change was to a large extent based on the upgrading of skills through what we today know as learning by doing. The advent of new machines was primarily caused by the ingenuity of ordinary workers who in the course of the evolving division of labour learned new ways to handle the productive process. However, the Smithian thesis was subjected to some debate. John Stuart Mill (1848), who questioned the savings in production times which according to Smith was an outcome of the division of labour (pp.150-51), felt that Smith tended to exaggerate the importance of learning by doing:

> ...much more depends on general intelligence and habitual activity of mind, than on exclusiveness of occupation, and if that exclusiveness is carried to a degree unfavourable to the cultivation of intelligence, there will be more lost, in this kind of advantage, than gained. We may add, that whatever may be the cause of making inventions, when they are once made the increased efficiency of labour is owing to the invention itself, and not to the division of labour.
>
> (Mill, 1848, p.154)[2]

Karl Marx (1867), who analysed the division of labour as the outcome of a process where the means of production became increasingly centralised in the hands of a few capitalists, proposed that Smith

> confunds differentiation of the instruments of labour, in which the detail labourers themselves took an active part, with the invention of machinery; in this latter it is not the workmen in manufactories, but learned men, handicraftsmen, and even peasants (...), who play a part.
>
> (Marx, 1867, p.348)

At the core of Marx's critique, we find the distinction between *minor* and *major* changes. Marx did not dismiss the Smithian hypothesis that detail workers may contribute to the improvement of production processes, but he thought it unlikely that they should be the source of new machinery. Smith was to some extent aware of this and argued that technical change in many instances originated from without the production sphere.[3] However, according to Marx, Smith tended to underestimate the importance of technical change as a force which shapes the social conditions and productive relationships of capitalist economies. Marx argued that technical change very seldom can be attributed to any individual, but instead is the outcome of social processes at the level of society. Furthermore, he believed that technical change tend to disrupt the social order and create new social conditions. Thus, the Marxian position may be described as one of *technology-push* in the sense that the line of causality primarily run from the productive forces to the productive circumstances. While serving as a Marxian source of inspiration on the macrosocial process, Mill (1848)

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2. By "intelligence", Mill (1848) refers to the diffusion of knowledge across the society, i.e. the educational level of the citizens and the exchange of information and knowledge among those who produce knowledge.

3. "All the improvements in machinery, however, have by no means been the invention of those who had occassion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines, when to make them became the business of a peculiar trade; and some by that of those who are called philosophers or men of speculation, whose trade it is, not to do any thing, but to observe every thing; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects" (Smith, 1776, p.21).

did, however, primarily adopt the opposite position in his study of how society may prevent the rate of growth from settling down at a stationary state. He had become interested in this topic because he was afraid that a stationary situation would prove detrimental to social welfare due to the growth of population. Consequently he studied the dynamic laws of productivity differentials at the level of nations and tried to answer why some countries experience a greater level of productivity than others. According to Mill (1848, pp.119-37), international productivity differentials could primarily be explained by differences in natural resources, skills and knowledge, and by the institutional set-up of society in terms of how knowledge was diffused among the citizens and how well the set-up contributed to the social coherence necessary for productive affairs.[4] Thus, to Mill, technical change was as much a result of social relationships as it was the generator of alteration.

As argued by Abramovitz (1989), the work of the classical economists lead to an appreciation of why and how the advance of knowledge may lead to social progress. The insights provided by the classical economists were to a large extent based on the study of industrial organisation in a broad macrosocial sense. The main conclusion were that technical change should be analysed as part of the general social fabric and thus the processes which determine the growth and distribution of the national product. Technical change ought to be described in terms of minor and major changes, and while minor changes to an important extent were based on learning by doing in production, major changes occurred as part of larger social influences. Finally, technical change contributed, in most cases, to the growth of productivity through labour-saving economies of scale in production and through demand-increasing economies of scale in markets.

3. Drawback: The marginalist revolution

The approach of the classical economists lead to the appreciation that changes in technology and the production structures in which technology is applied would be either continous or discontinous.[5] However, during the last part of the 19th century, the focus gradually changed in favour of the continous approach. This happened as the outcome of what has become known as *the marginalist revolution* which refers to a number of theoretical contributions which appeared in the early 1870s almost simultaneously, however dissociated in

4. Mill (1848) argued: "Conjoint action is possible just in proportion as human beings can rely on each other" (p.131), and he emphasised social security, meaning "the completeness of the social protection which society afford to its members. This consists of protection *by* the government and protection *against* the government. The latter is the more important" (p.134).

5. From a sociological point of view we may distinguish between approaches based on theories of regulation or radical change (Burrell & Morgan, 1979). Section 7 returns to this issue.

the sense that the authors had no knowledge of the work of each other.[6] The marginalists focussed on the maximisation of utility in final consumption, and they devoted their attention to the determination of how productive resources are allocated most efficiently in order to minimize cost and effort and maximize profits and satisfaction.[7] This analysis was primarily based on the assumption that the creation and distribution of wealth was determined by anonymous market forces, and that the relationship between supply and demand could be analysed in terms of gradual changes leading to equilibrium. The marginalists differentiated themselves from the classical economists in the sense that they focussed on processes of exchange rather than processes of production. While the classical economists defined the value of goods as determined by the amount of labour which had been put into the production of the goods, the marginalists argued that value is determined by the utility which the goods yield in consumption.

The idea of gradual changes found its way into the field of industrial economics by the work of Alfred Marshall who actually had been a student of J.S. Mill, but became inspired by the marginalists and tried to reconcile the two approaches by integrating the classical focus on production relations into the marginalist framework.[8] Marshall (1920) argued that changes in the industrial structure is either gradual or unstable because its stability depends on the speed by which the human beings involved acquire, understand and master new knowledge. Thus, although the technical opportunities may permit a revolutionising change of the organisation of industry, the ability of man to organise and manage this new organisation calls for slow progress:

> In fact our new command over nature, while opening the door to much larger schemes for industrial organization than were physically possible even a short time ago, places greater responsibilities on those who would advocate new developments of social and industrial structure. For though, institutions may be changed rapidly; yet if they are to endure they must be appropriate to man: they cannot retain their stability if they change very much faster than he does. Thus progress itself increases the urgency of the warning that in the economic world, *Natura non facit saltum*.

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6. These contributions were W.S. Jevons (1871), *The Theory of Political Economy*, Carl Menger (1871), *Grundsätze der Volkswirtschaftslehre* and Léon Walras (1874), *Eléments d'economie politique pure*, published in, respectively, UK, France and Switzerland.

7. This is often referred to as the analysis of how given ends can be obtained by scarce means which can be allocated among alternative uses. The marginalist revolution turned into what today is known as neoclassical, or mainstream, economics.

8. Marshall wrote a famous book on *Principles of Economics* which achieved widespread use as an economics textbook for generations. The first addition appeared in 1890 followed by seven revisions during 1891-1920. The book has been reprinted ever since, and its economic reasoning still dominantes mainstream economics.

(Marshall, 1920, p.207)[9]

Thus, by the end of the 19th century, the classical economics was being pushed back as the dominant paradigm by an economic analysis which focussed on how economic equilibrium is established through gradual changes. Why did this happen? Several explanations have occurred, as described by Blaug (1978, pp.309-24). Some have argued that the marginalist revolution occurred as a political response to Marxian economics, based on the fear that classical economics may stimulate the socialist movement. Others have suggested that it was the outcome of an autonomous intellectual development, especially evidenced by the fact that Menger and Walras hardly had been in contact with previous research based on the idea of marginal utility. Some have proposed that marginalism occurred as part of a general philosophical current, either as part of the renaissance of Kantian philosophy[10], or as part of a Catholic reaction to Protestant theorising[11]. Finally, it has been argued that the marginalist revolution reflected a change in the economic environment: Markets were being developed, and consumers were becoming increasingly important; hence the marginalist focus on consumer value and processes of exchange.

Although any of these explanations may be criticised, they are also difficult to refuse completely. For instance, Blaug (1978) argues that the marginalists were not acquainted with the work of Marx, and point out that they did not make references to philosophical or religious currents. However, it seems inevitable that the marginalists, as members of society, were influenced by the social, political and philosophical changes which occurred at that

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9. The line of causality between technical opportunities, learning processes and organisational issues is not clear in Marshall (1920). However, it appears that his main emphasis is on growth as a gradual phenomenon. In consequence, social and organisational changes must be gradual as well: "Project for great and sudden changes are now, as ever, foredoomed to fail, and to cause reaction; we cannot move safely, if we move so fast that our new plans of life altogether outrun our insticnts. It is true that human nature can be modified; new ideals, new opportunities and new methods of action may, as history shows, alter it very much even in a few generations; and this change in human nature has perhaps never covered so wide an area and moved so fast as in the present generation. But still it is a growth, and therefore gradual; and changes in our social organization must wait on it, and therefore they must be gradual too" (Marshall, 1920, p.622).

10. The marginal economic theory emphasises introspection as a source of intellectual analysis and recognition, and personal utility as the prime mover of behaviour. This is parallel to the emphasis on introspection and sense-impression within the Kantian philosophy.

11. This argument is based on the following idea: The classical economists focussed on production and argued that value is created by labour, i.e. the notion of labour value. The marginalist economists focussed on exchange and argued that value was based on personal utility rather than the amount of labour embodied in the goods. These differences are associated with the differences between a Protestant and a Catholic approach in the sense that Protestantism "places work and labor at the center of theology, while Catholic philosophy is supposed to exalt moderate pleasure seeking instead of work and money making" (Blaug, 1978, p.316).

time.[12] In consequence, it may be argued that the marginalist revolution occurred as a response to contemporary problems and ways of thinking. Blaug (1978) himself does, actually, favour an explanation like this. *First*, it appears that the idea of marginal utility was not new within economics. Actually, contributions in the 1830s and in the mid-19th century were precursors to the marginalists of the 1870s.[13] Thus,

> from the fact that marginal utility was independently discovered over and over again in different countries between 1834 and 1874, we might argue that there must have been a core of economic ideas which was held in common by economists all over the world, whose inner logic would eventually dictate the exploration of consumer's demand with the tools of utility theory.
>
> (Blaug, 1978, p.320)

Second, even though the marginalist economists did not respond directly to Marxian economics, they did respond to the classical analysis, and especially to Marx's precursors (Dobb, 1973; Blaug, 1978).[14] Their main argument was that classical economics was unable to explain the forces which shaped the emerging market economy.[15] *Third*, economics was gradually becoming a professionalised science which favoured the generalisation of economic behaviour into formal models. This development was highly stimulated by the progress within mathematics[16] that allowed the marginalist emphasis on generalisation through introspection to manifest itself in deductive mathematical reasoning. Consequently, while the classical economists had focussed on the social and historical development of society and applied inductive reasoning as part of their research based on observations, the marginalists reversed the chain of analysis.

In conclusion, it may be argued that the advent of the marginalist revolution represented a paradigmatic shift in the Kuhnian sense, i.e. a development where a dominant paradigm

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12. Dobb (1973) argue that there was a, at least indirect, dismissal of the classical way of thinking.

13. Blaug (1978) shows that the triad of Jevons-Menger-Walras in the 1870s followed upon two previous triads: Lloyd-Longfield-Senior and Depuit-Gossen-Jennings, all of whom had struck on the idea of marginal utility.

14. For instance, the marginalists strongly opposed the thinking presented by David Ricardo in his *Principles of Political Economy* (1817). Although critical towards Ricardo, Marx was at the same time greatly inspired by his work on value theory. Ricardo shared with Mill the concern for the causes and consequences of a stationary state of growth and suggested that technical change was necessary in order to stimulate growth.

15. Especially, it was difficult to explain the prices at which goods were exchanged by labour value alone.

16. Actually, Jevons and Walras employed mathematics as a dominating way of expressing their ideas.

was increasingly challenged by anomalies and new phenomena which could be handled by the emerging paradigm. Furthermore, in another scientific field, i.e. mathematics, a number of new insights developed which became a powerful tool in the hands of the new paradigm that was able to incorporate these new insights.

Regarding the analysis of innovation, two important developments occurred, as the marginalist approach became dominant and emerged into mainstream neoclassical economics. These developments implied both a more subtle view and a more simplified view on technical change.

First, economists became aware that technical change may be something more than just automatisation. To the classical economists, technical change occurred as an increase of the amount of capital per unit of worker because it took place as an increasing degree of mechanisation. Productivity would grow since a given amount of goods could be produced by increasingly less labour. Thus, although more and more jobs were created, the nature of technical change was to save labour.[17] The idea of labour-saving technical change dominated the economic thinking until the 1930s where economics became receptive to the idea that deflation may occur as the result of capital-saving innovations.[18] Furthermore, during the 1940s, empirical findings suggested that the capital-output ratio during some periods remained stable at the aggregate level of the industrialised economies, thus suggesting that technical change could be neutral. Although most economists retained the view that technical change was primarily labour-saving, these elaborations turned their attention to different types of technical change as well.

Second, although the dominance of labour-saving technical change was relaxed, this relaxation took place within a more simplified view. Instead of regarding technical change as part of the economic and social processes, economic modelling to an increasing degree treated technical change as something which affect the economic system from the outside. In the extreme cases, technical change was supposed to be infused without economic costs and appeared as an increase in the marginal productivity of production factors, irrespective

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17. In Marxian economics, the process of mechanisation was associated with a decline in the return on capital and thus an ensuing crisis and eventual breakdown of capitalism. Ricardo (1821), in the third edition of his *Principles*, also envisaged a crisis and consequently revised his view on technical change. He argued that although technical progress was, in general, beneficiary to all classes of society in terms of decreasing product prices, the benefits for the working class depended on whether or not the production of capital equipment was financed by retained earnings. If the reverse case apply, i.e. the production of capital equipment was financed by reductions in the wage fund, output may fall and unemployment increase.

18. Mostly, capital-saving innovations would lead to falling relative prices (and not falling absolute prices) which will induce demand to shift towards capital-intensive goods. However, in some cases falling relative prices may turn into falling absolute prices. One recent example is the computer industry where the sales price on computers has been falling steadily for a number of years.

of their age. That is, technical change was not associated with the advent of new production factors, but was perceived as disembodied technical progress falling like "manna from heaven".[19] In the less extreme case, the rate of technical progress was still modelled as an exogenous phenomenon, but infused into the economic system by the advent of *new* production factors, i.e. as embodied technical progress.[20]

4. Renewed upsurge: The birth of innovation economics

In spite of the increasing dominance of a tradition which treats technical change as an exogenous phenomenon, proponents of an alternative view did occur within the science of economics. The work of these proponents was, to an important extent, associated with the investigation of long term business cycles. During the beginning of the 20th century, the interest in long term business cycles flourished primarily within Marxian theoretical lines and was, consequently, inspired by the idea that capitalism would suffer from recurrent crises. However, initially the work concentrated on finding patterns of cyclical movements in growth rates and prices, and it was first after some time that a focus on technical change developed.[21] Technical change began to be seen as part of the development of cyclical movements of growth and was associated with the idea that different industries would be differently affected by the business cycle. Technical change entered the analysis of long

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19. Classical examples of this approach are Harrod (1939), Domar (1946) and Solow (1957).

20. This perspective is associated with the socalled "capital-vintage" models which may be distinguished aacording to the assumptions of factor substitution employed in the model. The model is described as (1) "putty-putty" if capital and labour can be smoothly substituted both before and after the installation of new capital equipment, (2) "putty-clay" if substitution is possible only before the time of installation, and (3) "clay-clay" if the proportion of capital and labour on the new vintage is fixed both *ex ante* and *ex post*. Hacche (1979, pp.110-14) provides an overview of these models.

21. Which is a little bit surprising since a core idea within Marxian economics is that changes in the forces of production lead to changes in the circumstances of production. Apparantly, the Marxist economist Alexander Israel Helphand, known as Parvus, was the first to investigate more thoroughly the fluctuations of economic growth. In 1901, Parvus issued *Die Handelskrisis und die Gewerkschaften* which "gave the bare outline of his long wave" (van Duijn, 1983, p.60) that had an important influence on the work of Trotsky who was an important political theorist in the early Soviet Republic until he was forced to emigrate and later assasinated by the Bolsheviks. Interest in the analysis of long term business cycles developed, simultaneously, in the Soviet Republic, the Netherlands and France, with the Russian economist Kondratieff and the two Dutch economists Van Gelderen and De Wolff as the most prominent. The work of De Wolff and Kondratieff followed upon the work of Van Gelderen, and there are interesting similarities to the marginalist revolution described above, since De Wolff and Kondratieff worked independently of one another (van Duiijn, 1983, p.61). An interesting account of the discovery of the long wave is given by van Duijn (1983, ch.4), who argue that the interest in the long wave of economic activity appeared among British economists prior to the work of Marx.

term business cycles in three ways: (1) Some argued that the cyclical movements were caused by alternate increase and decrease of the rate of growth of fixed capital; (2) some proposed that the cyclical movements could be attributed to reinvestment cycles in the sense that the rate of investment would decrease after periods of capital formation and subsequently increase after some time due to the obsolescence of capital; and (3) some attributed the upswing of the long wave to the occurrence of bunches of innovations.[22]

The third view occurred in Schumpeter's heretic work on economic development, which subsequently moulded the development of the innovation economics discipline that occurred in the afterwar period (e.g. Rosegger, 1986; Freeman, 1994).[23] According to Schumpeter (1934), the economic system never settled down at the equilibrium position assumed by marginalist economics because changes in technology and the organisation of industrial activity were inevitable. To Schumpeter, economic development was created by large changes that represented entirely new combinations of technology and industrial activity. He admitted the existence of small changes, but did not perceive them as causes of economic development since economic development in his opinion denoted a discontinous technological leap forward:

> In so far as the "new combination" may in time grow out of the old by continous adjustment in small steps, there is certainly change, possibly growth, but neither a new phenomenon nor development in our sense. In so far as this is not the case, and the new combinations appear discontinously, then the phenomenon characterising development emerges.
>
> (Schumpeter, 1934, pp.65-66)

The "new combinations" envisaged by Schumpeter (1934) covered five cases regarding product, process and market innovation:

> (1) The introduction of a new good - that is one with which consumers are not yet familiar - or a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned,

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22. Actually, in case (1) and (2) technical change may not be involved, since the growth of fixed capital and reinvestments may take place as growth of existing types of capital equipment.

23. Schumpeter (1883-1950), who was an Austrian, developed his ideas in the beginning of the century simultanously with the growing interest in long business cycles among economists at the European continent. He published his *Theorie der wirtschaftlichen Entwicklung* in 1912, but the impact of the book awaited the publication of an English edition which appeared as late as 1934. At that time, Schumpeter had left his native country (1932) and taken up a position at Harvard University. Subsequently, Schumpeter developed his theory on innovation in *Business Cycles* (1939) and *Capitalism, Socialism and Democracy* (1942).

> which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.
>
> (Schumpeter, 1934, p.66)

Schumpeter's proposition was that the new combinations were the outcome of entrepreneurial activities which destructed the market and technological positions of existing firms by creating new market opportunities and industries. This was a process of creative destruction in the sense that new products and processes, new sources of supply and new principles of organisation were associated with the emergence of new industries, i.e. the old industries and practices vanished so the new ones could survive. Innovation occurred in a swarming way as the new combinations were imitated by firms adopting a second-in approach and as economic, organisational and technological gains spilled over from entrepreneurial industries to other types of industries. Eventually, new principles of industrial activity diffused throughout the economic system.

In his early work, Schumpeter emphasised the role of the entrepreneur as the economic agent that infuses innovation into the economic system. The role of the entrepreneur is to overcome the initial problems associated with new combinations, serving as a pioneer who remove the obstacles confronting less entrepreneurial economic agents. In Schumpeter's view, entrepreneurial capability is a scarce resource because economic development requires that business beyond usual, and not business as usual, is undertaken. Schumpeter was inspired by the exogenous tradition of the marginalists in the sense that the role of the entrepreneur is that of a business prospector who exploit inventions that occur *outside* the existing firms and market structures.[24] However, in his later work Schumpeter admitted that new combinations may occur within firms, thus being caused by firms and not only being the cause of new firms.[25] An important source of inspiration for this transition was the

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24. To Schumpeter, the entrepeneur was an entrepreneur only as long as he carried out new combinations. When he had established his business and began doing business like everyone else, the entrepreneur ceased to be an entrepeneur and became an ordinary businessman instead. This type of reasoning is analogous to the modern theory on organisational life cycles which describes the organisation as travelling from a pioneering stage to a bureaucratic stage.

25. This second opinion occurred in Schumpeter's *Capitalism, Socialism and Democracy* (1942). The distinction between the young and the old Schumpeter is often referred to as Schumpeter Mark I and Mark II, or as Schumpeter I and Schumpeter II.

increasing importance of large firms in the capitalist system.

> The main difference between Schumpeter II and Schumpeter I are in the incorporation of *endogenous* scientific and technical activities conducted by large firms. There is a strong positive feedback loop from sucessful innovation to increased R & D activities setting up a "virtous" self-reinforcing circle leading to renewed impulses to increased market concentration. Schumpeter now sees inventive activities as increasingly under the control of large firms and reinforcing their competitive position. The "coupling" between science, technology, innovative investment and the market, once loose and subject to long time delays, is now much more intimate and continous.
>
> (Freeman, 1982, p.214)

Following Coombs, Saviotti & Walsh (1987), we may argue that the work of Schumpeter gave rise to two hypotheses about the origin of innovation, which pervaded the subsequent development of innovation economics. *First*, it appears from Schumpeter's analytical scheme that economic development is stimulated by the introduction of new technologies. Thus, technology becomes "the leading engine of growth" (ibid., p.95). This is what has become known as the technology-push hypothesis. *Second*, the ideas of Schumpeter II imply that innovation is stimulated by the advent of large firms with a high degree of market power. Large firms possess the resources necessary for undertaking major technological changes, and a high degree of market power ensures that they are able to appropriate the economic gains from innovation and thus capitalise their investments. Thus, contrary to the assumptions of mainstream economics, one would suppose that economic development is enhanced in circumstances of oligopolistic or monopolistic markets dominated by large firms.[26]

5. Innovation and markets

The Schumpeterian hypotheses lead to a debate on whether technical innovation was driven from the supply side by scientific discovery and R&D, or whether the innovative activities of firms and research organisations primarily occurred as a response to demand.[27] Both

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26. Actually, the second hypothesis may be split into two. First, we may hypothesise that large firms to a larger extent than small firms possess the resources necessary for innovation. Second, we may hypothesise that market structures which deviate from the perfect market are more conducive to innovation because they give rise to supernormal profits. The analysis of what is the best firm size to stimulate innovation may be intertwined with the analysis of what is the best market structure to stimulate innovation, but not necessarily. In the literature on innovation economics one may find examples of both a combination and a seperation of the two types of analysis.

27. Coombs, Saviotti & Walsh (1987, pp.96-103) and Mowery & Rosenberg (1979) present an

theses were strongly advocated during the 1960-70s, and following Mowery & Rosenberg (1979), one might argue that the debate was blurred by insufficient definitions of demand. The main problem was whether demand-pull should be understood as directly or indirectly related to demand. A direct relationship occurs in the cases where customers approach a producer with a request, while an indirect relationship occurs in cases where innovation is initiated at the supply side based on an understanding of actual or potential customer needs. In the last case, it might actually be impossible to distinguish between demand-pull and technology-push, since technical innovation *ex ante* is not, necessarily, related to demand for technical innovation *ex post*. The solution to the controversy was, not surprisingly, that a number of different cases exist. At the one extreme, we find cases where innovations are entirely generated at the supply side. At the other extreme, innovation occur as a pure response to demand. In between, we find intermediate cases where the supply and demand sides interact through feedback between producers and customers (see e.g. Langrish et al., 1972; Rothwell et al., 1974; Rosenberg, 1982).

Entwined in this debate was the issue of which market forms represent the strongest stimulus to technical innovation. Inspired by Schumpeter II, it could be argued that monopoly power was especially conducive to innovation for a number of reasons (Kamien & Schwartz, 1982). Monopoly power implies that the firm is in a better position to appropriate the economic gains from innovation because imitation and parallel competition is retarded.[28] Furthermore, a monopoly position enables the firm to accumulate resources for diversifying into new product markets, financing innovation internally, and attracting the most innovative parts of the labour force. The argument in favour of monopoly power was, however, met by counter-arguments based on efficiency considerations. Monopolies might be expected to be less motivated to seek new monopoly positions or to develop the technological base of their current position because they already enjoy supernormal profits. In fact, monopolies may become the victim of second-in strategies because newcomers might have a greater incentive to innovate (Arrow, 1962; Usher, 1964).

Does this imply that perfect competition is more conducive to innovation? Well, on the one hand we may argue that perfect competition implies a high level of competitive pres-

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overview of the most important studies within this debate. As argued by Kamien & Schwartz (1982), the origination of the technology-push hypothesis is mostly associated with Phillips (1966), while the demand-pull hypothesis is attributed to the seminal work of Schmookler (1966). Actually, although Schmookler (1966) concentrated on the demand-pull case, he also emphasised the importance of technology-push, comparing the innovation process to a pair of scissors where the two blades have to interact in order to produce a result.

28. "Put another way, market structure influences the speed with which transient quasi-rents are eroded away by imitators. The relationship is presumably what Schumpeter had in mind when he declared that perfect competition was incompatible with innovation" (Nelson & Winter, 1982, p.280).

sure which may force the firms to innovate. On the other hand, the conditions which must be fullfilled in order to secure perfect competition may actually invalidate the rate of innovation. In a perfect competition setting, optimal resource allocation is supposed to occur when there is free entry and exit at the market place. Proft-maximisation behaviour secures that the productive resources are allocated to those markets where it is possible to earn a profit on the quantity of production where marginal costs equal marginal revenue. The information on which the economic agents act is the demand schedule of each market, i.e. the knowledge of how the quantity demanded is related to sales prices. Thus, price signals are the only type of information needed in a competitive setting.[29] However, price signals may not be sufficient to stimulate technical innovation. Lundvall (1985, 1988) argues that technical innovation entails an *information problem*, as far the relationship between producers and professional users are concerned.[30] On the one hand, successful innovations must be based upon knowledge about user needs. On the other hand, innovations "will diffuse only if information about its use value are transmitted to the potential users of the innovation" (Lundvall, 1988, p.350). In a perfect competition setting where only price signals prevails, the user is restricted from observing more than superficial characteristics of new products while the producer "does not get any information about user needs which are not already served by the market" (Lundvall, 1985, p.17). As a consequence, product innovation is severely restricted and occur more or less by accident.[31] In real life, product innovation is relatively abundant, and account for 3/4 of the effort devoted to technical innovation

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29. This assumes, of course, that the economic decision maker knows how to combine his production factors and which levels of cost is associated with each factor combination. The microeconomic theory used for this type of reasoning comprises three sub-theories: A production theory which explains the relationship between different combinations of production factors and different levels of output; a cost theory which attaches relative factor prices to the different levels of output; and a demand theory which depicts the relationship between quantity demanded and sales prices. In order to employ the sub-theories in economic decision making within a perfect competition setting, we have to assume that the economic agent have complete knowledge about the available factor combinations, their relative costs and the demand schedule.

30. The Lundvall argument applies to the context of business-to-business relationships, while he does not deal with business-to-consumer relationships. By doing so, he is in accordance with most of the studies within the technology-push/demand-pull debate. Actually, the business-to-consumer relationships are very rarely touched upon in the field of innovation economics. Exceptions occur, mostly in the analysis of diffusion of innovations, as in the seminal work by Rogers (1983).

31. As pointed out by Lundvall (1985), this is in line with the fact that neoclassical theory in general neglects product innovation. The information problem is less severe in the case of process innovation because innovation occur within the producing unit. However, even process innovation will be restricted in a perfect competition setting due to the small scale of operation that prevails across firms within that setting. A small scale of operation implies that the amount of resources that will be devoted to innovation is correspondingly small.

in most industrialised countries.[32] From a theoretical point of view, this implies that the empirical relationship between innovation and market structure seldom applies to what is expected in a perfect competition setting.

Obviously, an alternative to the neoclassical microeconomic theory of the firm is required in order to explain the phenomenon of innovation. From the point of view of microeconomics, one might suggest that innovation is analysed in terms of monopolistic competition (Chamberlin, 1933) and barriers to entry (Bain, 1956) within the comparative static framework normally applied by microeconomics.[33] However, the extent to which such an analytical scheme provides explanatory power depends, once more, on the nature of the information problem. The post-Keynesian analytical scheme is adequate in explaining cases where information is overt and transmitted in a once-and-for-all fashion. The scheme is less adequate in cases where information is less overt and requires a process of learning where users and producers familiarise themselves with user needs and product characteristics. In that case, we need a different way of describing the relationship between market structure and technical innovation. Consequently, what has emanated from the debate on the relationship between market and innovation is the concept of the *organised* market:

> The organised market is characterized by interactions between formally independent units and by a flow of information on volumes and prices. But it also involves relationships of an organizational type. Those relationships might involve flows of qualitative information and direct cooperation. They may take a hierarchial form, reflecting that one party dominates the other, by means of financial power or of a superior scientific and technical competence. (...) a purely hierarchial relationship will, however, often prove insufficient. Mutual trust and mutually respected codes of behaviour will normally be necessary in order to overcome the uncertainty involved.
>
> (Lundvall, 1988, p.352)

The reason why a purely hierarchial relationship is less efficient in promoting innovation is that a hierarchial relationship is embedded with information assymetries. To the extent that producers are able to dominate users, the producers may enforce new products and processess on users which do not correspond to user needs. This will happen in the case where producers possess some proprietory technological knowledge which they do not

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32. This figure roughly holds (Christensen, J.F., 1992), whether product innovation is measured in terms of the share of the number of important innovations (Pavitt, 1984) or in terms of the share of manufacturing R&D (Gjerding, 1996).

33. That is, instead of retaining the neoclassical conception of the firm, the microeconomist may resort to the post-Keynesian alternative. Zamagni (1987, ch.12) provides a nice overview of the post-Keynesian theory of the firm which is one of the antecedents of the large heterodoxy within the theory of the firm that developed during the afterwar period (Gjerding, 1996, pp.63-64).

share with the users in question. Conversely, users may impose certain technological solutions on producers which do not correspond to the technological capability of the producers in question. In both cases, producer capabilities and user needs will be insufficiently aligned and the direction of innovation will take a perverse course quite different from the one that would apply to a setting of smaller information assymetries. In circumstances of high levels of technological uncertainty these types of mismatch are likely to occur, unless the economic agents involved rely on mutual adjustment and trust. Consequently, what is now argued within innovation economics is that organised markets are not only characterised by elements of organisation, but also by mutual trustworthiness which minimises uncertainty by eliminating opportunistic behaviour.[34]

This is a conception of the relationship between market structures and innovation that deviates considerably from the standard microeconomic analysis.[35] It includes the notion of market power exerted through information assymetries, and it incorporates the idea that innovation is embedded with contingency factors that requires uncertainty-reducing organisational mechanisms at the market in order to become effective. While mainstream economics argue that the market mechanism represents the most efficient way of coordinating economic activities, innovation economics argue that the market must be endowed with interorganisational arrangements in order to achieve coordinative efficiency in cases where there is not complete knowledge about the characteristics of new products and processes.

The legacy of Schumpeter is clearly visible in this point of view. According to Schumpeter, the economic system may function smoothly as percieved by the marginalist economists in periods of time where changes occur simply as the growth of existing activities and do not represent any type of economic development. However, the marginalist analytical scheme looses its validity in cases of economic development where uncertainty occurs as to what the new competitive positions at the market place may be when new products, new processes, new ways of industrial organisation, new materials and consequently new industries emerge.

6. Technical change and international trade

International economics has traditionally focused on the process of exchange and resource allocation between two geographical areas, retaining the nation state as the unit of econo-

34. Actually, the idea of organised markets did not only appear in opposition to the neoclassical theory, but also as a criticism of transaction cost economics (Williamson, 1975; 1985), cf. Lundvall (1985, 1988).

35. Furthermore, it is a conception which is able to comprise the microeconomic analysis of monopolistic competition and barriers to entry.

mic decision making. The focus of attention is on how the growth and distribution of wealth is determined by the international division of labour that occurs as products and production factors are being traded. However, the way in which this relationship is analysed differs among economists.

To the classical economists, the generation of wealth depends on the division of labour. They argued that the splitting of composite tasks into smaller units increases the level of productivity and thus the quantity of production. The extent to which production can be increased through the division of labour depends on the size of the market. In consequence, relying solely on domestic markets increases the amount of wealth only to the extent that technical change contributes to the increase of productivity. Thus, foreign trade is percieved as a generator of wealth because it represents an extension of the market.[36] According to Adam Smith, foreign trade occurred because the trading nations had absolute advantages in production, and nations exported those goods which they could produce by smaller amounts of labour than other countries while they imported those goods where they had to employ larger amounts of labour. This analytical scheme entailed, however, the problem that foreign trade would not occur in cases where one country had an absolute advantage in all the goods subjected to trade. Consequently, something else was required in order to explain foreign trade. This "something else" was represented by the notion of comparative advantages proposed by David Ricardo, cf. figure 1.

Figure 1. *Comparative advantage*

Man-hours required annually for production in each country

Country Product	Clothing	Wine
UK	100	120
Portugal	90	80

Source: Adapted from Ricardo (1821, ch.7)

36. This point of view actually occurred in opposition to the mercantilist way of thinking which dominated economic theorising during the 16-17th century. To the mercantilists, the national wealth was equivalent to the amount of precious metals held by the nation's citizens - remember that metals constituted the means of payment at that time. The amount of wealth could be increased by maintaining a positive balance of trade, thus securing that some part of the stock of precious metals in foreign countries was transferred to the country in question. However, this was a zero-sum game and the increase of wealth in one country was associated with the decrease of wealth in the outside world. The policy advocated by the mercantilists was that the nation should maintain severe restrictions on imports and stimulate exports by processing imported cheap materials into high-price final products which could be exported. The classical economists opposed this beggar-your-neighboor strategy, claiming that an international division of labour would lead to an increase in the wealth of all nations through trade.

According to the Smithian analytical scheme, foreign trade does not occur in the case described in figure 1. Portugal enjoys absolute advantages in the production of both clothing and wine and thus should become the exporter of both. In consequence, foreign trade would not take place since UK is unable to pay for her import with export earnings. Contrary, according to the Ricardian scheme figure 1 represents a case where foreign trade will take place. Even though Portugal enjoy an absolute advantage in the production of both goods, UK has a relative advantage in the production of clothing in the sense that clothing is relatively cheaper than wine in UK as compared to Portugal, and *vice versa*.[37] In consequence, both countries will benefit from trade if UK specialises in clothing while Portugal specialises in wine. In the extreme case where UK ceases to produce wine completely and concentrates on clothing instead, productivity will increase by almost 17%, and, similarly, Portugal will experience an 11% increase in productivity if production is switched from clothing to wine. At the international market, productivity decreases in the production of clothing but this is more than compensated by an increase in the production of wine. Consequently, the amount of wealth increases in both countries.[38]

The Ricardian scheme clearly improves on the Smithian scheme but suffers, nevertheless, from a number of deficiencies. First, it assumes a constant level of productivity irrespective of the scale of production. This point of view is disputed by mainstream economics which argues in favour of falling marginal productivity. Second, it explains international trade from the supply side and ignores the demand side. In consequence, demand conditions are not allowed to influence the composition of trade. Third, it implies two different theories of value. The price of the goods produced is determined by the amount of labour employed in production if we consider the countries as closed economies. However, when we allow for international trade, thus considering the two countries as open economies, the price of the goods equalises between the two countries irrespective of the differences in labour productivity. In that case, the labour theory of value does not apply any more and the Ricardian analysis would have to resort to a market theory of value.

These deficiencies are addressed within mainstream neoclassical economics by the socalled factor proportion theory, often referred to as the Heckscher-Ohlin theory.[39] The H-

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37. If P denotes price, c denotes clothing and w denotes wine, the following inequality apply when we compare UK and Portugal: Pc1/Pw1 < Pc2/Pw2, where 1 stands for UK and 2 for Portugal. Thus, clothing is relatively expensive in Portugal, and Portugal would benefit from exporting wine and importing clothing. This and the following reasoning is inspired by Kjeldsen-Kragh (1977).

38. The distribution of the increase of wealth among UK and Portugal depends on the relative prices at which the goods are traded. But unless a perverse price relationship exists, both countries will benefit from trade.

39. The main line of reasoning within this theory was, initially, presented by the two Swedish

O theory does not focus exclusively on labour as the production factor which determines trade, but includes capital as well and explains foreign trade by the relative proportion of the production factors in the trading countries. The patterns of specialisation in international trade are determined by the relative abundance of production factors in the following way. Imagine that the production of clothing is capital intensive while the production of wine is labour intensive. Furthermore, imagine that UK enjoys a large supply of capital relative to labour while Portugal experiences a large supply of labour relative to capital. Thus, in the UK capital is relatively cheap and labour relatively expensive, and *vice versa* in the case of Portugal, and in consequence clothing is relatively cheap in UK while wine is relatively cheap in Portugal. The composition of trade between UK and Portugal depends on the relative prices of final goods, and so UK specialises in clothing while Portugal specialises in wine.[40]

While the Ricardian scheme assumes that prices are determined by labour value alone and treats the relationship between capital and labour in terms of fixed production coefficients, the factor proportion theory assumes that capital and labour can be substituted for one another and includes the relative factor prices in the explanation of trade. The prices of the final goods traded at the international market is determined by the interaction between the supply side conditions and the demand schedule.[41] Thus, the H-O theory goes far beyond the scope of the Ricardian scheme in the sense that it combines explanations of both the determination of factor prices, income and prices of final goods.[42]

However, although the factor proportion theory remedies the deficiencies of the classical approach, a number of critical points may be advanced. First, the assumption of perfect

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economists Heckscher and Ohlin. Heckscher presented the main theory in 1919 in his article on "Utrikshandelens verkan på inkomstfördelningen" ("The effect of foreign trade on the income distribution", printed in the journal *Ekonomisk Tidsskrift*). Ohlin later elaborated the theory in his *Interregional and International Trade* (1933). The present paper resorts to Kjeldsen-Kragh (1977) for the explanation of the Heckscher-Ohlin reasoning.

40. The outcome of this process is a redistribution of income to the benefit of the abundant production factor at the expense of the scarce production factor. This applies to the extent that barriers to trade are absent. In the case of barriers to trade, income is redistributed to the benefit of the scarce production factor at the expense of the abundant production factor. This type of reasoning is associated with the Stolper-Samuelson theorem, initially presented in 1941 by W. Stolper and P.A. Samuelson in "Protection and Real Wages", *Review of Economic Studies*, Vol.9.

41. This is done within the line of neoclassical reasoning explained previously: At the supply side, the cost of production is determined by the production function and the cost function. At the demand side, the quantity demanded depends on the price of the final good. The interplay between the supply schedule and the demand schedule determines the equilibrium output at which profit is maximised, i.e. the point where marginal cost equals marginal revenue. See also footnote 29.

42. As argued by Kjeldsen-Kragh (1977, p.27) who claims that the H-O theory represents "a conquest as compared to the Ricardian theory" (my translation).

international markets may obviously be questioned on the same grounds as argued previously. To some extent, this problem is solved by including barriers to trade as in the Stolper-Samuelson reasoning. Second, the H-O theory assumes that capital is immobile and remains within the national borders. However, capital is far from immobile and transcends the national borders, in fact to an increasing degree. Third, the analytical method employed by the factor proportion theory is that of comparative statics. Thus, the stimuli to capital formation and technical change provided by international trade are excluded, and the H-O scheme is unable to capture the dynamic processes of growth and innovation described in the previous sections. In conclusion, although the factor proportion theory represents a scientific progress in the sense that it does, in fact, remedy the deficiencies of the classical explanation of international trade, it also represents a theoretical repercussion. Consequently, an alternative may be advocated.[43]

The alternative presented by innovation economics represents a combination of the Smithian notion of absolute advantages and the Schumpeterian notion of creative destruction. At the core of this approach is the idea that the composition of international trade, and thus the international division of labour, is determined by national differences in technological, organisational and financial *capabilities* rather than relative factor endowments.

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43. Other lines of criticism which may be advocated in opposition to the factor proportion theory include the way in which the theory treats production factors. First, it is assumed that the production functions are the same in the trading countries, but, for instance, "technology is very different in industrialised and developing countries" (Kjeldsen-Kragh, 1977, p.62, my translation). Second, the production factors are treated as homogenous which they are not. For instance, labour "may be more or less educated. The labour forces in an industrialised country and a developing country are, in fact, two different types of production factors" (Kjeldsen-Kragh, 1977, pp.62-63, my translation). This aspect was first touched upon by Leontief (1954, 1956) who analysed the international trade of USA and concluded that the American export was relatively labour intensive as compared to the American import. This result appeared quite astonishing from the point of view that capital is relatively abundant in the USA; in fact, it became known as the Leontief paradox. Leontief's results were subsequently scrutinised and subjected to criticism. One line of criticism related to the way in which Leontief measured the production factors. For instance, it could be argued that the level of education in the American labour force is relatively high. Thus, if education is regarded as an investment, the American export would appear to be more capital intensive than measured by Leontief - this argument reflects the notion of human capital. Another line of criticism related to the composition of trade. For instance, the American economy is relatively short of raw materials, and since the extraction of raw materials is capital intensive the American import becomes capital intensive to a larger extent than if the import of raw materials had been ommitted from the analysis. Furthermore, the American export comprises a relatively high proportion of high technology products, the development of which is labour intensive. Thus, if Leontief had taken the technology gap between USA and its trading parters into account, the paradox would have been less clear. However, despite the criticism, the Leontief paradox had a significant impact on the validity of the factor proportion theory because it forced a number of theorists to elaborate and amend the H-O scheme. Subsequently, the ensuing discussions lead to a gradual dismissal of the factor proportion theory.

These differences create technology gaps which reflect the process of creative destruction and form the basis for absolute advantages. In consequence, international differences in export performance and world market shares can, to a high extent, be explained by differences in innovative activities and productivity. There are three main arguments in favour of this conclusion.

First, the national composition of industrial activity determines in which areas of industrial activity the country in question specialises in international trade. For instance, Denmark has been able to gain more than average market shares in the field of equipment for food production due to a close relationship between the producers and users of such equipment. The development of an advanced manufacturing sector which processes primary products into food products for consumers have spurred the need for food processing technology, and to some extent these needs have been fullfilled and further refined through interaction between the manufacturing users and producers (Lundvall, 1985). This development reflects the evolution of what has become known as *development blocks* (Dahmén, 1988), i.e. strong and dynamic relationships between different lines of production and trade. These relationships provide stimuli to technical and organisational change and thus creates absolute advantages in terms of technology and productivity in the lines of production and trade which belong to the development block in question.[44]

Second, the levels and changes in income and income distribution provide an important stimulus for innovation and the development of absolute advantages. Opportunities for innovation are more likely to occur at high income markets where the composition of demand has shifted away from primary to secondary needs, implying a more sophisticated pattern of demand. Thus, countries which are characterised by a high per capita income enjoy more opportunities to develop and specialise in industrial fields that require a high and sophisticated level of technology and scientific knowledge. As income grow, the number of innovative opportunities increases, and consequently productivity may grow, partly due to the innovation process and partly due to the growth of markets. Simultaneously, productivity growth translates into the growth of income, thus stimulating the entire process.[45]

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44. The evolution of development blocks enters as part of the Schumpeterian creative destruction by creating structural tensions within the national economy. However, a development block may, in time, hamper competitivenes to the extent that the maturing of the development blocks exhausts the opportunities for innovation. Andersen (1992) provides an interesting discussion of structural tensions and the evolution of patterns of international specialisation.

45. This virtous circle of growth is not without exceptions, of course. The effect of and on productivity depends on the industrial structure, i.e. the way in which the various lines of production and trade are related (Kaldor, 1966, 1967; Cornwall, 1977). Furthermore, productivity may actually decline in times of rapid technical change if the organisational requirements needed in order to master technical change are not fullfilled (Gjerding et al., 1992). Furthermore, as

Third, the existence of technology gaps provides an important explanation of the difference between nations regarding the specialisation of international trade patterns.[46] High income countries which enjoy a superior level of income, high levels of R&D and a developed infrastructure are more likely to be located at the forefront of technological progress and thus have absolute advantages in a number of industrial affairs. The direction of these advances depends on the industrial structure, as argued previously, and countries located at the technological forefront may continue to develop new advantages based on their technological and commercial lead. The ability to develop a lead in new fields of industrial affairs is important, since the existing leads may deteriorate as countries located behind the technological forefront experience increasing markets for the products associated with the lead and learn to imitate the technological progress at the front.[47] Historical experience shows that countries located at the technological forefront may fall back while others assume their positions as world leaders (Maddison, 1982), and recent analyses have, in fact, proved that the international productivity differentials associated with technology gaps have diminished during the afterwar period, partly due to economic growth and increasing levels of domestic and foreign direct investments (Abramovitz, 1979; Maddison, 1991). This observation has lead to the notion of technological congruence, i.e. the idea that countries behind the technological forefront should adopt industrial structures similar to the ones characterising the lead countries in order to remove the productivity differentials. An important assumption behind this notion is the belief that technological progress is transferable by way of investments. However, a number of studies during the last fifteen years have indicated that the matter may be somewhat complicated. As pointed out, different countries enjoy different types of advantages and their pattern of specialisation reflect previous industrial and economic developments. Furthermore, the exploitation of technological progress depends on the *social capability* of the country in question. It is only partially dependent on investment, since it requires the accumulation of experience in practical use, the training of relevant parts of the workforce, and furthermore, in many cases, a national support structure in terms of knowledge-creating institutions and industrial and economic policy.[48]

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products become mature, production may be internationally relocated, partly due to an increasing importance of price competition and a decreasing level of technical and commercial uncertainty. This insight was first adopted by Vernon (1966) within a product life cycle perspective.

46. Hufbauer's analysis of the international location of the production of synthetic materials provide an important seminal work on the nature and effects of technological gaps (Hufbauer, 1966).

47. Thus, the lead time is determined by two components, i.e. a demand lag and an imitation lag.

48. The notion of social capability is to some extent inspired by the Japanese exprience on industrial development and policy and can be traced back to Ohkawa & Rosovsky (1973). The notion has gained widespread acceptance among scholars researching technology gaps, e.g.

The different elements of the innovation economics alternative are still being researched somewhat individually be different researchers, but some attempts have been made in order to construct a coherent theory. Dosi et al. (1990) provide an important attempt to unify the three arguments put forward above. The notions of industrial linkages and social capabilities have been carried further by a number of scholars and have evolved into the notion of national systems of innovation which provide a framework for analysing the interorganisational relationships within a national economy not only in terms of relationships among industries and firms, but also among industries, firms, and the technological, educational and political infrastructure (Lundvall, 1992; Nelson, 1993; Edquist 1997). Finally, recent work has merged these contributions into an analysis of the causes and effects of globalisation (Archibugi & Michie, 1997).

7. The epistemology of innovation economics

Initially, the present paper argued that the birth of innovation economics might be analysed as the outcome of a paradigmatical struggle on how to analyse technical change and, consequently, on how to perceive the functioning of markets. The discussion showed that innovation economics contradicts the basic assumptions of neoclassical mainstream economics and may be described as "new classical" in the sense that it retains the macro perspective of classical economics and describes how the economic system evolves through contradictions and change. The last section elaborates on this perspective by briefly exploring the epistemological nature of innovation economics.

Following the typology provided by Burrell & Morgan (1979), it may be argued that mainstream economics and innovation economics are similar in the sense that both of them adopt an objectivistic approach. Scholars within both traditions search for regularities and causal relationships, and claim that it is meaningful to construct categories of representative economic behaviour. However, they differ to the extent that economic behaviour is seen as creating order or conflict. Mainstream economics are occupied with equilibrium positions that are supposed to create need satisfaction which result in behavioural cohesion.[49] Contrary, innovation economics argue that economic behaviour reflects differences that result in and are stimulated by structural tensions which imply change. Innovation economics is mostly occupied with disequilibrating conditions and argue that although certain macroeconomic relationships, such as the capital-output or investment-GDP ratio, may be fairly

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Abramovitz (1986) and Fagerberg et al. (1994).

49. Actually, it may be argued that behavioural cohesion is as much a prerequisite as a result of the equilibrating movements of the economic system, since the assumptions of behaviour are designed in order to facilitate equilibrium solutions to the analysis.

stable during long periods of time, the qualitative nature of the economic system changes, and the apparent stability at the macro level reflects disequilibrium processes at the levels of industries and firms (Chiaromonte & Dosi, 1993). In consequence, the objectivistic endeavour of innovation economics has been preoccupied by creating typologies of behaviour which reflect the processes of structural tensions.[50]

While mainstream economics has been occupied with building theoretical models which reconstruct reality as something that can be observed but operates independently of the observer, the Schumpeterian legacy has prompted innovation economics to focus on regularities and breaks within the social fabric. Hidden behind these different endeavours are differences in the assumptions about human behaviour. Although mainstream economics has pictured the human as a self-interest seeking individual, the individuals have been treated as profit-calculating maximisers acting according to a stimulus-response mechanism. This position is equivalent to the extreme objectivistic position described by Arbnor & Bjerke (1997, ch.2). Following the typology proposed by Arbnor & Bjerke (figure 2), we may argue that innovation economics, in contrast, has understood man as a social fact in the sense that "society and its parts are seen as *an organically evolving process* that is concrete in its nature but ever-changing in its details" (Arbnor & Bjerke, 1997, p.28). Thus, in the attempt to explain enitireties in their regularities and breaks, innovation economics has moved away from the extreme objectivist position. Recent contributions have even taken innovation economics farther. At the heart of the critique of mainstream economics, innovation economics has stressed the importance of interactive learning in the creation and processing of information (Lundvall, 1988; 1992), and in continuation of the attempt to develop the concept of national systems of innovation the modern economy has even been described as a *learning economy* (Foray & Lundvall, 1996). As part of this theoretical development, attempts have been made in order to develop a theory on how formal and informal institutions interact with processes of learning (Johnson, 1992; Edquist & Johnson, 1997). In consequence, some innovation economists are pressing towards a comprehension of human nature, where man is seen as an *information transformer* or perhaps even as a *role-player* and *symbol-user*.[51] However, this perspective is still to be developed within innovation economics, and a classification of innovation economics as understanding patterns of social interaction in terms of symbolic discourse is not justified. For the time being, as the ideas of national systems of innovation and the learning economy are gaining

50. Such typologies have for instance been used to characterise innovation (Dosi, 1982, 1988; Freeman & Perez, 1988), the innovative relationships between industries (Pavitt, 1984), and the process of innovation at the level of the firm (Kline & Rosenberg, 1986; Christensen, J.F., 1992). Even when innovation economists divert themselves into the realm of subjectivist analysis, they tend to create typologies, cf. the work by Nonaka & Takeuchi (1995).

51. These terms are taken from the vocabulary from Arbnor & Bjerke (1997).

acceptance within the international community of innovation economists, the field is moving towards a medium position of figure 2 where economic behaviour is reconstructed in terms of information.

The approach to this reconstruction is contextual in the sense that innovation economics focus on systemic regularities. The overriding paradigm of innovation economics may be characterised as a processual systems approach in the sense described by Arbnor & Bjerke (1997), meaning that innovation economics searches for causal relationships between components which each comprises an interrelated set of components.[52] A good example of the approach is the concept of national systems of innovation which are supposed to comprise a number of interacting subsystems, both at the macro, meso and micro levels. The subsystems are open and co-evolving, i.e. they mutually represent the context for change of each subsystem. At each level of aggregation, major sets of subsystems are identified, and these *supersystems* interact in order to create new supersystems at higher levels of aggregation.

Figure 2. *Six social science paradigms*

Continuum	Ultimate reality presumptions	Ambitons for creating knowledge
Extreme objectivism	Reality as concrete and conformable to law from structure independent of the observer	To reconstruct external reality - the empirically general one
Medium positions	Reality as a concrete determining process	To explain entireties in their regularities and breaks
	Reality as mutually dependent fields of information	To reconstruct contexts in terms of information
	Reality as a world of symbolic discourses	To understand patterns of social interaction in terms of symbolic discourse
	Reality as a social construction	To understand how reality is constructed, maintained and defined
Extreme subjectivism	Reality as a manifestation of human intentionality	To develop eidetical insight instead of an empirical one

Source: Adapted from Arbnor & Bjerke (1997), table 2.1, p.27

52. Actually, Arbnor & Bjerke (1997, p.111) define a system as "a set of components and the relations among them".

Analysing the interdependences between the systems often takes a structural perspective as its point of departure where the constituent features of each systems are accounted for, but the subsequent analysis employs a processual perspective in order to clarify how the components and interdependences change over time. Thus, the analysis progresses from static to dynamic structures, including both regular and nonregular processes. Although homeostatic processes are often invoked, the main emphasis is on processes of positive and negative feedback which result in change through learning.[53]

In conclusion, innovation economics may be characterised as a medium-objectivistic, processual systems approach occupied with sources of economic change. Traditionally, innovation economics has been a descriptive and explanative discipline dealing with phenomena that are inexplicable within mainstream economics. Along these lines, innovation economists have with increasing success deviced a new body of theory, another grand narrative, which in time may substitute the generalisations of mainstream economics.

53. Thus, following the approach of Arbnor & Bjerke (1997, ch.5), we may say that innovation economics often refer to servomechanic models, or what Arbnor & Bjerke (1997) term biological systems models, but in general perceives systems as open, learning and structurally changing, i.e. what is termed the self-organizing systems model (Arbnor & Bjerke, 1997, pp.121-25).

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