

Long term innovation waves – the potential dissonance between Europe and Asia.

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The paper is in a very preliminary form!

The main idea of this paper is to put the present economic situation into a long term historical perspective and discuss the prospects of new innovation waves and their implications for Europe and Asia. In this version of the paper, the Asian perspectives are restricted to China, while Europe is treated with some more detail.

In the first section, a historical generalization is presented from the observation of different structural epochs in modern economic history, forming long waves. In the following section, some general implications are discussed regarding economic growth and innovations for the next decades of upswing in a new long wave out of the present crisis. Furthermore, the structure of two innovation systems – based on formal science and market-led interaction respectively – are contrasted in relation to assumed trends in innovation. The final section opens a discussion on conditions for innovation and growth in Europe and China (Asia) over the next decades.

A historical framework of big waves and long waves

The framework is a long term pattern of three *big waves* in the economic history of the modern world, or a sequence of three industrial revolutions

- The first industrial revolution took off in the late eighteenth century with steam engines and the factory system as the major innovations. It was geographically centered in Britain and on the Channel.

- The second industrial revolution accelerated from the late nineteenth century with the electrical motor, the combustion engine, sophisticated machinery industry and scientifically based industries. This revolution had a geographically widened center with Germany/Continental Europe and northeastern USA (the North Atlantic economy) as leading parts.
- The third industrial revolution was a the late twentieth century phenomenon with the breakthrough of microelectronics and with knowledge intensive interaction between industry and services. Once again, the geographical strongholds widened considerably with Western USA and Eastern Asia (the Pacific Economy) joining the old the North Atlantic Economy.

Furthermore, there is a pattern within each big wave with two structural epochs of about 40-50 years forming *long waves* or long cycles. The first long wave comprises the period of the industrial revolution and is focused on the technological breakthrough of radical innovations in the production sectors. The second long wave, on the other hand, is focused on the wider infrastructural, social and institutional developments, seeing the radical innovations develop into General Purpose Technologies, becoming part of the backbone of social organisation. Historically, the second waves have entailed the following enlargement of the radical innovations:

- From the 1850s and 1860s upswings with the wider constructions of railway networks, telegraphs and so forth combined with institutional adaptations to enlarged global interaction.
- From the 1930s and 1940s, upswings (really gaining momentum in the 1950s) with the wider social diffusion of combustion engines and electrical motors, with institutional adaptations to the industrial mass consumption society.
- Following the same pattern, one can envisage an upswing from the 2010s with the wider diffusion of networks and infrastructure based upon microelectronics (Internet) integrated with other means of communication, with institutional/juridical adaptations to these new conditions.

These sequences fit largely to the observation, which Nikolai Kondratieff made in the 1920s, of long waves back to the first industrial revolution. Since the time of Kondratieff, long waves of roughly 40 years have reappeared. Each long wave has been demarcated by international or global crises that have been both financial and structural in character. Such crises occurred in

the late 1840s, early 1890s, early 1930s and mid-1970s. These crises have been the lower turning points in the long waves. They were all preceded by decades of increased competition and fierce rationalization and they were succeeded by decades with decisive thrusts of long term investments, enlarging capacity in new trajectories of growth that brought forward radical innovations and transformed structures.

So far, the events around 2010 combine the characteristics of prior financial and structural crises and, furthermore, appear according to the time pattern of the long waves.

Long term pattern of innovation waves

1790s - First Industrial revolution

1850s- New infrastructure / institutions

1890s- Second Industrial Revolution

1930s- New infrastructure / institutions

1970s- Third Industrial Revolution

2010s- New infrastructure / institutions

The waves have had a number of common characteristics. Two such characteristics should be emphasized in this discussion; namely, shifts in relative prices and diffusion of industrialization. The Kondratieff observation of long waves in the international price level was largely corroborated by Walt Rostov's analysis of relative prices. Rostow indicated trend periods in the relative price of primary to secondary goods with a rising ratio in the upswing phase of the long wave that fits to shifts in demand for primary goods in periods of long term investments into new capacity, and to shifts in supply from that capacity when it was fully installed in the later stage of the wave. Historically, these waves saw an increased demand for raw materials in investment booms and a subsequent widened production capacity. Furthermore, in each wave, the global economy was enlarged. With increased investments and expanding new trajectories of growth, new industrializing economies and emerging markets have appeared. In the expansive phase, diffusion of modernization and

industrialization has stimulated demand in the global economy but over a couple of decades competition has increased with aggravated imbalances and widespread structural crises at the end, increasing pressure towards structural transformation.

The historical pattern of waves and structural crises also indicates that the modern society still evolves over epochs with certain stability or inertia, i.e. certain institutions and structures stay stable over periods of roughly the same length despite the fact that the pace of change in a number of areas is increasing over time. In this evolutionary perspective, structural crises are critical, since during such events a broader spectrum of choice of future trajectories are open within a rather narrow time-frame of opportunities, until the mechanism of path dependency increase over the wave. In this perspective the present crisis is structural, and raises a number of long term issues to handle with indications of a possible shift of future trends.

Trends in growth and demand for innovations during the next decades

Two major trends may be forecasted: In the recent wave, during the past decades, the widening of the global economy has been unprecedented in scope with the Chinese and Indian growth. The increase in the supply of labour has been enormous. This widening will continue to put a downward pressure on the relative price of labour in large segments of both industry and services – particularly when the labour process is fairly standardized. On the other hand, demand pressure will increase on goods intensive in natural resources such as construction materials, energy and food. This is particularly so, since output increases in this area need long term investments, which during the construction phase tend to further increase demand for material and energy (cf. the Rostowian relative price cycles between primary and secondary sectors). Price increases of energy and material may be further sustained by measures taken to restrict climate change. Thus, knowledge and innovations that enhance the supply or reduce the demand of energy, material or food may be richly remunerated over a period of some decades (until competition in such innovative areas increases again).

Knowledge of energy intensive processes both in traditional industries and in new areas such as biotech will be important to meet the challenges. The next step in the microelectronic revolution into nanotechnology and its fusion with biotechnology may create important new development blocks in these areas.

Secondly, income growth and relative price changes will shift demand towards new services with little material content. This will be particularly pronounced among medium and high income earners and thus, on an aggregate social level, in high income nations. So far, both USA and Europe have been dominant in advancing new consumption patterns. That has been due to factors such as income levels, the role of consumption in economic growth and the degree of openness in societies. Indian and Chinese growth has to a large extent been dependent upon consumption growth in Western economies. This should be a major advantage of European (and US) innovative sectors, being close to new trends in social behaviour, particularly since the coming second wave of the third industrial revolution will very likely have a strong focus on the wider social diffusion and consequences of the microelectronic revolution.

To Europe, though, this is a very pertinent question and challenge since the innovative pressure will be strong in the service sector, where Europe has been lagging to the USA due to obstacles to integration and flexibility that still have to be overcome.

Innovation in the learning economy

In studies of innovation and innovation systems, two distinctly different mechanisms are distinguished. On one hand, there is the science and technology-based innovation process, labeled STI, and, on the other hand, there is the experience-based learning process, labeled DUI (Doing-Using-Interacting).

The STI process has been much in focus for policy. It is characterized by investments in universities, in research institutes and in R&D, mainly by large firms. It is also characterized by increased interaction between these organizations in National Innovation Systems and by a greater number of trained academics in all organizations.

The STI system is advantageous when it comes to following a technological trajectory and to exploit possibilities at the frontier of knowledge. It is also of great importance for the ability to import and adopt technology and innovations at an early stage.

The DUI process puts emphasis on interaction in different respects, between groups of employees within the firm, between employees in different firms and, perhaps most of all, between firms and customers. Innovations come out of learning from experience and from

tests of a multitude of ideas. It goes without saying that DUI is more important in innovative areas related to new consumer behaviour and to social change.

The structure of DUI processes means that such innovations tend to come out of less hierarchical organizations, built up with rather autonomous groups that are open to communication. The process is of course still dependent upon a high level of knowledge among employees – and particularly upon problem solving abilities on all levels related to the doing-using-interacting functions.

In reality, the STI and DUI systems are not totally separated from each other since all processes relies upon formal knowledge and science to some extent as well as on experience and communication. It is however held by innovation economists that they dominate different spheres of the economy and characterize different economies.

Furthermore, it was largely the second industrial revolution that created the basis for the STI innovation processes. It was from the end of the nineteenth century with the breakthrough of more sophisticated technology that cooperation between universities and industry really started and that large firms established laboratories for R&D, superceding experience-based trial and error. The third industrial revolution, however, created scope for much broader interactive innovation processes within firms, between firms and with consumers. While STI processes will be fundamental in opening up new spheres of knowledge and innovative trajectories, particularly regarding the use of natural resources, the broader array of services and consumer goods in future growth, increase the importance of DUI processes.

The two major trends in growth have different implications for the innovation procedure. On one hand, the increased pressure on natural resources will increase also the pressure to advance knowledge in science-based technologies. Thus, innovations in the areas such as energy, materials, medicine and food will be highly valued. On the other hand, shifts in demand to services and to virtual economies will induce innovations related to new consumer behaviour and thus build upon interaction and trial-and-error in a more open evolutionary manner.

While the first trend may be met by concentrated efforts that to some, but only to some, extent have a better fit in rather more hierarchical organizations and societies, the second trend is definitely dependent upon an open society with flat organizations with close connections to experimenting consumers.

These trends may create windows of opportunities as well as challenges to the major economies in the world over the next decades. They will also create a new set of goals and new conditions for catching up processes over the same period.

Trends in growth and innovation systems

Among mechanisms behind global growth, two are particularly important – *innovations* that shift the technology frontier and *catch-up* with the leaders in different sectors. The closer the economy is to the frontier of production and consumption possibilities, the more dependent the economy is upon innovation for further growth, i.e. upon the ability to turn knowledge and learning into new combination of resources, while the mechanisms of catch-up (such as structural change from agriculture to industry and services, increase in capital intensity, transfer of technology) will approach depletion or decreasing marginal returns.

In each wave, a number of new countries have caught up with the leaders. That does not mean, however, that catch-up will disappear or even diminish as a mechanism in global growth. Firstly, new countries will enter the global scene, increasing competition upon late-comers such as China and India. Secondly, there is still much scope for catch-up in India and China and other emerging markets. Thirdly, scope for catch-up reappears over and over again during modern history since, in the upswing of the waves, some economies forge ahead when able to open up innovative trajectories and shift the frontier outwards – in some cases catching-up economies even have had the drive to forge ahead with very strong connections between knowledge creation institutions and production sectors (such as in the USA, Germany in the late nineteenth century and in Japan in the late twentieth century, at least in some sectors). It is likely though that the very strong catch-up drive behind growth in parts of Asia over the last decades will taper off. What are the prospects then of innovative behaviour in Europe and Asia? First, a few remarks are given on the US position.

The leading US economy is to some extent very fit to meet many of the challenges. It has great potentials in both STI and DUI processes of innovation. USA was also the leading economy in both the second and the third industrial revolutions. The present challenges facing the USA are however to a large extent of a different character than advancing new radical innovations. Basically the challenges are more social in character with the adaptation of institutions to a number of new imbalances. In that sense, the situation shows a greater similarity with the crisis of the 1930s which put a heavy transformation pressure on US politics. Around 2010 the challenge is to come to grips with the imbalances that have emerged

in relation to foreign markets and to natural resources due to a too lavish consumption. While, on one hand, the political and economic US hegemony has weakened in face of growing competition, the US demand for resources has, on the other hand, stayed at a high level both from consumers and from the global political apparatus. In particular, the American life-style developed during two centuries with an extremely rich supply of natural resources is at stake. Innovative change in direction of economizing with natural resources, above all with energy, would show a new American leadership, involving as well a rearmament of the social and material infrastructures.

The European economy clearly faces new possibilities but also challenges of adaptation to a new competitive world and of catching up in new areas. The Lisbon strategy addressed some of these challenges, mainly from the new growth trends in the USA in the 1990s, advocating enhanced knowledge intensity in Europe with a more rapid shift to an economy driven by innovation and services. It also entailed a number of European cooperative efforts in typical STI systems of knowledge creation and innovation, such as the enormous venture into the ESS centre in Lund.

A new European handicap to the integrated United States of America has emerged out of the third industrial revolution with the potential of large scale service integration that became very visible with the expansion of Internet and globalization in the 1990s. One of the major political challenges that confront Europe is within services, where markets to a large extent are fragmented nationally, despite decades of increased integration. Transformation pressure is augmented upon national social systems that were strengthened out of the crisis of the 1930s – particularly in small open economies such as in Scandinavia and the Netherlands.

Conditions for innovation and growth are however very different in different parts of Europe. That is due both to macroeconomic circumstances and economic structures at large but also to differences in systems of innovation and learning organizations. These conditions have shifted radically over the last decades as is shown in table 1, and new trends may be perceived from the 1990s.

Tabell 1. Annual percentage growth in GDP per capita and GDP per capita in international dollars of 1990 price level in European regions 1951/1955–2005/2009.

	Northwestern Europe	Continental Europe	Southern Europe	Central- and Eastern Europe
Annual percentage growth in GDP per capita				
1951/1955–1971/1975	2,8	4,0	4,9	3,8
1971/1975–1988/1992	2,0	2,0	2,5	0,4
1988/1992–2005/2009	2,2	1,3	1,8	2,3
GDP per capita in international dollars of 1990 price level				
1951/1955	7 958	5 406	3 377	2 315
1971/1975	13 812	12 095	8 942	4 998
1988/1992	19 439	16 964	13 741	5 354
2005/2009	28 297	21 274	18 634	7 844

Ann.: Northwestern Europe: Irland, Great Britain, the Netherlands, Denmark, Norway, Sweden, Finland and Iceland; Continental Europe: Austria, Belgium, France, Germany and Switzerland,; Southern Europe: Portugal, Spain, Italy och Greece; Central- and Eastern Europe: Poland, Czech Republic, Slovakia, Hungary, Yugoslavia, Bulgaria, Romania, Estonia, Latvia and Lithuania.

Källa: Maddison; The Conference Board.

The overall picture of European growth is clear. In the post-war period of high growth rates, there was a strong convergence with rapid growth in economically more backward regions of Southern, Central and Eastern Europe. The whole of Europe was catching up with the USA, but there was a strong internal catch-up with the more affluent Northwestern Europe as well. During the crisis-stricken decades of the 1970s and the 1980s, growth rates slowed down and the catch-up process withered, both externally and internally. Over the last roughly twenty years, since around 1990, a new pattern has emerged. The growth rate increased in Northwestern Europe and in Central and Eastern Europe, while there was a further deceleration of growth in Continental and Southern Europe. Thus, growth accelerated in the richest and the poorest part of Europe – divergence and convergence co-existed.

These differences in growth performance may be discussed in relation to structural conditions to meet the new innovative waves of IT and globalization that took off in the 1990s. In particular, work organization and systems of innovation changed but with different characteristics in different parts of Europe.

Adaptation to new conditions of growth from the 1990s was most significant in Northwestern Europe. Structural change in private enterprise was combined with new economic policies. Thus, macroeconomic measures, such as tax reforms, were undertaken in order to increase flexibility and labour supply. Even new political constructions were launched to meet the needs of both flexibility and social security, such as the Danish flexicurity in the 1990s. The Scandinavian countries and the Netherlands also took the lead in Europe as well as worldwide in changing the organization of work within the companies. The hierarchic taylorist or fordist model gave way for an organization where more responsibility was allocated to the employee who was expected to solve problems on his or her own and where knowledge creation and learning developed in a more interactive form both within the company and with customers. With this structural change, the innovation process of the DUI type was strengthened. These countries also performed very well with two critical and complementary investments – in IT equipment and English. They were able to adapt to the new conditions of globalization at an early stage. Once again – as in the 1930s – small open economies in the northwest of Europe showed an apt reaction to a structural challenge.

The two other countries in Northwestern Europe – Great Britain and Ireland – certainly were well prepared in respect of the complementarity between IT and English as well. Ireland could furthermore profit from educational reforms undertaken in the 1960s, enhancing supply of well educated labour from the 1980s, while Great Britain took advantage of global expansion in services. Work organization in these Anglo-Saxon countries differed however overall from Scandinavia and the Netherlands. It was characterized by “lean production” in the Japanese sense with a work organization that was more structured or bureaucratic and with more narrowly defined tasks of problem solving for the employee. In general, learning processes were weaker and more concentrated to the upper layers of the hierarchy.

In continental countries such as Germany and Austria work organization was close to the Scandinavian or Dutch type with more discretionary learning processes undertaken by the employees. In France, on the other hand, organization was closer to the British or the Irish type with a more standardized labour process. The weak economic performance of this group

of countries may partly be seen as greater difficulties in adapting to new conditions of growth – not least with the strong complementarity between global services, IT and English – but it was also the result of the great economic strain that arose in the 1990s from the German unification.

Deceleration in growth was similarly very marked in Southern Europe. In this region structural difficulties were furthermore augmented over the period into the 2000s. Favourable catch-up conditions were to a great extent exhausted while competition from expanding economies in Eastern Europe and from China became more severe. Above all, however, work organization in all these Southern countries was still either taylorist in character or traditional with a rather low knowledge intensity. That probably made them more vulnerable to the new low-price competition in manufacturing. One may envisage a higher structural threshold into a new phase of more innovative and integrated learning processes.

The expansion in Central- and Eastern Europe was very much of a catch-up character, largely driven by strong growth in manufacturing industries in countries with traditions in this area such as Poland, Czech Republic, Hungary and Slovakia, now open to the market economies. The former planned economies have certainly scope for further catch-up – showing growth figures over the last decade in manufacturing exports of machinery, vehicles and other equipment that are close to Chinese performance – but they will probably be rather weak players in terms of innovations over the next decades.

Asian economies are on very different stages in terms of economic growth and development, confronting different challenges for the future wave. On one hand, there are economies such as Japan, South Korea and Taiwan at income levels comparable to the OECD average with similar situations as many European countries and with internal differences in economic structure. On the other hand, there are the catch-up giants China and India that will have a strong impact both on the Asian and the global economy in the near future. And there are countries and regions in Southeast and South Asia that are candidates to become new low cost and high growth industrializing economies.

In this discussion, I will concentrate upon the Chinese perspectives since their future path will be very significant for the over all development. In an absolute sense and at the macro level, China has clearly advanced to a position close to the global frontier in terms of total gross domestic expenditure on R&R (GERD), second only to the United States and Japan. In relative terms, the Chinese level is certainly much lower than in most OECD countries but the

R&D intensity has increased rapidly – with R&D expenditures rising from 0.6 to 1.4 percent of GDP between 1995 and 2006.

The innovation system still has a number of weaknesses, though. The OECD review of the Chinese innovation system concluded that some “framework conditions for innovation are insufficiently conducive to market-led innovation, especially those relating to corporate governance, financing of R&D and technology-based entrepreneurship, and enforcement of intellectual property rights”. It also concluded there was a too great separation between knowledge producers and potential users and regions of science parks, which appear as “a very large number of ‘innovative islands’ with synergies insufficiently developed between them, limiting spillovers beyond them”.

With the strong orientation in the catch-up process to manufacturing for foreign markets, such weaknesses of institutions for market-led innovation are understandable. It is also quite natural that Chinese R&D is mostly dedicated to experimental product development while expenditure in basic research has been low. Furthermore, patenting has been dominated by foreign firms in China, while exports of high-technology goods have been strongly, and increasingly so, dominated by foreign owned companies or by joint ventures with foreign companies.

In the upswing from the present crisis, China will face the need of profound structural transformation. On one hand, international price development will probably turn negatively for the Chinese specialization hitherto, with price increase in the primary and tertiary sectors and with a further relative price decrease in the secondary sector of manufacturing. That will be particularly the case if industrialization keeps its global momentum and spreads to new regions of low-cost labour. Furthermore, consumer demand for Chinese exports from the American and European markets may weaken due to policies to get rid of current imbalances. On the other hand, internal pressure for transformation will probably increase; particularly if the present global crisis is prolonged with the two main driving forces over the last 15-20 years – investments and exports – faltering. Demand will increase for social reforms and regional balance within China, which is a situation similar to the one that confronted industrial countries in the crisis of the 1930s.

Such reforms will raise consumption and wages. Higher wages and social expenditures will strengthen internal growth and make it better balanced, but profits will fall within those companies that have been a mainstay in growth so far. Productivity will have to be raised

further, particularly when confronted with competition from new low-cost countries or regions. This is a transformation pressure that all industrial countries have to confront and react to. A number of smaller Asian countries have done so in a rather orderly fashion and very successfully since the 1960s, while industrialization has been diffused to new countries. Over the next years, the Chinese leaders clearly meet with needs for reform – one problem may be that reforms to strengthen consumption and regions in Western China will at the same time work against the interest of groups in Eastern China that has become prosperous and established interests over the last decades. That is a particular challenge to the political leadership in an economy that is both market-driven and planned.

The prospects for the effect on R&D and innovative capacity are mixed. Such reforms may, on one hand, reduce R&D investments in the short run but, on the other hand, they may improve the degree of market-orientation in R&D and innovation in the longer run. Above all, they may create scope for lower but sustained growth rates in China over the next wave.

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