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**DRIVING FACTORS AND CHALLENGES FOR THE EU INDUSTRY
AND THE ROLE OF R&D AND INNOVATION**

EXECUTIVE SUMMARY

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I. Background

According to industrial economist theorists, in the last three decades global industrial organization has been determined and structured by few large forces with their own internal dynamics:

- New technologies that enable the relocation and control of distant industrial operations (including R&D) and the creation of new markets for mass and customized mass production;
- Flexible labour and regulation (fiscal, product, safety, health, etc.);
- Deregulation of capital flows to enable specific industrial operations to be considered as cost/profit centres, thus facilitating FDI and fast relocation (or re-assignment) of industrial activities.

These three global drivers have led to changes in global patterns of industrial production and posed great challenges for industries and countries with a small proportion of domestic capital involved in international production of goods and services. For those economies with firms that can operate at the global level, these drivers have produced benefits in the form of greater efficiencies and the ability to profit from rapid innovation and fast changing markets. Currently, nations (in some instances, trade blocks) compete on several fronts both to conquer new international markets for final and intermediate goods and to retain critical industrial sectors that work as multipliers for their national economies. This has produced new challenges the outcomes of which for the global pattern of industrial production are largely unknown.

It is well understood by policy makers in leading and competitive nations that the level of investment on knowledge infrastructures, R&D and innovation is strongly related to the current and future competitiveness of their industries. It is also well known that the creation of a competitive edge involves a long process of knowledge and skills accumulation at the societal level. Given the fact that economic resources are limited, innovation and R&D investment must be targeted towards strategic areas that will potentially function as economic multipliers. In the case of the EU, industry faces the challenge not only of remaining competitive in traditional sectors but of becoming a forerunner in a new market environment where competition is *for* markets, not *in* markets. Here R&D and technological innovation play a central role. But is sustainable to try to increase R&D, innovation and creativity? There are indications that European industry is struggling with these challenges. Visions and policies at national and EU levels will undoubtedly be important in determining future outcomes. This study enriches what is already known about the industrial organization and institutional landscapes by, taking into account demand side trends. It identifies some clear trends from the huge complexity, that should challenge industrial and innovation policy design to be more targeted, especially in terms of the three main forces referred to above.

Section two of this Executive Summary provides a brief review of the overall methodology used in this report. A more detailed description and discussion is included in each main chapter of the report. Section three presents a summary of the global trends and technological developments affecting markets. Section four, based on global demand, supply and institutional side trends charts the main challenges for European industry in the medium term. Section five highlights the challenges for European competitiveness and Section six outlines the broad policy implications and the role of innovation in confronting the challenges raised by global trends to European competitiveness.

II. Objectives and methodology

This study was designed to be a preliminary to much wider research on the outlook for EU industry in the long-term. The present study had two main objectives:

- To identify and analyse the main socio-economic and institutional driving forces that are likely to shape world markets to 2020.
- To trace the links between these driving forces and the likely evolution of European industry and the challenges that the EU economy will face in the future.

The analysis of the drivers and challenges that will confront European industry in the medium term demonstrates the need to link the determinants of competitiveness with competitive performance. Both these aspects have been widely studied at the level of products, services, industrial sectors, nations and regions but no comprehensive theoretical framework has been developed to analyse competitiveness that takes account of emerging supply, demand and institutional side trends. This study is ambitious in its aims to link global level trends with trends at the European and sector levels.

The study is based primarily on desk research and analysis. It builds on existing studies and is exploratory in nature. The work of the research team has been complemented by insights from a number of experts in different areas of enquiry relevant to this study (i.e., economics of technical change, industrial economics, international economics and prospective technology studies). In order to achieve the two objectives, four tasks were designed:

- Task 1: Identification of the main drivers affecting the shape of future markets over the next 15 years;
- Task 2: Analysis of the implications of the insights gained in task 1 for EU industry, and particularly for its competitiveness;
- Task 3: Identification of industrial sectors of strategic interest to the EU and those particularly affected by the outcomes of tasks 1 and 2.
- Task 4: Organization of a one day expert workshop to elicit constructive criticism and validation of the results of the research

The selection of drivers (or important issues) to be included in the study was based on the expertise of the research team and insights gained during the review. The final selection of topics to be included was achieved by cross referencing different sources and identifying convergence on issues of relevance at global level. The selection was based on a morphological method for policy analysis and guided by the notion of the role that R&D and innovation might play in measuring up to the challenges identified. The definitional system created in the conduction of a morphological analysis can be considered the first step in identifying a set of relationships that underpin a set of hypotheses and a theoretical model. Thus, this report represents a first step in the design of a general model that integrates demand, supply, institutional and emerging economy aspects to test the relationships between competitiveness and economic growth. The number of challenges we identified was large and it is not possible at this stage to account for all potential effects. Although we give an indication of which drivers are considered to be the most relevant and deserving of policy intervention we do not pretend to make an exhaustive prioritization across all themes and drivers. We acknowledge the cognitive limitations of the research team to account for all implications for the future of EU industry implied by the drivers identified. The reader is invited to conduct his or her own analysis.

III. Global trends shaping markets

World production and consumption systems and associated institutions are in a greater state of flux than ever before. Science and technology (S&T) is playing an important role, and can be likened to the ancient oracles. In the face of new regional and global trends the European economy must expect huge challenges. In particular, those industries characterized by medium-advanced technologies (e.g., automotive, steel, textile and clothing, footwear, etc.) face both threats and opportunities with the entry

of new players into global production systems, and the emergence of new markets. The *global trends* that are likely to shape the world market up to 2020 are *classified into three broad categories* that provided a structure for the report: *demand, supply and institutional settings*.

Demand side

On the demand side we searched for those trends where solutions are needed via the provision of services, and new social and institutional infrastructures from the supply and institutional sides. We examine *global challenges* in general and *consumption trends* in particular. Global challenges are the major cross-border issues that affect the whole of society. They are problematic and their resolution requires careful discussion, appropriate measures and observation over several years. Global challenges are necessarily on the international political agenda, and require collaboration between countries. *Global challenges* are identified by international organizations such as the United Nations (UN), G7/G8, OESO, OECD and the European Union (EU). From the literature the following *global trends* were identified: *ageing populations, climate change, environmental degradation, epidemics and pandemics, global shifts in economic power, increasing pressure on health care, over-exploitation of natural resources, overpopulation, pervasive globalization, social equality, sustained economic growth, terrorism and pervasive insecurity* as being among the most immediate priorities. Consumption trends are directly related to income and growth levels. As population and economic growth have continued to rise over the last three decades, levels of consumption have also increased. *Key global consumption trends are energy, materials usage and waste, water, mobility, urban concentration and food.*

Supply side

On the supply side we are witnessing some *fundamental changes in the organization of production* in the industrial system and in the multipliers of economic activities arising from the S&T infrastructures. These changes are influencing what will be on offer in global markets over the next 15 years. These global trends can be summarized under five headings. *First*, in terms of the organization of production increasing the role of *knowledge* is an important *source of economic value*. The generation of new knowledge, through innovation, has become the key driver of competitive advantage at firm and country level. In the new knowledge economy, public organizations supporting innovation (S&T policies) and a variety of public and private organizations producing and diffusing new knowledge in the industrial system have assumed a key role (entrepreneurial firms, entrepreneurial universities, innovative firms, etc.). *Second* there is increasing openness in the system along several dimensions. Markets have become more open to international competition and to globalization of production and distribution of products, services and knowledge. Firms have become more open, increasingly outsourcing activities, widening their supply chains, and relying on collaborations with external parties for R&D, innovation and production. *Third, networks are becoming increasingly important*. Industrial firms increasingly see themselves as network organizations whose competitive advantage depends more on their ability to interact in order to connect technologies, people and organizations, than on a their own R&D investment. *Fourth* there are *new scientific and technological paradigms shifts*, which include advanced biomedical sciences, cognitive sciences, molecular biology, etc. Underpinning these are whole new areas of economic activity and business models, such as cleaner environmental processes, effect-based security operations, effective health care, smart housing, sustainable agriculture, etc. *Finally*, there has been an upsurge in the *emerging economies and production centres* that is changing the balance of trade and financial flows at global level.

Institutional side

Institutions provide the structures that hold, organize and sustain market functioning. Five global trends were identified concerning global institutional structures in relation to production and consumption. These were increasing globalization in a context of innovation and rationalization, trade-offs from intellectual property rights enforcement, international outsourcing and labour markets, organizational change as a trigger for competitiveness and unrestricted financial markets.

The interaction between globalization, technological progress and organizational change is 'knowledge-biased' at all levels of the workforce. As far as labour markets in the developed world are concerned, global competition and outsourcing would seem to imply either an increase in unemployment or an increase in income inequality and labour market deregulation. A possible alternative to these trends might be achieved through greater competitiveness derived from innovation and increased productivity. In particular, economic policy should encourage product innovation in high-tech sectors and in those sectors characterized by higher income and demand elasticity. At the same time, technological and organizational change is imposing increasing demands on knowledge-based workers and combining the three angles of innovation, organization and human resources management seems the only way to efficiently compete with emerging economies in the long-run (as opposed to short-term responses such as decreasing wages, increasing wage dispersion and increased labour flexibility). Here the only feasible alternative to the "race to the bottom" strategy to face competition from the emerging economies appears to be an efficient combination of technological and organizational innovation with effective education and training policies, both at the national and European levels.

Emerging economies

Emerging economies are a new source of challenges to European competitiveness. Traditionally emerging economies were considered recipients of medium and advanced technologies and providers of cheap labour and markets for consumer and durable goods. In some sectors, this picture has gradually but radically changed in the last decade. We examine two of the most relevant emerging economies – India and China - and attempt to draw some conclusions about the latest developments in these emerging economies.

India's real GDP accelerated in 2003/2004 to its highest level in over a decade. At 8.2%, real GDP growth was double that recorded in 2002/2003, when India suffered its worst drought for over 15 years. This remarkable recovery was spearheaded by agriculture where growth reached 9.1% in 1996. Industry grew by 6.7% and services grew by 8.7%. This development is the result of an ambitious reform programme introduced after the country's balance of payments crisis in 1991. There was a marked willingness to begin an effective shedding of its hitherto dirigisme economy and to introduce industrial and trade liberalization, and financial deregulation. Policies conducive to privatization and FDI were introduced, along with improvements to India's regulatory systems. These reforms helped to accelerate the country's hitherto dismal rate of growth which followed the years after its independence in 1947. The 1991 reforms built upon the 1980s reforms which were "fledgling" by comparison.

India has undertaken sterling measures in its attempt to move from being a regional economic power to a world economic powerhouse. However, it still faces some challenges. The economic momentum of the early part of the 1990s and the average growth rate of 7% per year up to 1997 have not been maintained. Exogenous factors such as droughts, high energy prices and earthquakes have been partly responsible for the slowdown and to understand India's, or any other country's growth it is necessary to understand its ongoing problems as they have the potential to sideline progressive growth. India should guard against complacency over the amount of progress that has been achieved. *The country faces many challenges including deregulation of its labour markets, revitalization of agricultural growth and increased infrastructure investment.* There have been calls for India to privatize and deregulate beyond what has already been achieved.

China's economic growth has averaged just less than 10% a year over the past 25 years. China has emerged as a production hub for all kinds of products. It is manufacturing products that are being produced in the US and Europe, such as home appliances, automobiles and a wide range of components. It is also producing technology intensive goods, such as flat screen televisions, chips and military aircraft. It has introduced new standards in mobile phones and video compression (the Enhanced Versatile Disk – EVD). China is a major player in capital-intensive sectors, such as automobiles and commercial aircraft assembly. The labour-intensive industries in Europe, such as textiles, apparel and shoes, are already facing huge competition from China. There are signs that Europe's furniture industry will be the next to suffer competition from China. However, the lower priced low labour cost New Member States may counteract this threat to an extent

Although we can expect that *China will continue on its path of growth, it too faces several challenges*. It has a declining fertility rate and a *fast growing ageing population*, which may result in labour force problems. The majority of its population still lives poverty, and the income gap is growing. Disposable incomes are rising bringing a taste for stylish products, including imported goods. China faces a critical shortage of skilled and experienced workers, despite its efforts to improve the educational and skills levels of its population. China's socio-economic challenges require non-ideological state intervention to deal with the practical problems that the market alone may not be able to solve. China needs to reform its financial system as this has the greatest potential in the near future to trigger system disintegration. There are other challenges that are beyond the remit of this report. A comprehensive understanding of these challenges will provide better insights into China's current and future growth. History has shown that China can experience huge policy reversals.

IV. Global trends: Implications for European Industry Competitiveness

This section provides some insights concerning the global trends identified in the previous section and their implications for European industry and particularly its competitiveness. There are some macro economic implications; i] structural and organizational changes in industrial activities; ii] scale and sectoral composition; iii] research, technological development and related requirements; iv] human resources, skills, labour market conditions; v] localization of economic activities, infrastructure; and vi] framing conditions for investment attractiveness. The exploration of these themes required us to define what we understand by competitiveness and the competitive process. Given the prospective nature of the study we focused on the front end of the competitive process, thus, we saw the six themes listed above as inputs in terms of preparedness for future competition. Furthermore, it was necessary to define the boundaries of these themes in terms of what would be affected by the global trends identified. As this study has been conducted at a rather general level there will be some inconsistencies and some important drivers, challenges and implications will have been overlooked. Despite its limitations, however, this report identifies some unarguable factors which are summarized below.

Regarding the *structure, organization and sectoral composition* of industrial activities in Europe a few global trends were considered to have immediate relevance. On the demand side there include : the ageing population; on the supply side they include globalization, the entrepreneurial economy, the service economy, open innovation, new technologies and new inventions; and on the institutional side they include IPRs, and organizational change. The implications of these global drivers and challenges for EU competitiveness were considered against three indicators: industry structure, industry dynamic and sectoral distribution.

On the demand side, the population of retired people expected by 2010 can be seen as the potential next generation of entrepreneurs. It is well known that individuals who become entrepreneurs late in life, after retiring from a former occupation, have different characteristics from younger entrepreneurs. They tend to be less risk averse. They bring the experience accumulated in their previous job into their new ventures. There will be new opportunities from the creation of new markets (and social costs)

related to care and long term health. The challenge for EU industry is to match the new market opportunities arising from the changing nature of market demands, and the new supply of entrepreneurial skills and human capital, with new business propositions, products and services.

On the supply side, there are some divergent implications from globalization for EU industry. International trade could potentially enhance the competitive position of established firms if they manage to exploit the scale economies from larger markets and larger supply chains. By increasing variety in demand, globalization creates new market niches that can be exploited by entrepreneurial firms. However, increased competition from emerging countries may lower the chances of survival of new and small firms that lack the necessary resources and institutional support to scale up and take advantage of global opportunities.

To accompany the potential new wave of entrepreneurs, there is a need to promote entrepreneurial activity in Europe as this is commonly regarded as a source of competitiveness and economic growth. The challenge for government is to design public policies that reduce structural barriers to entry and the liabilities of new firms in their formation stage. Industry must create a favourable ground for the creation of new firms, for example through venturing activities by established firms (e.g. joint-ventures, spin-offs, technology incubators, etc).

The implications of technological change for industry structure and dynamics are shaped by the nature of technology. New research paradigms that destroy or disrupt the technological capabilities of established firms, create opportunities that are more likely to be identified and exploited by new firms. In contrast, technological advances of a more incremental nature strengthen the capabilities and competitive advantage of established firms, and increase the barriers to entry in combination with R&D sunk costs.

The new model of 'open' innovation has been increasingly adopted by leading firms, to organize their innovative activities and increase innovative performance. This model also favours the creation and success of entrepreneurial firms, which can benefit from strong relationships with established firms. The challenge for government and industry is to increase the commitment of businesses and institutions to open innovation, collaborations and knowledge transfer. For small firms to survive in the long term in the face of these new forms of organization of innovation, government and industry must favour the creation, through an effective IPR regime, of a market for technology that provides both new and established firms with alternative means to commercialize their ideas and gain economic returns from innovation. A further challenge is related to the emerging trend towards an open model in the production and dissemination of knowledge, which affects firms of different sizes to different degrees. This new model of commercialization of innovation requires new managerial practices and organizational arrangements. The challenge for industrial firms is to develop new practices that enhance internal capabilities (by mobilizing available skills and human capital) and external capabilities (by drawing on external collaborations and social capital).

In terms of *research, technological development and related requirements* this study briefly explored some of the research implications of the drivers and trends analysed. It does not undertake an exhaustive study of the research fields that these trends suggest; many far-reaching and comprehensive foresight and technological forecast studies have developed detailed analyses of demand trends and socio-economic conditions, and technological and scientific capabilities and proposed detailed technological and scientific strategies. Here we underline some of the general fields of R&D activity derived from the initial analysis of demand drivers and identify some general traits.

First, and most importantly, all the drivers mentioned have a bearing on a variety of research disciplines, technologies, and industrial sectors. Similarly, most R&D areas impinge on several drivers.

Further, the technologies mentioned here draw on knowledge from a variety of research fields.¹ It follows, therefore, that from a policy perspective, it is unadvisable to “bound” areas of research, technological and innovation policies within single disciplines or user communities. Policy design and implementation, as well as policy analysis, must be based on interdisciplinary, and “systemic” approaches. Second and related to the above, many of the areas of activity we describe in this study are no longer “purely industrial.” For many problems, solutions include a combination of novel products and different ways of organizing either production, delivery, or maintenance. For instance, increased energy efficiency in transport depends, not only on more efficient engine technologies (an industrial issue), but also on new traffic management systems to counter congestion. The development and implementation of the latter may be connected to services rather than to industry.

Third, many of the scientific and technological developments referred to in this, and many foresight studies, are of an incremental nature. Most of the areas mentioned are already the subject of public R&D programmes and have been the subject of focused policy initiatives for some time. New capabilities need to build on existing scientific and industrial resources. Fourth, innovation is not only a technical pursuit. Regulatory environments and other socio-economic conditions are crucial to the deployment of many of the technologies discussed in this report, and, at times, they are even the main focus of change (for instance, the dispersion of technology controls to address security concerns). Often, research on socio-economic issues will be necessary to support the construction of adequate socio-economic conditions and institutional environments for the application of technological solutions to social problems.

On the subject of *human resources, skills, labour market conditions* five dimensions are defined the boundaries of the theme. These are globalization and technological change; employment impact; employment and new technologies; skill bias and increasing wage inequality; globalization and skills: challenges and possible solutions; and Innovation, organizational change and human resources management. The main implications of these dimensions in the face of global trends and challenges identified in Task One are outlined below:

Globalization and technological change, and especially the pervasive use of ICT, has renewed debate concerning the relationship between technology and employment. The fear is that international outsourcing and new technologies have weakened the positive correlation between growth and employment. The problem here is the paradox of the apparent inverse relationship between the direct labour-saving effect of international outsourcing, the beneficial indirect effects of export-led growth and the unpredictable job opportunities from new innovations. This is particularly important in terms of European competitiveness. Indeed, product innovation represents the “high road” to international competitiveness as an alternative to cost-cutting process innovation, lower wages and worsening labour market conditions. From this point of view, the challenge posed by the emerging economies should be faced not with a “rush to the bottom” in terms of labour-saving process innovation and wage cutting, but rather through labour-friendly product innovation both in high-tech sectors and in the innovative niches of traditional ones.

The net employment impact of globalization and the diffusion of new technologies depends on the balance between process and product (service) innovation and on the effectiveness of different compensation mechanisms via decreasing prices and new investments. Against this background, the challenge to competitiveness challenge posed by globalization and advanced technologies requires European economic policy efforts to strengthen both the providers of the new technologies (such as telecommunications, biotech sectors, electronics and nano-technologies and so on) and the users of the new technologies. Amongst the latter, advanced services assume a crucial role as a focus of a targeted industrial policy

¹ See for instance, the five yearly studies conducted in France to identify “key technologies” (CMI International 2000).

The advent of strong competition from emerging economies, together with new technologies implies a change in the relative ratio between skilled and unskilled workers with the demand for labour shifting in favour of the former. This tendency in the labour market can imply either lower wages for the unskilled or higher unemployment rates among the unskilled. Hence, authorities should promote interaction between the public education and training system and the private demand for skills, to maximize economic performance. However, the widespread diffusion of the “skill bias” as a global trend will require greater investment in education and training to sustain long-term European competitiveness. Thus, the challenge for policy is to find the right combination of increased education and training and interaction between the public education and training system, and the private demand for skills, in order to maximize economic performance and Europe’s competitive advantage.

The last main challenge from the current waves of technological progress and globalization concerns the organization of the workforce at firm level. The empirical evidence suggests that the massive organizational changes required at firm level can be summarized as decentralization and de-layering, collective work, and multi-tasking. Blue collar workers face an increased risk of redundancy when exposed to globalization and labour-saving organizational and technological changes. Blue-collar workers are not necessarily the victims of an intrinsically labour-saving process of globalization and technological change; but they are negatively affected by an inefficient mix of these phenomena with organizational change that demands new working practices. Human resource management and education policies could mitigate the impact of globalization and technological change upon the most vulnerable workers.

With respect to the *location of economic activities*, according to general wisdom, the main factors affecting the retention and attraction of economic activities to a specific location are the cost and availability of educated and skilled labour, degree of labour unionization (deregulation of labour markets), fiscal incentives (tax exemptions), infrastructure, regulation (health, safety, environmental), how easy it is to open and close businesses, social and government stability and internal market consumption. In relation to these factors the main drivers and challenges found to have direct implications for Europe in the face of global change were the ageing population; energy availability and price; mobility and trade; off-shoring, trade and environment; knowledge infrastructures and innovation science; and emerging economies.

Off-shoring is a concern not only for Europe, but also, according to the literature, for all economies. It is important to make an assessment based on reliable statistics of the types and numbers of jobs (especially white collar jobs). This involves gathering data across all member states and in relation to the international trade balance. How will the trade balance behave in the long term? Some main implications for the EU were identified. First, the size of the ageing population will increase after 2010 and reach a peak in 2050. This is likely to make a large proportion of the labour force relatively more expensive and less flexible. Second, the recent trend in steeply rising energy prices is likely to continue with the advent of emerging economies that will increase the demand on fossil fuels. This could have a strong negative effect on economic activities, and reduce the trend in relocation of manufacturing based on cheap labour in the short term. However, it will likely trigger innovation on alternative energy sources and transport systems. Third, and closely related to second point, the movement of merchandise has hugely increased the demand for transport services in recent years. This trend is expected to continue depending on energy prices, trade liberalization and its impact on environment.

Fourth, concerning regulation especially environmental protection, safety and health, experience has shown that intensive energy and natural resources business are more likely to relocate to countries with cheaper sources of energy (e.g., oil and hydraulic). Fifth, In high tech sectors we can expect an increase in competition based on knowledge structures and struggles for the market underpinned by innovation science and technology. Sixth, the trend towards international collaboration and

subcontracting of R&D and innovation – sometimes known as open innovation – brings challenges in the form of public investment and subsidies for R&D. If moved off-shore who benefits?

Last, emerging economies appear to be being more successful at attracting and expanding FDI. This must be assessed against the social cost incurred by the host nations in order to learn from others' experience. Traditionally the off-shoring of industrial activities has been cost based mainly in relation to unskilled labour. Recently this trend has come to include the whole spectrum of business operations from unskilled labour to smart outsourcing of R&D, management and marketing. It is not clear what is the relative social cost of sustaining the “right conditions” to foster economic activities. The challenge in the face of new forms of off-shoring for Europe, given its diversity in many areas, is to strike a balance, and set thresholds for how far we can go in setting the conditions to retain and attract new investments. There has been a deterioration in the welfare state. It is clear that if Europe opts not to follow the models of emerging economies - where the disparities between the highest and the average earners are huge - innovation, innovation science, and strong knowledge infrastructures to create and retain jobs and re-insert layoff workers (mostly older workers) as support for the institutional frameworks to ensure returns from investment in R&D and innovation will be crucial.

With regard to framing the conditions for *investment attractiveness*, the prospects for the growth of global FDI flows will rise if economic growth becomes more widespread. Further corporate restructuring, the persistence of profit growth and the continuing pursuit of new markets will likely lead to more foreign investment. Furthermore, the continued need of firms to improve their competitiveness through innovation and new markets, alongside the need to reduce costs and access natural resources and strategic assets, such as new technologies and knowledge, from abroad, will provide incentives for further FDI growth. For developed countries, improved profitability of trans-national companies will likely trigger greater merger and acquisition activity, which in turn could increase levels of FDI. If Europe is to remain competitive, efforts must be made to maintain and improve investment policy, investment promotion and facilitation, trade, tax and competition policy, corporate governance, and general public governance, and human resources development. The EU with an expanded number of developing country Member States, will want to draw in much needed foreign investment as direct investment yields greater economic benefit to the host country in terms of acquisition of skills, knowledge and technologies, job creation, higher standards of living, etc.

The introduction of business-friendly policies and practices does not necessarily serve as an attraction for FDI. The enforcement of these policies is a paramount feature of investment promotion measures but care must be taken to ensure that they are not too complex or difficult to implement. Potential investors need to be assured that they can operate in a risk-free, stable and predictable environment where the rule of law effectively applies. Europe needs to ensure that such an environment is pervasive, and that property, whether intellectual or physical (intangible and tangible), will be safe from misappropriation or destruction. Europe needs to demonstrate that it is a region that is attractive to foreign investors through the advantages and benefits that they may reap.

V. European competitiveness: Patterns of drivers and challenges

This exploratory study aimed: (i) to identify and analyse the main socio-economic and institutional driving forces that are likely to shape world markets in the next 15 years; (ii) to trace the links between these driving forces and the likely evolution of European industry; (iii) to identify the challenges that the EU economy will face in the future. The achievement of these aims involved three main tasks. First, identification of the main drivers affecting the shape of future markets over the next 15 years;

second, analysis of their implications for EU industry competitiveness; third, based on tasks one and two, identification of industrial sectors of strategic interest to the EU.

Unlike other studies that have focused on one aspect of the demand-supply-institutions system, this exploratory report defines the main elements of the system in some detail. However, the amount of detail and the number of issues and variables involved makes the report rather dense. In this section, we summarize and highlight the most relevant aspects identified in the report, concerning global trends and European competitiveness. This report should, however, be seen as a first attempt to identify relationships between global trends and drivers, current conditions, and policy implications for European competitiveness over the next 15 years. A draft version of this report was put out for review by a number of experts and, despite the huge amount of information it contains, the level of agreement and convergence in the comments of these reviewers on what issues should be seen as the most relevant, was high.

The report identifies many drivers and challenges which made the task of prioritizing them difficult. Due to the lack of discrimination between endogenous and exogenous drivers, and the implicit interrelationships between the themes relating to competitiveness, the patterns identified are far from unequivocal. Despite these shortcomings some overall and specific patterns concerning the determinants of European competitiveness were identified.

There is an *overall pattern* in which different trends have different relevance in the themes and the sectors analysed. In many cases, there are some factors that are important in some themes, but which are fairly irrelevant in others. The exceptions here are globalization and emerging economies, which are very relevant in all the themes and sectors analysed. It should be noted that these two drivers are intrinsic contributors to global economic integration. Another important pattern is the cluster of drivers on the institutional side (IPRs, outsourcing and effects on labour markets, organizational change, and innovation and rationalization), which are also relevant to all themes and sectors analysed and have been the subject of some of the recent literature. Other known drivers of competitiveness identified in the analysis were shown to be less important. These include ubiquitous computing, the availability and cost of energy, and mobility trends. Some entirely new patterns related to European competitiveness emerged, including the ageing European population; the emergence of markets for technologies in conjunction with high technology manufacturing; sustainability and the environment; increasing reliance on human resources for science and technology; the increasing interdependence between services and manufacturing; and the rise of innovation science.

More specific patterns can be identified when we look at the areas that define the necessary inputs for competitiveness at European. First, somewhat surprisingly, the demand side cluster of drivers and challenges for *structural, organizational and sector composition* were not found to be sufficiently relevant to have a significant impact on the industrial organization of European industry. This is most likely due to the level of aggregation and abstraction in the analysis, a hypothesis that is supported by the fact that some trends were found to be relevant for the competitiveness of the three sectors analysed. On the supply side, the cluster of trends including innovation as source of competitive advantage, globalization, new research paradigms and innovation waves was found to be highly relevant. All these trends had relevance for the institutional side and for emerging economies.

Second, in the case of *research and science and technological development requirements*, demand side global trends were identified as important challenges in the next 15 years. These include the ageing population, climate change, epidemics and pandemics and globalization, energy, raw materials usage and waste, water and mobility. On the supply side the response of science and technology will be moderated by the level of government support for it, the increasing reliance of firms on the 'open innovation' model to create synergies and reduce risks, and the increasing reliance on human resources and lack of skills. In addition, the requirements of science and technology development will be mediated by the increased level of innovation waves such as effect based security; new concepts for governance, health and food safety, the information society and sustainability.

Third, in terms of *human resources, skills and labour market conditions* there are a few demand side global trends that are relevant. These include the ageing population and its impact on the cost of labour and pensions, global shifts in economic power, pervasive globalization and social equality. Supply side drivers, such as the growing role of the service sector in the economy, the emergence of markets for technology and the increasing reliance on human resources for science and technology. All institutional side aspects (innovation and regionalization, IPRs, international outsourcing and organizational change) and the emerging economies were considered highly relevant.

Last, with regard to the patterns of trends and drivers at sector level and their likely effects at European level, we can say that overall our hypothesis is valid. That is, it is clear that global trends and consumption trends will have an impact on the structural, organizational and sectoral composition of the European economy. In the European level analysis in Task two these effects are not discernible, but are definitely identified in the sectoral analyses.

VI. Policy implications - The role of R&D and Innovation policy

Here we highlight the main policy implications of the insights and discussion based on the patterns described above. First, the ageing population must be taken account of in industrial policy and competitiveness. The large numbers of elderly people are expected to promote the creation of new markets for products and services (including leisure), put pressure on government expenditure on care and health services, produce a new breed of entrepreneurs and affect the capacity of regions to retain and attract economic activities given their cost structures. Innovation is required in the institutional arrangements that facilitate the retention of talent including the introduction of flexible retirement arrangements and financial mechanisms that enable experienced people to start up businesses. The ageing population demands the coordination of several streams of policy linked to industrial and innovation policy (e.g., health, immigration, pensions, labour, etc.).

In the 1980s and 1990s the upsurge in inter and intra country trade in intermediate goods led to structural changes across the economy, Currently, changes in R&D and Innovation are occurring and having similar effects. The new model of *open innovation* has been increasingly adopted by leading firms to organize innovative activities and increase innovative performance. This model favours the creation and success of entrepreneurial firms, which can benefit from collaboration in innovative activities with established firms. This is confirmed by the sectoral analyses in this study. The three sectors surveyed (telemedicine, aeronautics and traditional and cleaner environmental technologies) are characterized by the fact that they integrate and source not only intermediate goods from other sectors but also R&D and innovation. The role of and challenge for government policy is to increase awareness, commitment and skills in relation to the systems integration of businesses and institutions to enable them to operate successfully in an environment of open innovation, collaboration and knowledge transfer. This will be especially important for small firms. If SMEs are to survive in the context of open innovation, government and industry must encourage an effective IPR regime to provide a market for technology that provides both new and established firms with alternative means to commercialize their knowledge and innovations in order to reap economic returns from them. The new mode of commercialization of innovation requires new managerial practices and organizational arrangements. The challenge for industrial firms is to develop new practices that enhance internal capabilities (by mobilizing available skills and human capital) and external capabilities (by drawing on external collaborations and social capital).

For *research and technological development and their related requirements* we highlight some of the general fields of R&D for which policy implications have been identified.

First, all the trends and drivers identified have some implications for the variety of research disciplines, technologies, and industry sectors. Similarly, the innovation waves and research paradigms identified draw on knowledge from a variety of research fields. Thus, from a policy perspective, it would not be sensible to “bound” research, technology and innovation policies within single disciplines or user communities. Policy analysis, design and implementation must be based on interdisciplinary, and “systemic” approaches (exemplified by this current report). Second, many of the issues covered in this report have connotations that go beyond mere industrial policy (e.g., the ageing population and the environment). The solutions to many of these challenges require a combination of novel products and different ways of organizing their production, delivery, and maintenance. Here, the service sector will assume great importance. Third, most of the research paradigms mentioned have already been the subjects of public R&D programmes and focused policy initiatives, and have produced incremental innovations. Some of the challenges will require new knowledge and capabilities to build on existing scientific and industrial resources (environmental sustainability). Fourth, and most importantly, *innovation should be related to human social behavioural change*: all three types of innovation - technical, organizational and institutional change are needed to ensure a better quality of life for citizens. Thus, a direct policy implication is that regulatory environments and other socio-economic conditions are crucial to the deployment of many of the technologies discussed in this report and should be the main focus of change (for instance, technology used to address security concerns). A consequence for research policy is that research on socio-economic issues will be necessary to support the establishment of socio-economic conditions and an institutional environment enabling the application of technological solutions to social problems.

In terms of *human resources*, there are three policy issues related to skills and labour market conditions. First, globalization and technological change and the labour-saving effects of international outsourcing present a critical challenge for European competitiveness. The impact on employment of globalization and the diffusion of new technologies depends on the effectiveness of different compensation mechanisms via decreasing prices and new investments that facilitate fast reinsertion of displaced labour. Thus European economic policy should support both the providers and the users of the new technologies. Second, the emerging economies combined with new technologies, are likely to induce a change in the relative ratio between skilled and unskilled workers in favour of the former. This will affect the labour market in two ways. On the one hand, this change is already resulting in lower wages for both unskilled and skilled workers, and higher unemployment among low skilled workers. On the other hand, the reduction in wages has been accompanied by increases in productivity and profits. This has two particular policy implications. In terms of competitiveness, there is a need to promote public education and training and re-training systems to satisfy private demands for skills, in order to maximize economic performance. Also, blue collar workers will be exposed to a higher risk of redundancy in the context of globalization and labour-saving organizational and technological changes. Human resources management and education policies may be able to mitigate the impact of globalization and technological change upon the most vulnerable employees.

In relation to the *location of economic activities and investment attractiveness* four issues should be highlighted. First, the net effects of off-shoring in the last 20 years have been positive concerning profits and productivity and negative on wages.² Thus, there is a need for industrial policy related to smart outsourcing to benefit local jobs and wages while boosting productivity and profits. The design of such a policy should consider the trends in the average age of European country populations bearing in mind that a large proportion of the labour force will become relatively more expensive and less flexible from 2010, reaching a peak in 2050. Second, high energy prices are likely to continue as a result of increased demand. This will likely have a negative effect on economic activities and affect the relocation of manufacturing activities dependent on cheap labour. The policy challenge here is to ensure reliable sources of energy for the EU, while putting in place the framework conditions required for investment in alternative sources of energy and new transport systems. Third, in terms of regulation related to environmental protection, and health and safety, experience has shown that

² See for example *The Economist* (Sep 16, 2006, p.14).

energy and resource intensive businesses are more likely to relocate to countries with cheaper energy sources. Fourth, if Europe is to remain *competitive and attractive to investors* in a context of unrestricted global FDI flows it must maintain and improve investment policy, investment promotion and facilitation, trade, tax and competition policy, corporate governance, and general public governance, and human resource development. The introduction of business-friendly policies and practices and their enforcement through good regulation will be necessary to attract investment. Potential investors need to be assured that they can operate in a minimum-risk, stable and predictable environment where the rule of law applies. In this regard European policy and regulation should ensure that intellectual and physical (intangible and tangible) property will be safe from misappropriation or destruction to persuade investors of the benefits to be gained. The challenge of this package of policies will be to strike the right balance between the benefits to be derived from investment and the effort involved in attracting it.

Lastly, the focus of industrial policy will be important. The guiding themes in this report are competitiveness and the role of R&D and innovation. Competitiveness is the capability and performance of a firm, an industry, an industry cluster, a nation or a region to sell and supply goods and/or services to a market - local, regional, or global. A region or a nation's competitiveness is generally assessed in terms of its capability to maintain a position of surplus in the international trade balance through control of part of the global market. Such a competitive position can be maintained, improved, or lost over time. Thus, national performance is dependent on the ability of governments and industry to co-design and implement appropriate policies and framework conditions. The role of government is to implement the necessary and sufficient conditions for firms to participate in the international competitive process. We have seen from the above that the challenges are many, that there are interrelationships and causalities among trends, and in turn these are related to optimal inputs for competitiveness and competitive performance.

This study shows that there are new research paradigms that can potentially enable structural change in the economy. Such events are at the low end of the cycle of innovation (i.e., R&D). Structural change occurs only when application and mass diffusion becomes an innovation wave (for example, the application of steam, or microelectronics). These waves are always underpinned by institutional reform, new knowledge structures and new services. The sectoral analyses in this report have shown that in some sectors currently it is less important to support R&D while in contrast it is crucial to deploy and apply technologies that already exist, but have not been sufficiently diffused due to institutional and market failures. Examples here are telemedicine and end-of-pipe environmental technologies. In some cases both aspects are equally important, for instance in the aeronautics sector while in others, for example sustainable innovation, major R&D efforts and discovery are required to make a difference. The lesson for policy design is that there is a need to look at the whole innovation cycle to design policy packages that are multi-dimensional and systemic in nature. Thus, they encompass not only R&D initiatives but also support and promote new products, processes, practices and services for global diffusion. The problems involved are that such policies will be complex and their implementation and evaluation of performance not straightforward.

A final remark concerning the role of R&D and innovation. In the face of much information and lack priorities perhaps it is worth considering competitiveness and industrial policies against the five dimensions that determine whether a sector (or firm) can be competitive now and continue to be competitive in the future. A sector will be most competitive if what it offers - regarding processes, products or services - *are valuable, scarce, non imitable or imperfectly imitable, substitution free or quasi-free, and non-separable from the system in which they are embedded*. Here we can clearly see the role of R&D and innovation as new products, processes and services encompass all these characteristics, at least for a while, pointing to the need for constant renewal.