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## The Future of Manufacturing in Europe A Survey of the Literature and a Modelling Approach

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### Purpose

Manufacturing in Europe is facing challenges that may impact on its performance in the near future: the emergence of international competitors, new technologies allowing the emergence of new business models, increased off-shore and relocated activities. The aim of this study was to provide policy-makers with a long-term vision of European manufacturing, its characteristics, its place in the EU economy, in the world and the main challenges it will be facing. Its purpose was to identify, on the basis of current demographic, environmental, technological, economic and social trends, and possible scenarios, the likely bottlenecks, unsustainable trends and major challenges that European manufacturing will have to face over the coming 30 years. From this, implications for various microeconomic policies, notably for industrial policy, were explored, contributing to the mid-term review of industrial policy in 2007 by the European Commission's Directorate-General for Enterprise and Industry.

### Future of European Manufacturing

Manufacturing in Europe is affected by a changing world. In 2004, ten countries joined the EU followed by Bulgaria and Rumania in 2007. Most of the new member states have a different economic structure and other comparative advantages than the 'old' EU-15, in particular in labour-intensive industries. This is also the case for the candidate countries from the Balkans and Turkey. Enlargement hence not only offers opportunities in terms of a larger domestic EU market, but also in terms of specialisation and – associated – economies of scale and scope.

Secondly, a new wave of globalisation unprecedented in terms of scale and speed is unfolding. This process of economic integration – with resources becoming more mobile, economies becoming increasingly interdependent and financial markets becoming increasingly international – has important implications for the

future of manufacturing. This also holds for the integration of China and India in the world economy; each is home to about 20 percent of world population. Both countries are leading and highly competitive exporters, India in software and IT-enabled services, and China in skill-intensive manufactures. Especially China has emerged as the powerhouse of the Asian region and has in less than 20 years become the world's manufacturing and trading platform. Globalisation has also impacted European manufacturing in another way: lower production costs and the potential of new consumer markets have caused European manufacturers to increase the quality and design of their products and have led to international sourcing of (parts of their) production.

Thirdly, consumer demand in Europe itself is changing. As its citizens are becoming wealthier, they demand more services and place higher requirements on manufactured goods. Demographics (ageing) might strengthen this change. Finally, the pace of technological change appears to have sped up in view of globalisation and increasing international competition.



Globalisation, EU integration, shifting demand and progress in science and technology, and innovation – whether disruptive or not – will all have a major impact on how the manufacturing landscape in Europe in terms of location, production, distribution of labour and physical appearance will manifest itself in the near and longer-term future.

The purpose of this long-term scenario study was twofold: (1) to provide policy-makers, decision-makers and others with two long-term scenario-based views on the future of European manufacturing and (2) to explore the scope for EU policies to positively address and influence the future.

## Combining Qualitative and Quantitative Foresight Approaches

The scenarios in this study have been developed in three consecutive stages, consisting of (i) a survey of existing futures studies, (ii) the drafting of qualitative scenarios, and (iii) a quantification of the scenarios using WorldScan, a dynamically applied general equilibrium model for the world economy. This approach was designed as a hybrid combining the traditional foresight studies with more quantitative oriented economic-scenario studies.

One important difference between the two groups of studies is the detail with which technological factors are explored in the foresight studies compared to the economic-scenario and modelling studies, which generally treat them as exogenous factors. Furthermore, while the foresight studies, in contrast to

the modelling studies, largely employ qualitative scenarios, this study aims at combining the benefits of both approaches: first synthesising the results from many foresight studies to develop qualitative scenarios, followed by a quantification of the expected implications to check for the consistency of the scenarios as well as assess the expected impacts of policy packages. Furthermore, the communities conducting foresight studies and economic-scenario modelling studies have largely co-evolved with little interaction between them. This has led to foresight studies, focusing on participative processes and qualitative (policy) analyses and recommendations, producing results that are challenged by approaches focusing on quantitative analyses. This study therefore aimed to bridge the two communities by employing methods used in each of them. As such, the results of the study can also be seen as an experiment on how to conduct such studies in the future, combining methods from different communities.

## A Three Part Structure

As outlined above the study consisted of three distinct parts: a literature survey, the development of qualitative scenarios and the quantification of the scenarios using a modelling approach.

### Survey of Future Studies

The survey of futures studies<sup>1</sup> served two goals: (1) to help identify the relevant main drivers and trends that form our current perspective and knowledge that can be seen as key to the future of manufacturing in Europe and (2) to explore what other expert groups and think tanks regard as possible manufacturing futures.

The timeframe considered in the literature surveyed ranged from 2015 to 2050. During the course of stage one, 101 foresight reports, scenario studies, academic publications and policy documents were surveyed along five clusters: international, technological, social and environmental trends and drivers as well as new business models. The studies surveyed covered European studies, global studies, North-American studies and South-East Asian studies in order of importance.

*FutMan*, *ManVis* and *Manufuture* – three major EU-wide foresight projects conducted over the past five years – formed the backbone of the survey. The results of these foresight studies were supplemented by other materials ranging from theme or aspect futures studies (e.g. expected income developments; impacts of climate change) to similar foresight studies carried

out in other countries, such as the U.S. (e.g. IMTI, 1998; SRI), Japan (Nistep, 2005) and China (NRCSTD, 2005 – for further references see full background report [Zee & Brandes, 2007]).

### Qualitative Scenarios

The survey identified at least five sets of major drivers affecting the future of European manufacturing. These drivers are: (1) globalisation and international competition, (2) technological progress, (3) socio-demographic change (in income and wealth, social values, shifting preferences, ageing), (4) energy and resource scarcity, and (5) climate change and the environment. Based on these, two scenarios were developed: *Cosy at Home* and *Adventuring the World*. The two scenarios exemplify two explicit but ‘moderate extremes’ based on further integrating markets, on the one hand, and a stalling or reversal of market integration, on the other. In *Cosy at Home*, inward-looking, risk-averse, indecisive behaviour dominates the public as well as the private realm. In *Adventuring the World* outward-looking (resulting in a further opening-up), risk-loving and pro-active behaviour is prime.

***Cosy at Home*** This scenario depicts a European manufacturing sector that faces an overall business and political climate that gradually becomes more inward-looking and passive. Uncertainty and indecisiveness at world level are answered with a European response of retreat. Politically unstable regions, threats of international terrorism, absence of binding action at global scale to tackle the negative consequences of climate change and the inevitable depletion of fossil fuels, and – related – a lack of real breakthroughs in alternative energy production and promising new technologies (nanotech-

<sup>1</sup> Published as an independent background report to this study, see Zee & Brandes (2007).

nology and to a lesser extent biotechnology), give people the feeling of standstill and uneasiness. This in turn translates into a downturn in consumer and producer confidence and more inward-looking and risk-averse behaviour. Trust is something that may be found close by, but certainly not far from home. Rising energy prices and strong increases in monitoring and control of international movements of persons, goods and services result in a cost explosion in international transport and trade, which significantly alters the turn-of-the-century trend towards a further integrated world economy.

**Adventuring the World** This scenario depicts a European manufacturing sector that is faced with an overall business and political climate of international cooperation, openness, but also strong competition. European self-confidence strengthens as the political and ideological emptiness that characterised the turn-of-the-century era has been replaced with new inspiring notions of Europe's role in the world. This includes Europe assuming the position of a front-runner in solving problems of global warming, energy use and ageing as well as major breakthroughs in European social and cultural integration. Renewed decisiveness has triggered momentum at the global level and geo-political instability and threats of international terrorism are gradually disappearing. Considerable progress is made in alternative energy production and promising new technologies (nanotechnologies and biotechnology) have taken hold. A general upswing in consumer and producer confidence combines with new openness, and outward-looking and adventurous entrepreneurial behaviour. Trust relationships thrive. Rising energy prices stimulate new and more cost efficient energy-saving ways of transport of persons and products. Adequate road pricing and energy taxation increasingly supplant traditional labour taxes, making mobility and energy consumption better manageable and curbing harmful consequences.

### Quantification of Scenarios

In the third step, the scenarios were quantified using an applied general equilibrium model for three main purposes: (1) the model ensured that the scenarios were consistent, since economic variables allow to describe and relate constraints and the current knowledge about interactions in the economy in a consistent form; (2) the quantification gave a feeling for the relative importance of various developments for the future well-being of society; (3) the model also offered the possibility of assessing the impact of framework policies and their relative importance.

However, large parts of the scenarios could not be quantified, as the general trends observed are expected to impact variables over

too long time horizons for workable quantitative assumptions. The complex feedback loops furthermore make it only realistic to illustrate the scenario trends related to economic growth and economic integration, which are at the heart of the WorldScan model. (For details on the quantification of the scenarios and their expected impact on manufacturing please see the 'final report').

### Impact of Framework Policies on Scenarios

The quantification of scenarios sketched the macroeconomic developments, showing the possible impact of globalisation, technological change, ageing and structural change towards a service economy on economic growth and trade. Europe is expected to become less important as a place for manufacturing production in both scenarios as manufacturing shifts to Asia. The question whether these trends could be affected by policies was assessed in the third step. Rather than thinking about targeting and subsidizing specific industries, framework policies that could affect the environment where industrial production takes place in Europe were modelled for potential impact on the scenarios. The framework policies analysed were: (1) upgrading skills, (2) more effective regulation and less administrative burdens for firms, (3) R&D and innovation policies, (4) a strong competitive single market, (5) environmental policies, (6) supporting energy policies and (7) global trade policy.

The macro-economic outcomes for the EU as a whole in 2025 for both scenarios were analysed under the different framework policies. The differences between the two scenarios are minor. In *Adventuring the World*, GDP increases slightly more than in *Cosy at Home*, mainly because of the large impact of R&D and internal market policies. Exports increase faster in *Cosy at Home*, largely due to a composition effect of a higher share of total exports destined for other European countries. An increase in intra-EU exports due to new single market policies thus has a larger effect on total exports. R&D and innovation policies have the largest impact representing about 40% of the total GDP effect based on the lower bound returns in the literature. The reduction in administrative burden adds about 1.5% to GDP, internal market policies about 2% and skills even less. However, over time, when the whole labour force has been educated, the effects of upgrading skills will be larger. From Gelauff and Lejour (2006) we know that GDP effects will be three times as high in 2040 compared to 2025. However, compared to other framework policies, the economic effects even in 2040 will be unsubstantial.

## A Future for Manufacturing

The analysis has shown that the share of manufacturing in employment and value added has decreased in Europe for decades reflecting structural changes in the global economy. However, manufacturing will remain important for trade and productivity increases, outpacing by far the service sector.

Global manufacturing is expected to grow, fuelled by Asian economic development. Nevertheless, there is a future for manufacturing in Europe. In 2025, Europe's share in global manufacturing production and trade is estimated to be about 20%, much higher than its share in global population. Manufacturing is also estimated to contribute more than 15% to European value added in 2025 and to remain the most important driver for exports. A further strengthening of the internal market and adequate R&D and innovation policies can have a

substantial impact on these shares. Both can be influenced by EU policy-making, but the framework policies cannot reverse the trends in shares of value added and employment.

Within the manufacturing sector various developments will take place. The study discriminated between ten aggregate manufacturing sectors: 'food products', 'textiles and wearing apparel', 'wood and other manufacturing', 'pulp, paper and publishing', 'chemicals, rubber and plastics', 'basic metals', 'non-metallic minerals', 'electronic equipment', 'transport equipment' and 'other machinery and equipment'. Based on historical productivity growth paths of these sectors, their trade openness, R&D intensity, energy efficiency and skill intensity, it is highly likely that these (sub)sectors will develop differently over time. This also applies to subsectors *within* the ten sectors identified. Most sectors can distinguish between basic and specialized manufacturing activities, with basic manufacturing on average being more affected by international competitiveness than specialized manufacturing.

### Openness a Key Determinant

A number of interesting conclusions about the future of manufacturing in Europe were drawn. The increase in trade and, more generally, globalisation appears to be one of the most important drivers, making the sectors that are already most open to international trade also the ones mostly affected in the future. They include textiles and wearing apparel, wood and other manufacturing, chemicals, rubber and plastics, electronic equipment, transport equipment and other machinery and equipment. Overall, the sectors food products and pulp, paper and publishing will be less influenced. These are more domes-

tically oriented sectors, less R&D intensive and face less technological progress. Europe has no comparative advantages in textiles and wearing apparel, electronic equipment and basic metals. This disadvantage will become further manifest in the oncoming twenty years. In particular, this applies to electronic equipment, which – while in the past representing a relatively large sector – will decline even further. Textiles and wearing apparel is an already small sector in terms of value added and employment, which means that an even less prosperous future for this sector will also have less overall impact. Chemicals, rubber and plastics, transport equipment and other transport and equipment will be the most important manufacturing sectors in Europe, despite a deteriorating comparative advantage in the other machinery and equipment sector. These sectors are important for European exports and will account for about a quarter of global production and trade in these sectors over the coming decades.

Of the framework policies analysed in this study, improving skills, reducing the administrative burden and increasing energy efficiency, have the least impact on manufacturing. R&D and innovation policies and strengthening the internal market, on the other hand, have the strongest and most positive impact on manufacturing. They are also the most ambitious in terms of policy formulation and implementation, and potentially very effective in supporting manufacturing because of their R&D intensity and open-to-trade nature. In the coming decades, Europe's decreasing share in global manufacturing production and trade will flatten. The EU framework policies support this slowing of the relative decline of manufacturing activities in Europe, which may even come to a near standstill in sectors such as chemicals, rubber and plastics, and combined machinery and equipment.

## Sources and Links

The key results of the study were published as part of Chapter 5 of the European Competitiveness Report 2007. More details and the full scenarios are published in the background reports and final report and can be accessed via the website of the European Commission and the CPB the Netherlands.

[http://ec.europa.eu/enterprise/enterprise\\_policy/industry/index\\_en.htm](http://ec.europa.eu/enterprise/enterprise_policy/industry/index_en.htm)

Brandes, F., A. Lejour, G. Verweij & F. van der Zee (2007) "The Future of Manufacturing in Europe", Final Report, 31<sup>st</sup> May 2007, available at:

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