STRUCTURAL TRANSFORMATIONS IN INDUSTRY AND FILIÈRES

Patrizio Bianchi and Sandrine Labory
Department of Economics and Management
University of Ferrara

1. INTRODUCTION

This paper argues that the large changes in the extension of markets outlined in the introduction to this special issue call for a renewed analysis of production organisation and the filières in which firms produce and sell products, in order to better understand structural changes in industries. After a review of structural changes, we briefly discuss some of the concepts and approaches existing in the literature to study production processes; of these, we consider the filière, global value chains and sectoral systems of innovation and production.

The filière concept seems interesting given that the term has emerged again in the literature and in policy-making, especially in France where a "politique industrielle de filière" has recently been implemented.

The global value chain concept has been widely discussed in the literature in the last twenty years, to account for the organisation of production on a global scale, governance issues and implications for government policies.

Last the sectoral systems of innovation and production approach has been developed within the evolutionary theory and is interesting because it is dynamic, focused on both market and non-market interactions.

All these approaches are useful to provide detailed analyses of the organisation of production within the firm and outside, with their networks of suppliers. However, they do not represent theories that could help predict in what circumstances certain specialisations or technological developments could be preferred. All approaches however appear to be complementary in deriving industrial policy implications: while the GVC approach highlights governance issues in the network between firms, the filière approach strongly relates to market competition and competitiveness by highlighting that the dominance of the strategic phases of these networks, chains or processes is key to a firm's competitiveness. The SSIP approaches focuses on issues related to technological change, which is one of the main initiator of structural changes, although not the only one. A deeper reflection on the way in which these approaches can be used to provide insights on structural changes appear therefore useful in order to derive precise industrial policy recommendations.

The paper is organised as follows. The second section reviews major structural changes experienced in industry in the last 20 years, namely technological changes, increasing competition due to the entry of new competitors (from emerging countries) and rising quantity and quality of demand (new consumers in emerging markets, rising income levels inducing consumers to ask for higher quality). Firms have re-defined their market strategies, re-organised production processes as a result, using new technologies (especially ICTs) and higher skills. Production re-organisation essentially involves unbundling or global value chains. However, we also show that the structural changes have to be better understood: for instance evidence on production re-organisation is still largely anecdotal, based on case studies, and further research is needed to get more systematic insights about short-term versus long-term changes. The third and fourth sections examine different existing approaches to the study of production and innovation networks: filières, global value chains and sectoral systems of innovation and production (SSIP). The fifth section concludes on the usefulness of detailed sectoral studies, using these approaches in a complementary manner.

2. MAJOR STRUCTURAL CHANGES IN INDUSTRY IN THE LAST 30 YEARS

Structural changes refer to long-term patterns of evolution, changes in products, production organisation, leading to different industrial structures with a re-allocation of productive factors among the various sectors of the economy, driven by the strategic choices of firms that reply to changing competitive contexts.

The changing competitive context of industrial firms world-wide has been amply discussed in the literature, and summarised in our introduction to this issue: globalisation, the ICT revolution, financialisation, triggered an evolutionary process whereby the extent of firms' markets dramatically increased, with the emergence of new competitors and new markets and with technological changes reducing transport and communication costs. Firms redefined their products, production organisation, therefore R&D and marketing strategies to face this new and evolving competitive context. The enlargement of the market indeed did not arise from one day to the next, but across many years, whereby political changes in some countries induced them to transform into market economies and rising income levels implyied changing consumer needs and rising demands in emerging markets. For this reason, a dynamic analysis is fundamental to avoid looking at particular points in time and missing the process of change that is unfolding.

Structural changes are generally stylised in both industrial and development economics as the shift from an economic system largely based on agriculture with little industry, to industrialisation and the development of the manufacturing sector, to tertiarisation where income levels of the population are high, services take greater importance relative to manufacturing products which shift to higher levels of sophistication.

However, we are now in a new phase that goes beyond this stylisation. It is true that some countries are still industrialising while others are shifting to economies where services take relatively greater importance. Today's structural changes are important in that they are generating a new competitive context, different resources and technologies, so that industrialising and developing today requires different resources and strategies

than in the past. New sectors are developing, in particular green technologies that will be fundamental to confront climate change, some old sectors that characterised certain levels of development, like the textile sector, might substantially change as a result of the use of new technologies, such as biotechnologies and new materials, and the composition of 'traditional' sectors may change as a result, making them less labour intensive and less low tech.

The ICT revolution has been important essentially because it has allowed the implementation of new strategies, such as production organisation on a world basis.

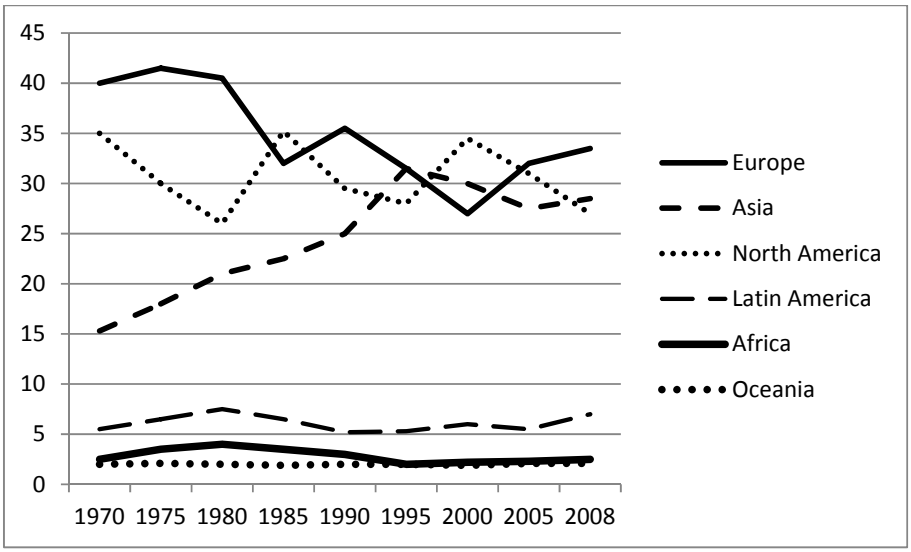
Memedovic and Lapadre (2009) make an analysis of the structural changes that arose in 30 countries in 18 sub-sectors in the last 40 years. They find evidence of de-industrialisation in the sense of growing importance of services relative to manufacturing since 1970. The share of services to world value added was already above 50% in 1970, while that of manufacturing was about 40%. The gap between the two started to increase from 1980 up to 2005, where the share of services reached a peak of almost 70%, while the share of industry reached a low at about 30%. Interestingly the trend has largely reversed since 2005. Between 2005 and 2008, the growth in value added has been slower in the service sector than in industry. This reversing trend is true for Europe but not for North America. The share of manufacturing to value added rose in Europe by 17% in the period 2005 to 2008. More recent data reflect the global financial crisis and recession that followed in many countries, so that it is better to wait before including these figures in long-term trends.

Regarding the geographic distribution of production activities, figure 1 shows that the share of Europe and North America in world production fell respectively from 40 to 33 and from 35 to 27 % between 1970 and 2008, to the benefit of Asia which share rose from 16 to 29 %, while those of Latin America and Oceania experienced a small gain, and that of Africa remained low.

These overall trends hide short-term fluctuations, as shown by figure 1, Europe recorded the lowest level in 2000 with about 27% but the share

constantly rose afterwards, while the share of North America peaked in 2000 at almost 35% and reduced thereafter. The Asian crisis is reflected in the data in that the peak for Asia is in 1995 with 31.5%, falls thereafter until 2005 at which date the share starts rising again.

Figure 1. World value added by region (% shares in current prices and exchange rates) 1970 to 2008



Source: UNIDO calculations based on UN statistics (data in current prices in US $), in Memedovic and Lapadre (2009, p. 10).

Memedovic and Lapadre (2009) also analyse the long-term trends in the structure of world manufacturing industry, selecting a sample of 30 countries[1] over the period 1970 to 2006. The data show a strong increase in the value-added shares of industries producing ICTs, machinery, transport equipment, precision instruments, chemical, plastics and rubber products, while other industries experience a decrease in these shares. The strongest increases are that of ICTs (+ 143% over the period), medical, precision and optical instruments (+ 122%), and machinery and equipment (+ 89%), followed by chemicals and chemical products (+ 38%). All

1 Argentina, Australia, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Denmark, Ecuador, Egypt, Finland, Greece, India, Indonesia, Italy, Japan, Kenya, Mexico, Poland, Republic of Korea, Singapore, South Africa, Spain, Sweden, Turkey, United Kingdom, USA, Uruguay, Zimbabwe.

the other industries[2] record a falling share in value added over the whole period, the strongest decrease being that of tobacco products, textile and clothing and footwear (about – 60%).

The industries where value added rises are those more intensive in technology and highly-skilled workforce. These industries have grown especially in advanced countries, but also in emerging countries and in Asia in particular.

The drivers of all these changes are numerous and have been pointed out in various publications (see Bianchi and Labory, 2011, for a review). First, demand is expected to rise in the next years, especially in emerging markets which are expected to represent about half the global consumption by 2020 (McKinsey, 2012). This means that the volume of demand will rise, but also the variety of products, because products have to be adapted to consumer needs in each local market. Together with the rise in demand for goods, the demand for services will also increase, from households but also from businesses, since the expectation is that the demand for high value-added services and software will rise in parallel. Many firms in industrial sectors indeed increase their supply of pre- and post-sales services in order to differentiate from competitors and attract customers. This means more services of maintenance, financing, risk sharing, training and support.

A second driver of structural changes in manufacturing is the availability of appropriate skills and resources (in particular, intangible assets). The demand for highly-skilled labour, and technicians and engineers in particular is expected to significantly rise in the future, creating a global shortage of these skills.

Third, commodity prices are rising and becoming more volatile, creating obvious pressures for changes.

Fourth, transportation costs are expected to rise in the future due to a lack of capacity relative to demand. Hence the strategy of global value

2 The other considered industries are food and beverages, tobacco products, textiles, clothing and footwear, wood products, paper and paper products, printing and publishing, petroleum products and nuclear fuel, non-metallic mineral products, basic metals, fabricated metal products, and other manufacturing.

chains might increasingly be challenged and the strategy of near-shoring preferred. There is growing anecdotal evidence that firms are reversing their choice and are re-shoring their manufacturing processes (GE in the USA, IKEA in Europe, see Bailey and De Propris in this issue), because the rising transportation costs add to other risks that have emerged in GVC management, in particular quality control (quality problems have created huge costs to many multinational companies), shipment or production delays, as well as the loss of externalities between different phases of the production process that are possible to exploit if phases are realised close to each other.

Fifth, government policy has an impact on structural changes: trade policies, innovation and IP protection regimes, the provision of infrastructure, of training and education, as well as competition policy and fiscal competition between countries all affect the strategic choices of firms in industry.

The current structural changes are numerous and complex. Very often attention in the literature has focused on off-shoring, meaning outsourcing to foreign suppliers implying the creation of global value chains or global production networks.

However, other changes are occurring in industry. An important one is the development of new process technologies, such as digital modelling or robotics. Digital modelling is the use of ICTs to create digital models of the whole manufacturing process of firms, of their value chains, allowing higher efficiency and effectiveness. Digital modelling allows to improve not only the coordination of the whole process, but also the realisation of the single phases, for instance more rapid and effective R&D, by improving the link between research, design and product development, by better identifying product defects and avoiding the multiplication of prototypes building. Robotics is increasingly used in manufacturing and robots are more and more efficient and useful.

Changes also include the adoption of new business models, such as mass customisation, whereby production is personalised even at large volumes (e.g. personalised medicine market in the pharmaceutical industry). Another example is the extension of the production process to the "second

life" of the product, from R&D, assembly, commercialisation, to include recycling and reuse in so-called remanufacturing facilities.

Hence changes in production processes include more than offshoring, and more evidence would be needed on the different changes and their interrelations. Not all firms offshore, not even across sectors but also within sectors. Global value chains seems to be related to decentralisation, since production is fragmented across territories, but there are also tendencies for centralisation, at least of some functions. Samsung and Apple are the leaders in the smartphone market and they are rather vertically integrated, although some productions are delocalised.

In addition, the growth of intermediate trade is often argued to be a sign of growing offshoring, since the organisation of production phases in different countries generates trade in intermediate products. However, De Backer and Yamano (2012) point out that trade data do not reflect the increasing importance of intermediate trade over the last decade: the evidence is that intermediates indeed make up for the majority of international trade (56% of goods and 73% of services), but the share has remained quite constant over the period 1995 to 2006. Trade in final goods grew at the same pace as trade in intermediate products. In addition, according to the OECD, data on intra-firm trade, namely trade between parent firms and their affiliates (within multinational companies) has remained relatively stable over the last decade. This could mean that multinationals have set up global value chains before the last decade, so that the growth in trade between multinationals' divisions would appear in the period before the mid-1990s. Another reason might be the limitation of the data, such as the limited number of countries considered.

However, as mentioned in the introduction of this special issue, data resulting from input-output tables are more appropriate to measure the importance of global value chains and point to different results. The OECD itself has started computing such tables and the evidence points to increasing importance of global value chains in the period 1995 to 2005.

The analysis of GVCs also requires considering trade at a detailed level of product classification, and comparing imports and exports and the different origins and destinations. Not all intermediates are traded because of

GVCs: in order to provide precise evidence of GVCs one should provide evidence of the flows of parts and components at each stage of the production process. Offshoring implies that imports and exports increasingly move together because of the sequential production process and back-and-forth trade between countries. Without reviewing all the methodologies that have been used in the literature to better account for GVCs, we can summarise the evidence. First, offshoring is indeed a growing phenomenon until the period immediately prior to the crisis, and it primarily regards industries such as electrical machinery, radio, television and communication equipment, office, accounting and computing machinery and motor vehicles. Second, offshoring primarily arises within regions, in that firms from Europe, North America or Asia mainly offshore within their respective region (De Backer and Yamano, 2012).

Many American firms have recently re-shored production phases, but this has at least partly largely been induced by the US government policy in favour of re-shoring, aiming at raising the job demand in the country. Given the rising transportation costs and frequent quality problems arising in global value chains, many firms have find it profitable to re-shore. However, the evidence about this phenomenon is still anecdotal and measures and data should be improved to provide more systematic evidence on both offshoring and reshoring.

As a consequence, the overall evidence about structural changes is that they fundamentally regard production processes, defined as the process of transformation from raw materials to final products, including perhaps recycling and reuse, as well as all the supply phases of the production process. Changes in the extent of the market (overall demand and number and types of competitors) determine changes in firms' market strategies, including the type of product to be manufactured and the markets in which to sell these products, hence production organisation has to be changed in order to realise these new strategies. These changes in production organisation determine the structural changes in the industry and the economy. Indeed, the new production organisation may require higher skills, in which case institutions have to adapt to provide the necessary skills (e.g. governments changing education policies to raise the level of skills in the workforce). The changing production organisation also determines infrastructural needs (e.g. international transportation facilities in

case of offshoring; need for more powerful telecommunication technologies, etc.).

Hence the institutional framework determines the possibilities for production organisation (offshoring cannot be considered in a country with no international infrastructure) but also the need for new production organisation should induce specific changes in the institutional framework: not only in terms of the provision of appropriate infrastructure, but also in terms of rules, including for instance competition policy (firms may be tempted to build monopolistic positions to face the changing competitive conditions) or international trade laws, as the rise in IP protection (TRIPS agreement) following the advent of the knowledge economy in the late-90s shows.

After highlighting the importance of the analysis of firms' production processes to identify the roots of structural changes, the next sections examine some of the concepts and approaches that have been developed to study firms' production processes. We start with the French filière concept in section 3, while the GVC and SSIP approaches are discussed and confronted subsequently.

3. THE USE OF THE FILIÈRE CONCEPT TO BETTER ACCOUNT FOR STRUCTURAL CHANGES

The concept of filière was used in the 1970s and 1980s by French industrial economists to better account for structural changes and industrial policies than what the traditional analysis permitted. It has recently been revived in France to re-launch industrial policies.

The evidence about structural changes is that they are still unfolding and perhaps the most important aspect is that they are now in constant evolution: products rapidly change thanks to innovations in design or technologies, there are many innovations in generic technologies with potential impact on new and existing industries, as research continues for instance in nanotechnologies, biotechnologies and genomics, robotics, ICTs, and

so on. As a consequence production processes also change and a dynamic analysis is necessary. For this purpose, adopting the point of view of filières might be useful.

A filière is a sequence of conception, R&D, sourcing, production and commercialisation phases. It has been widely used in France in the field of agricultural economics to describe the filière of particular agricultural commodities, especially in developing countries and Africa in particular, with the aim to derive appropriate development policies (Raikes *et al.*, 2000).

The concept of filières experienced a renewed interest in the 1970s and 1980s thanks to the French school of industrial economics which made it an autonomous topic of analysis (Stoffaes, 1980; Sekkat, 1987). The creation of the *Revue d'économie industrielle* is important from this perspective (Morvan, 1985).

The analysis of filières therefore identifies the different segments of the production process and their vertical interdependence relations. Whereas partial equilibrium analyses consider particular markets, where specific products are made by firms in their given production process and exchanged, the notion of filières allows to consider competition at the different stages of the production process, the different tasks realised at different stages, as well as their evolution as new products or product varieties are developed or as new phases are added, as the recycling and reuse phase envisaged to reduce the environmental impact of production.

The notion of filière thus allows a more global view of production, strategy and competition:

- From the point of view of the firm, it considers not only market strategies but also strategies regarding sourcing, technologies, supply, logistics;
- From the point of view of the industry it goes beyond the sectoral decomposition and allows the consideration of synergies between sectors, between technologies, and between territories.

The interrelations between manufacturing and services can thus be considered: there are both manufacturing and service activities in a filière and the way these various activities are organised and managed determines a firm's competitiveness.

The literature on filières was concerned in the 1980s about the issue as to what stage of the filière should a firm specialise, rather than aiming at controlling the whole production process (Stoffaes, 1980). At that time most filières were regional or national, in the sense that they were realised in the same territory. Nowadays filières become global, and the issue becomes not only which stage of the filière to control, but also which stage can be delocalised without losing control now or in the longer term. A production stage might be delocalised without any consequences for the specific sector considered, but the territory may subsequently lose possible synergies with other filières. For instance a firm might decide to delocalise the production of a mechanical part or component to a foreign country but other firms in the same territory and other sectors might find it useful at certain points in time to use this production competence for their purpose, adapting the part or component to their needs.

When value chains are global, a firm may not necessarily create more value by specialising in a specific sector, but may create more value by exploiting complementarities between different stages of the filière and by controlling only the most strategic stages of the filière. A firm may create more value by controlling a given technology that is used by different filière, becoming a critical node in different filières. Thus for instance Samsung has managed to become a key competitor in smartphone: one reason for this is that it has gained control of the production of microchips that it even sells to the other leader of the sector, namely Apple. Microchips are also used in other electronic products developed by Samsung. Another example is firms specialising in logistics: they operate at crucial phases of filières and can have different filières as customers. A territory specialising in logistics is thus competitive at only one phase of the filière but represents a crucial node and therefore has a market, and large market shares if the firms are able to develop capabilities in their specific logistics tasks.

In fact the French literature on filière developed already in the 1980s two reflections that are still relevant today. First, the analysis of filière aimed at identifying their strategic phases or segments, which are key in order to ensure a firm market power and competitiveness. The dominance or control of these strategic phases is therefore an important aspect of firms' strategies and, for countries, for ensuring industrial competitiveness, job creation and growth. Even today in GVCs what is important is the control of strategic phases of production and not the control of the whole filière. Second, while governments in the 1980s tended to favour the national coherence of filière, namely the complete control of filière on the national territory, economists already warned in these years that these objectives of national coherence were at odds with firms' objectives in their management of filières. Thus Jacquemin and Rainelli (1984) argued that firms adopted different strategies according to the characteristics of their filière with the aim of reducing the competitive threat and ensure market dominance, but not to nationally control all the filière. The authors stressed that firms could choose to rely on foreign suppliers in the upstream of their filière if this allowed them to reach more efficient production. Hence industrial policy should not aim at the national control of filière but at helping firms control the strategic phases, by providing an adequate environment (competition, innovative system) and resources (human capital in particular).

In addition, scholars already stressed in the 1980s that filières constantly evolve according to the product life cycle. In expansion phases upstream stages tend to be more strategic while at maturity phases the distribution stages are more important. Already in the 1980s managers' perspective appeared to be increasingly becoming global (Jacquemin and Rainelli, 1984).

After the 1980s the notion of filière was progressively left aside perhaps as the literature started to concentrate on decentralised production modes, industrial districts and flexible production systems. In addition, industrial policy progressively became a taboo largely believed to be useless in the neo-liberal phase of policy that started in the 1980s (Bianchi and Labory, 2006, 2011).

The analysis in terms of filière might be useful today to better understand the characteristics, scope and implications of global value chains, of

offshoring or reshoring. However, this analysis incurs in a number of difficulties. First, there are no fixed and given filière. The definition of filière varies according to the object of analysis: at national level one might want to study the interdependencies between macro-filières, between sectors, while at industry level the filière is the sequence of firms that produce and distribute different goods and services and are linked by market transactions, from the first stages upstream to the final stages downstream. The strategy of firms therefore depends on the characteristics of its filière at a certain point in time and on its expectations about future evolutions. There are two implications of this aspect. First, there is no single reading of the filière but different analyses, representations and interpretations are possible. Second, filière are endogenous, directly dependent on firms' strategies and resulting structural changes essentially depend on these endogenous evolutions.

In addition, the filière perspective outlines that an important determinant of firm success is their definition and implementation of filière strategies. Firms may decide to guide a filière or insert in a filière, but the aim in order to get market power is always to control strategic phases. A good filière strategy may allow to reduce production costs, thanks to a better coordination of the different production phases, better communication of information and knowledge between phases, better incentives and higher quality of production of each phase. The filière strategy may change as a result of changes in demand: for instance, the strategic phases may change as uncertainty in demand rises, and the firms may try to innovate and renew the product so that the phase that it controls becomes the dominant one.

Policy implications are that a country should not aim at controlling a whole sector but at providing the conditions for its firms to gain or maintain control of the strategic phases of the filières. In other words, conditions should be provided so that firms be able to both anticipate demand and technological changes that determine the changes in the strategic phases, and innovate, hence influence the evolution of filière to their advantage.

For instance, cluster policy is a part of industrial policy and one can argue that the Austrian cluster policy illustrates this approach in filière.

A cluster is a set of firms usually in the same sectors that localise in proximity to exploit various externalities. Recently cluster policies have addressed the issue of synergies between clusters (hence between filières), in that in many cases policy-makers have decided to create not one cluster but different clusters in the same territory, so that synergies between the different filières could be exploited. The Styria cluster in Austria is an example, where the authorities developed seven clusters in an area dominated by an old, declining industry. The new clusters built on the existing knowledge and competencies present in the territory, but also attracted new knowledge and competencies, new technologies, and seven clusters were created in order to exploit synergies between them: automotive, food and drink, wood, biomedical, green technologies, new materials and creative industries. Each cluster does not include all stages of the filière: the clusters of new materials, green technologies, and biomedical are concentrated on the research phases of their respective filières, while automotive, food and drink and wood comprise more stages of the filières locally (they develop, manufacture and sell products). The government therefore seems to have aimed at favouring the control of the strategic phases of the filières, namely R&D and commercialisation. The government, through the entity in charge of coordinating the clusters (ACStyria), has also favoured synergies between filières by organising common training, meetings, exchange of knowledge of various kinds between actors of the different clusters.

When production processes become global it is essential for firms to develop distinctive capabilities, be it for innovation, design, logistics or other functions, so as to be able to control strategic phases of filières. In a dynamic perspective, innovation capacity can allow the successful conquest of entire filières, because the essential or strategic phases of the filière constantly move along the filière as new components, parts or technologies are invented and implemented; a technological innovation can induce the multiplication of competitors increase at that stage, so that the stage is no longer strategic, while other stages become more strategic: patent races in sectors like that of the production of smartphones might be read in this light. Innovating a part or component of the smartphone and obtaining a patent allows to get a monopolistic position in the concerned phase of production. In the smartphone market, competition is intense at the final product level but it is even more intense at the upstream stages of

the production filière: R&D, production of parts and components, design, and so on. Firms are involved in a patent race or more precisely, a patent war in that they try to constantly innovate and rapidly obtain patents even for small parts of the final product, because this can allow them to get a monopolistic position in a specific phase of the filière which allows them to dominate competitors and get higher value from their products.

4. FILIÈRES, GLOBAL VALUE CHAINS AND SECTORAL SYSTEMS OF INNOVATION AND PRODUCTION

Like the filière literature, the literature on global value chains suggests to analyse the set of acitivities and agents involved in the production processes of goods and services, from R&D to sourcing, manufacturing, distribution, up to recycling and re-use after consumption. This literature also stresses that competition is not only at the level of products but also at the level of tasks, meaning at the different stages of the filière.

The management literature developed the concept of supply chain management and outlined the growing importance of logistics in the supply chains. The work of Porter (1985) contributed to this evolution, outlining the need for a disaggregated analysis of the supply chain in order to understand the performance of firms and nations. He introduced the concept of value chain (Porter, 1985), which describes all the activities that have to be carried out in order to transform material and other inputs into a product: from R&D to distribution. Production is only one of the activities that create value, and mainstream analyses summarising the whole value chain in the production function do not capture all elements of competitiveness. A firm might derive higher profits from lower costs, but these lower costs might be due to technology or to a particular governance of the supply chain.

The concept of global value chains has been developed on these bases. It is defined as an inter-organisational network aimed at realising a particular good or service and relates consumers, firms and governments in the world economy. Whereas the analysis of filière was essentially developed

to provide insights on industrial policy, the GVC concept aimed at explaining the global governance of multinational enterprises.

Global value chains can be characterised by four elements:

1. The sequence of tasks and activities from R&D to manufacturing and distribution, including re-use after consumption;
2. A geographical and economic space defined by the localisation and concentration of activities and the flows between them;
3. The institutional context: policy, regulation, etc.;
4. A governance system: power relations that determine the allocation of (human, financial and material) resources in the GVC, and the value created at the different stages.

Gereffi *et al*. (2005) distinguish five governance types of GVCs: 1) simple market linkages, governed by prices; 2) modular linkages, where complex information is codified and transmitted to highly competent suppliers; 3) relational linkages, where tacit knowledge is exchanged between buyers and highly competent suppliers; 4) captive linkages, where buyers provide less competent suppliers with detailed instructions that the latter execute; 5) hierarchical linkages, realised within a vertically integrated firm. These 5 types of governance are found to vary according to three main variables, namely the complexity of exchanged information, the competencies of the suppliers and the codifiability of the information. They find for instance that relational GVCs typically require co-location, agglomeration and industrial clustering. Table 1 summarises predictions of type of governance according to these three variables. For instance, modular GVC linkages ease the coordination of distant activities even when complexity is high, while relational linkages characterised by an exchange of tacit knowledge require co-location and agglomeration. This framework allows a dynamic analysis, for instance modular linkages can become relational of technological changes imply an increasing complexity and reducing codifiability of knowledge. In contrast, captive linkages or hierarchy are preferred when the competencies of suppliers is low.

Table 1. Governance in the GVC

Variables: Linkages:	Complexity of transactions	Ability to codify transactions	Suppliers' capabilities
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low
Hierarchy	High	Low	Low

Source: Sturgeon (2008, p. 11).

Sturgeon (2008) recognises the GVC literature has been influenced by a number of theoretical approaches in their definition of governance types of GVCs. The main inspiring approaches are, according to Sturgeon (2008), transaction cost theory, economic geography and the capability and competence views of the firm in the strategic management literature.

Like the filière approach, the GVC literature develops the concept of power in the GVC, arguing that lead firms generally have power in the GVCs, resulting either from specific strategies, the control of key assets or inputs or holding specific competencies. Suppliers can take power if they develop competencies or control of key assets or inputs. When the competencies of suppliers are generic they are better-off developing relationships with different clients, in order to spread the risks associated with competition from other generic suppliers. The filière literature does not a priori define a lead firm, since suppliers can become powerful of they take control of a strategic phase.

Contrary to the filière literature, the GVC literature does not develop the link between GVC governance and competition in final markets. The competitive conditions in final markets, namely demand and supply characteristics, will drive the choice of strategies of lead firms and consequently all the filière.

Hence the two approaches appear complementary to a certain extent: the GVC literature analyses governance in more depth, while the filière literature is more oriented towards identifying strategic phases and deriving consequences on market strategies and performance.

Another theoretical framework that may be useful in the analysis of structural changes and industrial policy implications is the literature on sectoral systems of innovation and production, developed in the evolutionary theory framework. According to Malerba (2002, 2004), the concept of sectoral systems of innovation and production (SSIP) aims to provide a multidimensional, integrated and dynamic view of sectors. SSIPs are defined as sets of "new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products" (Malerba, 2002, p. 250). These systems are characterised by a knowledge base, technologies, inputs and demand. Interactions include competition, command, exchange, cooperation and communication. The co-evolution of the four elements characterising SSIPs determines their process of change.

Like the filière literature, the concept of SSIP is a useful tool to comprehensively describe the evolution of sectors. However, the SSIP literature does not provide much insights as to the prediction of the evolution of these systems. Empirical analyses are proposed describing the features of SSIPs but no theory is suggested to indicate what parameters imply particular set of features. The main aim of firms is to innovate and emphasis is put on the determinants of innovation, seemingly assuming that production processes naturally and easily adjust to adopt new technologies and new products. The reasons for and consequences of different production organisations in firms even in the same sectoral system are not analysed, so that only a part of structural changes are considered in the analysis. The Japanese automobile producers gained markets shares in the 1980s thanks to production processes that produced higher variety at lower costs, without introducing major technological innovations. As a result, policy recommendations focus on innovation policy tools and not the wider set of industrial policy tools. Castellacci (2009) acknowledges this by arguing that the SSIP approach aims at studying the sectoral specificities of innovation activities, which are an initial part of structural changes in industry: firms innovate or adopt innovation, and change their products, production processes and organisation as a result, which are the core of the structural changes that must be understood in order to define proper industrial policy.

However, the analysis of structural changes deriving from technological innovations are deeply analysed. Thus for instance Dolata (2009) develops a framework for the analysis of the impact of technological changes on sectors, based on two key variables which are first, the transformative capacity of the technology itself, namely the degree of change enabled by the new technology, and second, the socioeconomic adaptability of the elements characterising the sector, namely the institutions and actors confronted with the challenges presented by the new technology. These variables allow to qualitatively assess the impact of new technologies on sectors. Dolata also rightly stresses that not all sectors can be considered as innovation systems, since they mainly use technologies developed elsewhere and adapt them to their necessities. According to Dolata, the media industries as well as banking and finance are examples of such sectors.

However, the analysis of structural changes caused by new technologies is interesting and useful to include in a wider analysis of structural changes. As stressed in the second section, structural changes are determined not only by technological innovation but also by changes in:

- the nature and extent of the market, as consumers' income levels and tastes change;
- institutions: one example is the economic integration process realised by European countries from the 1950s leading to the single market and the European Union. Bianchi and Labory (2009) analyse in depth industries' structural changes induced by this process; another example is the transformation of former communist economies into market economies, implying their entry into global markets;
- tangible and intangible assets, such as infrastructure regarding the former and human capital, e.g. higher education levels of the population providing higher skills to firms, as an example of intangible assets.

Dolata also rightly emphasises that structural changes are generally gradual, made up of "a multitude of more or less consistent organizational, structural, and institutional readjustments, thereby highlighting the numerous tentative, erratic, and highly competitive sectoral restructurings that span a longer period of time" (Dolata, 2009, p. 1074). Structural breaks and sudden changes are not frequent.

In addition, the concept of adaptability stresses that firms need to be open to changes and flexible in order to keep pace and realise structural changes. One condition for this openness to change is the degree of competition in markets: the competitive threat represents an incentive to keep open to change and ready to operate structural changes if needed. Hence competition policy is an important part of industrial policy aimed at favouring structural changes.

5. CONCLUSIONS: INDUSTRIAL POLICY FOR FILIÈRES

The analysis provided in this paper highlights a number of points regarding the analysis of structural changes:

1. There is a need for a deeper understanding of structural changes;
2. The analysis of production processes, filière and networks should be useful in this respect;
3. For this purpose, there is a need to compute richer and more detailed data on industries; as a start, sectoral analysis in case studies are useful;
4. This is fundamental in order to give concrete recommendations on industrial policies, which policy-makers are looking for.

The three approaches mentioned in this paper, namely the filière, the GVC and the sectoral system of innovation and production approaches appear complementary in this project. All approaches provide in-depth analyses of production organisation both within the firm and between the firm and its environment (relationships with other firms in the same or other sectors, and with other actors such as universities and research centres, government and other public or private institutions). They therefore allow to provide insights on the interdependencies between manufacturing sectors and between manufacturing and services, which Andreoni and Gregory show in this issue to be important to examine. The filière approach outlines strategic issues and their relationships with competition and performance, while the GVC approach is more focused on the single firm and internal governance issues. The SSIP adds the importance of

a dynamic analysis, although it tends to be focused on innovation issues and innovative sectors.

There is much to gained from deeper sectoral studies using these approaches, to better understand structural changes and their impact on market structure, so as to derive appropriate policies supporting the competitiveness of enterprises and favouring structural changes, namely industrial policies.

In fact industrial policy cannot be effectively defined without taking account of the filières (or GVCs or SSIPs) present in the country together with their links to the rest of the world. An analysis of the filières allows to understand two things: first, the various specialisations of the country or territory, together with the phases at which domestic firms are most competitive; and second, the complementarities or potential complementarities existing between the phases of the same filières and of different filières.

A primary objective of industrial policy should be to help firms control the strategic phases of their filières, in a dynamic and flexible way in the sense of being ready to adapt and change strategy if the phases to be controlled change over time. For this purpose, competition policy is key, as well as provision of infrastructure and assets (especially human capital and appropriate knowledge base and interactions for innovations).

Firms' capabilities are essential for them to be able to control strategic phases of filières. Capabilities may be helped by government programmes aimed at developing new technologies. The policy-makers may choose to promote the development of specific technologies because they are considered as generic and with wide impact on many sectors, but this may not help the competitiveness of domestic firms if these are incapable of getting control of strategic phases of their filière. Hence the risk of such policies is that the country innovates in these technologies that are then used by firms in other countries to get more competitive (case of green technologies in Europe and China: Europe, Germany in particular, has developed technologies to generate electricity from solar energy, but European firms have been surpassed by Chinese firms which were able to produce these technologies at lower costs: they controlled a strategic phase of the filière that European firms did not? Or was it simply price competition?).

Examining these issues in more depth is beyond the scope of this paper. However, it is on the agenda of future research of the authors and the other participants to this special issue.

REFERENCES

BIANCHI P., LABORY S (2011a), *Industrial Policy after the Crisis. Seizing the Future*, Edward Elgar, Cheltenham.

BIANCHI P., LABORY S (2011b), "Industrial Policy after the Crisis: the case of the Emilia-Romagna Region in Italy", Policy Studies, forthcoming.

CASTELLACCI F. (2009), "The interactions between national systems and sectoral patterns of innovation. A cross-country analysis of Pavitt's taxonomy", *Journal of Evolutionary Economics*, 19, 321-347.

DE BACKER K., YAMANO N. (2012), "International comparative evidence on global value chains", OECD Science, Technology and Industry Working Paper 2012/3.

DOLATA U. (2009), "Technological innovations and sectoral change. Transformative capacity, adaptability, patterns of change: an analytical framework", *Research Policy*, 38, 1066-1076.

JACQUEMIN A., RAINELLI M. (1984), « Filières de la nation et filières de l'entreprise », *Revue économique*, 35(2), pp. 379-392.

MALERBA F. (2002), "Sectoral systems of innovation and production", *Research Policy*, 31, 247-264.

MEMEDOVIC O., LAPADRE L. (2009), "Structural change in the world economy: main features and trends", UNIDO, Research and Statistics Branch, Working Paper 24/2009.

MOATI P., MOUHOUD E. M (2005), « Les nouvelles logiques de décomposition internationale des processus productifs », *Revue d'économie politique*, 115(5), 573-589.

MORVAN Y. (1985), *Fondements d'économie industrielle*, Economica, Paris.

Sekkat K. (1987), « Filières de production : revue de la littérature et comparaison avec la théorie néo-classique », *Revue d'analyse économique*, 63(1), 118-142.

STOFFAES C. (1980), « Politique industrielle et filièeres », *Revue d'économie industrielle*, n° 13, pp. 86-99.

STURGEON T. J. (2008), "From commodity chains to value chains: interdisciplinary theory building in an age of globalization", *Sloan Industry Studies*, Working Paper WP-2008-02.