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Manufacturing Challenges and Opportunities in Europe: Emerging Models and Policy Interventions for Local and National Growth

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Abstract

This policy paper piece sets out some of the main challenges and opportunities facing European manufacturing and the emerging models and public policy interventions which are being used to reshape local economies and to contribute to national growth. The paper sets out principles which the Italian region of Friuli could follow to revive its economy and makes recommendations applicable to the regional government and Chambers of Commerce of Udine and Pordenone.

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Introduction

A multitude of recent analyses converge towards a reconsideration of the role of manufacturing in advanced economies for economic growth and prosperity. Before the 2008 economic crisis, developed economies were argued to be able to thrive on capabilities connected to innovation and intangible value creation processes (such as design, marketing, logistics, retail), while commoditized manufacturing had dramatically shifted towards emerging economies. Such an emphasis on the relocation of manufacturing to central and Eastern Europe and Asia and on a novel international division of labour turned out to be excessive, with significant implications for the erosion of the European Union (EU) manufacturing base and a dangerous concentration on untradeable sectors.

Sectoral unbalances in some EU economies combined with current account imbalances led to a much more precarious and lengthy economic recovery, whilst those countries that had chosen to maintain a solid manufacturing base and run current account surpluses were found to reset their economy more quickly and therefore to be more "resilient" (Aiginger, 2015).

This policy think piece offers a short overview of some of the headline drivers and processes at play in promoting a process of manufacturing renaissance that enables the upgrading of existing manufacturing competences as well as developing and anchoring new technological capabilities across EU manufacturing regions to ensure regions embark on an enduring growth path that support jobs creation and higher standard of living. It will disentangle a number of key issues around the theme of the "new manufacturing", in order to shed light on what could drive a competitive advanced manufacturing sector in this region, and therefore secure jobs and prosperity. At the core of the paper's agenda lies a desire to investigate the meaning and recent trends in the debate about a new manufacturing model Manufacturing 4.0 that is emerging in the wake of the latest technological advancements. Its components and policy implications are examined across six themes that include: manu-services; glocal value chains; skills; the rise of phoenix industries; open innovation; and implications for regional resilience and industrial policy (see figure 1 below).

It will also briefly highlight some bottlenecks, resistances and challenges in the current climate and in the light of competitors' faster growth performances. The aim of the paper is motivated by the belief that "Manufacturing 4.0" and other developments in modern manufacturing present a real opportunity for the EU to pursue more distributed and sustainable socio-economic growth across its diverse regions.

It should be noted that innovation and industrial policy is very much back on the agenda driven by concerns over competitiveness, globalisation, de-industrialisation, unemployment and the comparatively slow growth of economies in the post-recession phase. At the same time, industrial policy has been seen as a catalyst for designing economic recovery strategies at regional, national and EU levels as offering the potential to stimulate the development of new "clean-tech" industries to tackle environmental challenges, to help "rebalance" the economy, and to support new forms of manufacturing driven by a perceived "new industrial revolution" (Bailey et al, 2015).

Figure 1. Key themes of the Policy Think Piece

Why manufacturing matters for Europe?

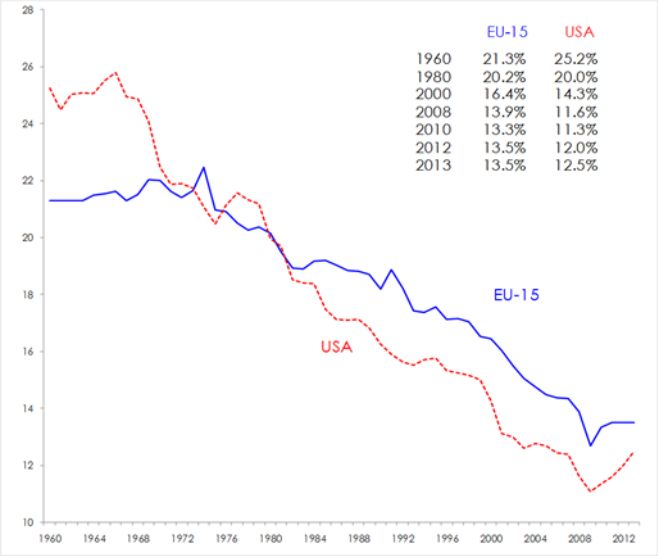
Manufacturing hollowing out presents a number of costs for EU economies. Various streams of research contested the assumption that manufacturing processes and innovation might easily be decoupled and relocated independently of each other. This means that the offshoring of labour-intensive manufacturing functions could pull along also more innovation-intensive ones, potentially destabilizing the EU innovation base. This is already seen to be occurring in pharmaceutical, advanced engineering and ICT. The demise of manufacturing activities results in an impoverished "industrial commons that had previously fuelled advanced economies" innovation capabilities and allowed suppliers in emerging economies to gradually climb up the value ladder, through so-called processes of "learning by supplying".

The loss of skills, competences and tacit knowledge across a sufficiently diversified suite of sectors could have also a long term effect on the ability of EU regions to maintain an industrial base able to secure long-term prosperity for its citizens. Indeed, critiques of novel forms of organization have pointed to the larger societal drawbacks of the offshoring "bandwagon", highlighting how the "hollowing out" of large firms and the relocation of manufacturing abroad contributed to increasing levels of inequality in advanced societies.

The 2008 Global Financial Crisis (GFC) proved to be an "eye-opener" for advanced economies such as the United States and Europe since it showed the weakness of relying purely on services as innovative intangible value-creation processes (such as design, marketing, logistics, retail), while commoditised manufacturing had dramatically shifted towards emerging economies. Post GFC, there has been a renewed recognition that manufacturing matters (Bailey et al, 2015). Indeed, in Europe for instance 80% of exports originate from manufacturing industries; more broadly, the trade surplus has been argued to be one of the main triggers of economic recovery in the Germany for instance. Also 80% of R&D spend in Europe is associated with manufacturing activities (European Commission, 2014). Manufacturing industries (as statistically defined) account for one in four private sector jobs and up to one in three in Germany, Italy or France); moreover, for every manufacturing job, two other jobs are created (ibid). As Europe and the US attempt to rekindle a sector they had neglected, data shows that the share of manufacturing in GDP (at current prices) for the United States and EU15 saw an increase after 2008 (see figure 2 below). We are interested in understanding the drivers that let manufacturing to pick up somewhat after the 2008 economic crisis.

As Aiginger (2015) notes, increasing attention towards the manufacturing sector, and calls to limit or reverse its decline have arisen since 2000 at least for two reasons: firstly, emerging-market countries inroads into global manufacturing; and secondly, industrialised countries experience of the impact that bubbles in non-trade related sectors had on the severity and length of the financial crisis.

Figure 2. Percentage shares of manufacturing in GDP

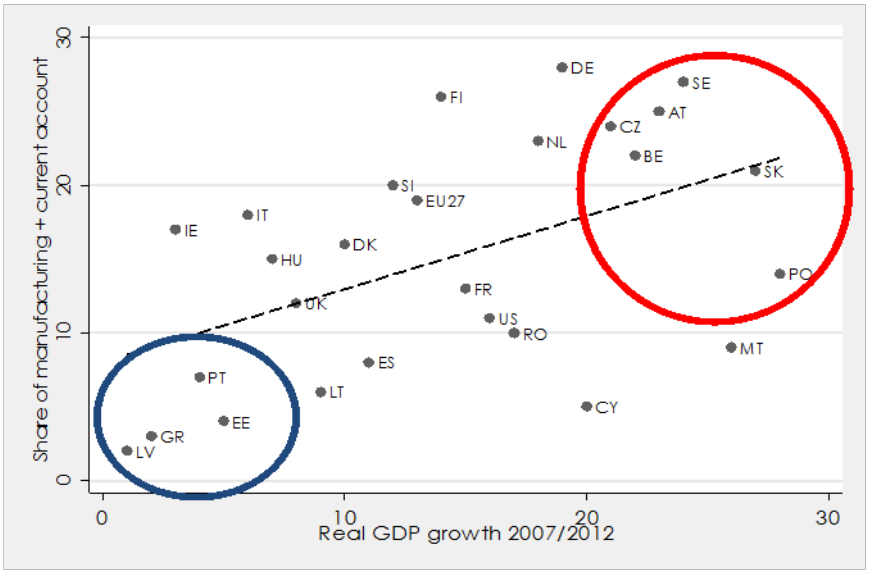


source: Aiginger, 2015

On the first point, industrialised countries are losing market share to emerging-market manufacturers, which are making inroads in more sectors, and not only in traditional, labour-intensive ones. China now has the largest industrial sector in absolute terms. The trade deficits of several large industrialised countries have grown and can no longer be offset by service exports. This has resulted in large current-account deficits (especially in the United States, as well as in the United Kingdom, France and Italy) (ibid).

On the second point, countries with current account deficits at the start of the crisis together with a small manufacturing base endured a particularly long crisis and output is often still lower than in 2007 (see figure 3 below). As Aiginger (2015) notes, in Southern Europe, where the share of manufacturing declined to 11% (2012) from 16% (1960), and current account deficits amounted to 13% of GDP before the crisis, GDP is today still more than 10% below its pre-crisis peak. Ireland, which also had a severe crisis resulting from bubbles in the construction and finance sectors, recovered more quickly in part by boosting exports through its industrial base.

Figure 3. Depth of the crisis vs. "industrial base"



source: Aiginger, 2015

The renewed interest in "making things" has coincided with an understanding of the fundamental impact that new technologies are going to have across sectors. We would argue that in such a fluid context, the interplay between the local and the global scales is redefined (see below).

Towards a new manufacturing model ("Manufacturing 4.0")

The manufacturing sector is changing and a new manufacturing model is emerging as Marsh (2015) outlines in his excellent report for the OECD. Recent scholarly debate has also unpacked this "production organisation revolution". It is timely to understand what form this new manufacturing model will take in Europe and how it can contribute to the European growth and jobs agenda. Indeed, the core of this new manufacturing model is that it may offer *the potential to develop and anchor manufacturing activities* in a high-cost and affluent economy such as that of the EU.

Three drivers essentially enable the new manufacturing model:

(1) *technological changes and the pervasive penetration of digital technology are enabling distributed and cross-media digital communications.*

Technological change has always altered economic activities by introducing new ways of organising production inside and between firms, the use and composition of new resources, and new skill requirement, but it also forces new constraints. Mechanisation, steam power, and Taylorism contributed to the "first" industrial revolution where Marshallian industrial districts and cottage industries were dwarfed or replaced by mechanisation, convoy belts and factories. Standardised demand was satisfied by mass production thanks to scale and scope economies. The breakup of mass markets led to the resurgence of firms' localised clusters (notably the industrial districts of the "Third Italy") as accumulation loci for economic growth thanks to their flexibility and innovation. Technology and globalisation made the world smaller and more interconnected; new players entered global markets and the production paradigm saw multinational corporations controlling global value chains delivering mass production to a global demand. In parallel, there has also been a second production paradigm associated with new industries centred around either the

technological capabilities of universities or the intangible creativity of embedded competences such as in industrial clusters.

The new manufacturing model coincides with locally embedded small-scale manufacturing firms addressing significant and expanding market niches of uniquely customised or small batch demand. Such productions rest not on scale economies but on other forms of firm efficiencies able to ensure adaptability, responsiveness and innovation. Technological change is become pervasive with concepts such as cyber-physical systems, the Internet of Things and the Internet of Services, leading more broadly to the vision of Smart Manufacturing or "Manufacturing 4.0" which Peter Marsh has detailed in his work (Marsh, 2013).

(2) *A new emerging demand.*

There are untapped market niches for personalised, customised and innovative products. These need to be produced in small batches or even as unique pieces. Such demands cannot be satisfied by the mass standardised products that low cost economies have completely captured. Such niche markets require customers to co-innovate or even co-produce with the manufacturer or the maker. Technology such as 3D printing is now available to enable innovators and inventors to become manufacturers and further to connect directly with markets -no intermediaries. Closer interaction between manufacturers and customers translates into more distributed consumption of distributed manufacturing, whereby customers source or commission the-making-of-products locally. Equally, digital communications empower manufacturers to produce locally whilst customising and selling globally.

(3) Sustainability and the green agenda.

Recent research (see www.foreurope.eu) shows that well known concerns (that the green agenda pushed by the EU equates with costs for businesses in the short term as they adjust) must be counterbalanced by the opportunities that it offers. Research suggests that firms that innovate with green new products or processes perform better than those that innovate more broadly. Green innovations have created new niche sectors and in them new "green gazelles", fast growing firms that have identified fast growing markets unlocked by new regulations. Indeed one needs to examine processes and systems in their entirety along the manufacturing value chain in order to identify changes that will provide holistic solutions to embed socio-economic-environmental sustainable management practices.

Overall, "distributed manufacturing" or "Manufacturing 4.0" or the "new manufacturing" are all terms used to capture the rapidly changing geographies, organisational structures, value chains and distribution networks associated with new advances in materials sciences, engineering, "smart" and flexible machining, and digital and enabling technologies (EPSRC, 2013). These developments include a shift towards smaller-scale local manufacturing, encouraged by changes in transport and labour costs, the availability of materials and energy, the need for sustainability, and access to information. It is thought that this smaller scale manufacture has been made possible by combinations of new technologies; for example developments in ICT as an enabling technology, flexible manufacturing equipment, and new manufacturing processes. These in turn are seen as driving the development of new business models and value chains, changing dynamics of work and community, and are thought to have implications for industrial policy (ibid).

Hence manufacturing 4.0 coincides with locally embedded small scale manufacturing firms addressing significant and expanding market niches of uniquely customised or small batch demand. Such productions rest not on scale economies but on other forms of firm efficiencies able to ensure adaptability, responsiveness and innovation. Such productions would exist at the interface between local and global spaces (see below on local and global value chains).

In a developed and relatively slow growing economy, manufacturers are driven by change; they must increase manufacturing flexibility to meet the demand for more personalised and customised products. The new manufacturing model requires:

- Flexible processes able to produce a wide range of products from one manufacturing plant.
- Low capital per unit of production and lower inventory upstream, in process and downstream.
- The development of manufacturing processes with lower costs and equivalent/improved quality.
- Increased velocity through the Research-Development-Innovation pipeline; shorter gaps between demand and manufacturing; multiple batches of small-volume products to be delivered near the point of use; linking plants in networks using smart ordering, scheduling, control and delivery systems using "big data" approaches.
- More sustainable processes that use resources efficiently through remanufacturing and the reusing of components or the use of bio, waste or natural products as feedstocks.

Box 1. Some questions for policy makers:

Will it be possible to network new manufacturing plants into systems that can supply both mass demand and personalised products? A new manufacturing model will need great collaboration between enterprises. What form would this take and how could it be promoted locally?

To what degree will firms require local anchoring? Will new manufacturing enable rural and urban convergence in manufacturing intensity?

Some industries will lend themselves to a distributed approach more easily than others. Which are the best examples, regionally, which want to make the change and how can this be supported?

Does a new manufacturing model favour SMEs, medium sized companies or large companies in this region? Can incumbent large companies change to distributed models? What technological shift is necessary for it? Does it require major industry restructuring?

Are the necessary workforce skills being developed in the region for the new manufacturing?

How can regional innovation-centres facilitate and accelerate the growth of new manufacturing?

How can policy promote cooperation between firms that is critical in the new manufacturing?

A shift to "Manu-Services"

The traditional model of economic development envisages a sequential transition through distinct categories from primary (extractive) to secondary (manufactures) to tertiary (services) to "quaternary" (intellectual, knowledge-based) as part of economic modernisation (Pike et al, 2013). In the latter stages, economies are seen as developing specialised services adding further value and sophistication and a transition toward the knowledge-based economy, along with the application of sophisticated knowledge in new products and services creating defensible positions against lower cost competition and imitation (Pike et al, 2013).

This model has been influential for policymakers who identify manufacturing with the "past" and services with the "future". However, this model has received criticism due to its overly simplistic logic and the crude categorisation of activities. As Pike et al (2013) note, a specific weakness of the model can be seen in the emergence of "manu-services" where firms actually combine goods and services into packages. Typically, this involves manufacturing businesses used to producing tangible things having to understand and invest in intangible assets such as R&D, design and brand equity and becoming "hybrid" manufacturers. Different forms of intangibles are important for different manufacturing sectors; for example R&D can be seen as key in pharmaceuticals while branding and design may be critical in clothing. "Manu-services" may potentially benefit from having a skilled and adaptable workforce, a strong and internationalised service sector, and high quality universities and research and technological development institutions.

The evolution of manufacturing into manu-services has a number of implications for regional economic resilience. First, "Manu-services" can be seen as an area of non-technological and "soft" innovation. This raises the challenge for manufacturing businesses in thinking how new combinations of goods and services can meet existing, new and unmet needs and how this might be profitably and sustainably delivered. This may involve the ways in which the manufacturers interact with their customers and suppliers as well as how they organise their innovation activities and marketing. Second, to benefit from the growth of manu-services and underpin their own future resilience, manufacturing businesses will have to adopt different ways of thinking and business strategies and models. This will include fundamental review and reflection on what manufacturing businesses do and how they do it, often requiring new ways of organising and new skills.

As Pike et al (2013) suggest, manu-services could provide one specific area where differentiation and competitive advantages could be built that could contribute positively to regional economic resilience.

Box 2. Some questions for policy makers:

- *How can smart industrial strategy and policy support the networks for the non-technological innovation required by manu-services?*
- *How can the barriers of risk, capital and transition faced by manufacturing firms keen to develop manu-services be overcome?*
- *How can manu-services make a stronger contribution to the region's resilience than "pure play" manufacturing firms?*

From Global to Glocal Value Chains

Production dynamics and organisations change as the division of labour adjusts to respond to changes in the nature and geography of demand. There is not an optimal organisation of production in absolute terms. The volume production of the Fordist factory successfully satisfied large numbers of first-time buyers with homogenous products, but once consumers became less predictable and demanded variety and innovation, successful organisations became those that were flexible and responsive. The disintegration of the production process in the post-Fordist era was driven therefore by efficiency gains no longer related to scale economies but to external and agglomeration economies that nevertheless required geographical proximity. This is evidenced by the huge literature on clusters and industrial districts that has developed since the 1990s (Becattini et al 2009).

The decomposability of the production process meant that individual production functions could be carried out separately from the others, powering the entire production process with great flexibility. The cluster model paved the way for a new way of organising of production, one where the production line was replaced by a production system populated by firm-to-firm market or quasi-market transactions. Indeed task-specialised firms could plug themselves into the production system or supply chain, hence being complementary whilst integrated. Firm-level economies of scale and scope were replaced by system-level agglomeration and external economies, whereby firms benefitted from the latter as systemic economies were underpinned by the spatial proximity of supply chain outsourcing.

The offshoring of outsourced manufacturing functions occurred soon after as the forces of globalisation swept the world of production. It coincided with the choice either to rely on suppliers - especially for labour intensive activities - no longer located inside the local system or the local economy but in lower labour cost countries; or to shift production activities to the same lower labour costs countries through foreign direct investment. Over the 1990s and 2000s, Central and Eastern Europe (CEE) and East Asia became key beneficiaries of such trends.

A wealth of literature going back to the 1970s has dissected the drivers of firms production internationalisation strategies (why) and related operations (how). The location choices of multi-national firms are motivated by the contribution that different "places" can make to their overall division of value. More recently, Scholte (2000) argues that the globalisation of production activities has "de-territorialised" production choices.

The globalisation of production activities that emerged from the combined offshoring of manufacturing activities created so-called global production networks (GPNs) (Coe et al 2008), commodity chains (Gereffi and Korzeniewicz, 1994), or global value chains (GVCs) (Gereffi and Fernandez-Stark, 2011). Consequently, the Smithsonian division of labour became a division of "value additive functions", whereby each production stage contributes to a higher or lower extent to the value addition of the final output. Value chains comprise components that embody different value added content and which therefore contribute differently to the overall value added.

Manufacturing, production and assembly are deemed to produce low levels of value added, because in imperfectly competitive markets (i.e. global markets), a reduced price elasticity is constructed by embodying in products a high content of intangible value through innovation, advertising and marketing. There then appears to be those value chain functions that most contribute to firms' extraction of market power and are therefore higher in value-added. Value chains are defined as "the full range of activities which are required to bring a product or a service from conception, through the different phases of production (…) delivery to final consumers and the final disposal after use (…) Production per se is only one of a number of value added links" (Kaplinsky and Morris, 2002). What contributes most to the value added of the final production is clearly what is likely to be seen by the firm as a "core activity" or a "strategic activity". Global value chains tend to comprise a mix of arm-lengths market and internalised relations (Gereffi et al 2005).

Global value chains are models of organising production when the market is characterised by cost competition and firms pursue constant cost saving strategies. Such strategies peaked just before the 2008 crisis when the global economy found itself at the end of a technological cycle with incremental innovations increasingly exhausting technological opportunities (Rifkin, 2011). A number of recent contributions have suggested that the 2008 crisis has actually enabled a new technological wave to "bubble up" and seep across sectors. The applicability and pervasiveness of key enabling technologies are exemplary of a techno-economic paradigm emerging: Manufacturing 4.0, we would argue (see below). We believe that the value chain approach is useful to fully understand what manufacturing activities can a relatively high cost regional economy attract, develop, maintain, and be competitive.

Global scenarios are changing and some of the factors and conditions that made offshoring desirable and economically viable in the late 1990s and early 2000s are being reconsidered (hence the debates in the US and UK over "reshoring"); for example, increasing wages and inflationary trends in emerging economies, combined with relevant costs of quality control of offshore production, rising non-monetary costs of long-distance logistics, and production-distribution rigidities forced many practitioners to reconsider the offshoring cost equation. In the recent debate, we have pointed to some sort of counter-movement opposed to offshoring by offering cases and rationales for the re-shoring of production (Bailey and De Propris, 2014). Finally, digital manufacturing technologies–i.e. 3D printers, laser-cutting machines and the like– promise to challenge the scale imperatives of manufacturing processes in a variety of industries, by making business models based on small batches and customized items economically and financially viable to satisfy an emerging a new hands-on demand.

As noted above, there are a number of sound reasons for attempting a re-coupling of services and the making of such high value added manufacturing activities. Firstly, these activities are less sensitive to labour costs because they are less labour-intensive and less reliant on scale economies, but are instead deeply linked to innovation and design as well as post-sale services. Within the value chain framework, the process of increasing the servitisation of manufacturing coincides with the strategy of extending value creation both upstream and downstream. As noted, in the new manufacturing model, activities become therefore a hybrid between the assembling and the making, together with the designing, branding, innovating, advertising, and servicing that directly or indirectly involves the customer or user. Secondly, there is a new generation of products for which a co-production of innovation between the producer and the user is necessary to the extent that innovation tends to be embedded in the production itself. These are by definition highly customised products with very detailed specifications. Their uniqueness warrants the co-location of innovation and production.

We believe that "high cost" economies can still have a "competitive" manufacturing sector, or rather the portion of it that comprises extremely high value-added activities, as seen in Germany, Scandinavian economies, and to some extent France. High-value engineering, manu-services, personalised manufacturing, or high tech manufacturing are all the labels used to describe the making of "things" with a high content of technology, innovation, customised design or servicing. These are "things" for which demand is less price-elastic and for which therefore technology, knowledge and innovation shape the competitiveness contest.

Box 3. Some questions for policy makers:

- *What will the value chain look like in specific industries? How are firms connected along the value chain in the new model? Will the value chain be internalised in firms or externalised across firms? Which sectors and technologies should the region aspire to retain and grow?*
- *What activities could be reshored? What activities could remain onshored or EU-shored? And how can policy assist or unblock reshoring of manufacturing activity in the context of firm realigning their global value chains when examining the new manufacturing?*
- *Does the integration of high value-added services affect the composition and performance of Manufacturing supply chains with a presence in the region?*

Skills for the new manufacturing

While the debate on the nature and role of manufacturing in advanced economies is still fluid, analyses of these various phenomena have percolated to the policy-making arena and manufacturing has re-gained centre stage in a variety of industrial policy initiatives in Europe as well as in the United States. One of the key bottlenecks for manufacturing renaissance identified in several countries is a more or less endemic skill erosion or skill gap depending on the extent of manufacturing hollowing out. Therefore, one of the fundamental areas of policy-making to support the upgrading and transformation of manufacturing in advanced economies is in terms of skill development. Recent surveys conducted by think-tanks and policy analysts (such as the Brookings Institutions' series on Advanced Industries) urge scholars and policy-makers to devise innovative strategies to avoid a mis-match between the competences firms require and the skills the labour market is able to channel from the education sector. A constantly topped up (replenished) pool of human capital that is able to match or even to anticipate firms' need appears to be a condition for ensuring the transition to novel forms of manufacturing and, in turn, economic and employment growth. Local labour pools of talents are crucial for small and medium sized enterprises rarely able to recruit globally as multi-national enterprises might be doing. This means that policy has a chance to connect or re-connect the education and training systems with the local labour market and thereby the local industrial sectors.

The new manufacturing model will require new sets of skills and new know-how; the ability to translate knowledge to bridge distant practises, and the adaptability to apply, to transfer or to stretch competences in unconnected contexts. It can be suggested that the new manufacturing model require more complex combinations of skills that somehow meshes together dimensions of competences that have been until now seen as separate, as per the well-known division between analytical, synthetic and symbolic knowledge suggested by Asheim (2012).

An additional point is the investigation about the new skills required by the internationalization process undertaken by companies. For larger firms, the right skills may more easily be acquired in their standard recruitment process; for SMEs, in particular for those extending abroad "firm specific assets "created through local externalities, the right skills to govern an international organization are far more difficult to find. To keep industrial commons operating at local level in a framework of international organization of production, a specific investment in human capital is required.

The debate on education and training policies in the last 20 years was influenced by the overall debate on the transformation of the economy. In particular, the purported specialization of developed economies on "intangible" activities and processes influenced policies and reforms of national education systems. On the one hand, some point to the risk of skill shortages due to the demise of vocational education and training in some countries (i.e. Italy), while other point to the virtuous cycle ignited by a focus on vocational education and training in countries like Germany. How higher education contributes skills and competences to a novel and redefined manufacturing sector is another area where crucial research questions emerge. The governance of systems of skill formation and the creation and re-creation of industrial commons are, more specifically, key questions for policy makers.

Box 4. Questions for policy makers

What sorts of skills and human development needs will the new manufacturing need and how will policy at different levels – locally, regionally and nationally - need to adjust?

The emergence of "Phoenix industries"

Phoenix industries have been described as clusters of small and medium-sized businesses working with broadly similar technologies that have sprung up in former industrial areas. They benefit from the historic, relatively immobile, investments in industry knowledge and workforce skills that have taken place over a long period of time in these areas. They typically research, develop and produce sophisticated components for use in a range of industries and hence are sometimes described as "enabling industries". Christopherson (2009; 79) describes them as benefiting from "initial advantage" including "personal networks, technical skills and market knowledge that have developed over a long time, giving them an edge over less "rooted" clusters in the same industry." Such phoenix industries can be seen as a potential escape route from "negative lock-in" for old industrial regions on a declining development path - either as a source of "escape" from an existing path or as offering a more positive, evolutionary path.

The notion of phoenix industries is related to the wider literatures on regional economic trajectories. Whether they are viewed as providing radical or evolutionary change varies depending on how tightly the initial definitions of a region's industrial strengths are framed. More narrow, static, definitions of existing cluster strengths make it less likely that opportunities for inter-industry evolution and growth will be identified. A number of factors are identified in the literature as being important to the development of a phoenix industry in an old industrial area. These include the presence of: relevant skills in the local labour force and in (potential) supplier firms; technical skills and expertise in nearby colleges, universities and other training or research facilities; personal networks and market knowledge related to the industries concerned; capital for investment; and reputational factors.

Relevant skills in the local labour force and in (potential) supplier firms

Christopherson (2009) describes how advanced manufacturing firms can find the necessary expertise, capital and labour force skills to be able to innovate and expand in places where there have been long-term investments in industry knowledge and workforce skills. These are typically areas where there are many firms working with broadly similar technologies. Treado (2010) examines the successful transition of Pittsburgh, in the United States, from a steel making town to home to a successful steel technology cluster. Although the area lost most of its steel-making capacity, it did not lose its steel-making expertise. She identifies the key factors in this transition as being the area's location, its industrial legacy and its labour expertise. According to Treado, *the ultimate source of regional resilience in the Pittsburgh case – and in the other studies she has reviewed – is the surviving industrial expertise of the regional workforce.* Here, the technical knowledge of the workforce was the overriding reason given for a firm's choice of location in the Pittsburgh area.

Technical skills and expertise

Similarly, Christopherson (2009, 78-9) characterises phoenix industry firms as benefiting from "initial advantage". This is seen as making them different from more traditionally described industry clusters. Specifically, such firms are seen as benefiting "from personal networks, technical skills and market knowledge that have developed over a long time" (ibid). Hence, although many routine production jobs have been lost in these industries, the knowledge of how to produce and innovate has remained to some extent. This could be, for example, in the courses run by local universities and in the skills of the labour force. Similarly, Treado (2010) highlights the importance of Pittsburgh's broader tradition of expertise in materials-based industries, for example the expertise contained within the engineering departments of the region's major universities, plus the location of a number of major private sector research facilities in the region, and the fact that several important trade associations and relevant professional societies are headquartered in the region. Amison and Bailey (2014) highlight the role of universities in the phoenix low carbon automotive and manufacturing cluster in the Midlands, United Kingdom.

Availability of capital

Christopherson (2009) references the availability of capital as a factor that may contribute to the establishment of a phoenix industry.

Reputation

Treado (2010) argues that regions such as Pittsburgh, with a strong reputation in a particular industry or set of industries, may find reputation-building easier than other regions. Although globalisation has increased the range of possible locations where production may take place, it has also increased the search costs of finding the right supplier. The location of a supplier within a well-known cluster can therefore act as a signal that purchasing firms may use to help narrow their search options.

The ability to apply new technologies

Christopherson (2009, 78) argues that industries in old industrial areas may have "the key assets needed to support process and product innovation and the actual application of new technologies." Work on the United Kingdom Midlands low carbon auto cluster by Amison and Bailey (2014) found that "There is evidence from the interviews conducted with firms in the Midlands low carbon cluster that, in a number of cases, the specific skills necessary to produce innovative products or components were embedded within firms' workforces. In some cases, this was the principal means of protecting the firm's intellectual property. To some extent, phoenix industry firms can be seen as an environment in which knowledge and skills related to "old" and "emerging" technologies are combined. Physical products, largely, still have to be developed, made and tested to prove their worth – they cannot just be designed. It is this ability to combine "old" and "emerging" technologies which appears to have contributed to the success of a number of the firms in the cluster.

The "initial advantage" possessed by phoenix industry firms and their ability to develop and apply new technologies means that they can have an important role to play in the deployment of "smart specialisation" strategies (see below).

In contrast to a number of other cluster studies (for example Todtling and Triple, 2004), Treado (2010) found university-cluster firm linkages to be relatively unimportant in the Pittsburgh case. She cites Christopherson and Clark's (2007) finding that this was typical of small firm clusters, perhaps because they cannot accumulate the investment necessary to access university research knowledge. In the Midlands case noted above, however, university linkages were indeed found to be important to firms. This may in part be due to the advanced nature of the technologies involved. The greater significance of university-firm linkages in the Midlands case could also be a result of the important role that publicly-funded R&D projects were found to play in the sector. These R&D projects encouraged collaboration between firms and between firms and universities.

The role of many small and medium sized firms in replacing their large-firm predecessors in old industrial areas was highlighted by Christopherson (2009). The new firms are characterised as typically developing and producing sophisticated components - or prototypes - for products manufactured globally. The term "enabling industries" is sometimes used to describe such groups of firms, as they develop technologies used in many different industries. A number of the firms interviewed were involved in the production of sophisticated components, or prototypes, for products manufactured by other firms either locally or on a worldwide basis. They were typically "suppliers of innovation" to their customers, usually combining a mix of R&D, engineering services and low volume manufacturing capabilities. An important feature of the sector was the extent of collaboration between firms, encouraged by state-supported collaborative R&D projects. In addition to reducing the cost of undertaking R&D, firms also benefited

from participating in these projects because of the opportunities they afforded for identifying and working with firms that could subsequently become partners, suppliers or customers in fully commercial ventures.

In Treado's (2010) work on the Pittsburgh Steel Technology Cluster, member firms were linked by the market that they supply rather than the product they produce. All of the firms sold to the steel industry but rarely did they sell exclusively to that industry. A corresponding pattern was found by Amison and Bailey (2014) in their study of the United Kingdom Midlands low carbon cluster. Many of the firms interviewed served industries beyond automotive. The most often named customer industries were aerospace, defence and motorsport but firms were also involved in supplying industries such as renewable energy and medical technology. The more diversified nature of these firms' markets, particularly when compared to their large-firm predecessors, should mean that the economy of the local area is more resilient to single-industry shocks, and may be seen as a response to previous industry shocks. It also opens up possibilities for further diversification of the region's portfolio of industries, increasing related variety, which is expected to enhance regional growth.

Box 5. Some questions for policy makers:

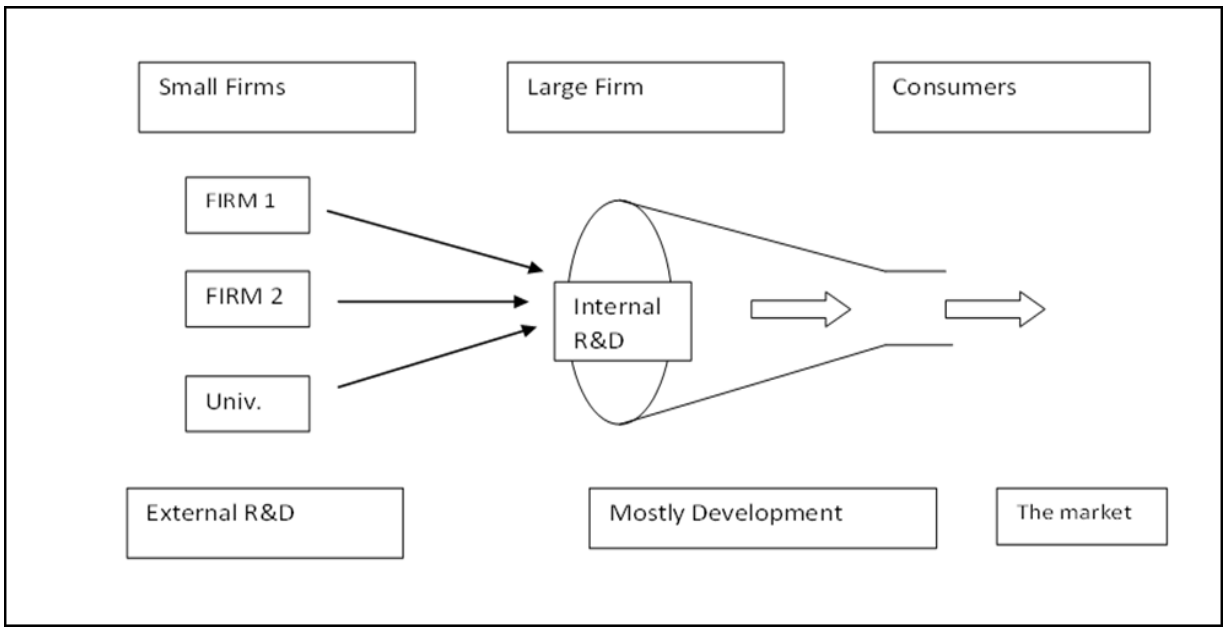
Are there existing Phoenix industries in the region, or is there the potential for Phoenix industries to emerge? How can such industries be supported?

Towards an Open Innovation Model

Linked to the emergence of phoenix industries in some mature industrial regions, the process of innovation has become increasingly "open" (Chesbrough, 2003), shifting from taking place within a single firm to taking place across firm boundaries – involving other firms, universities, research institutes and end users. For individual firms, such an approach enables an extension of the pool of knowledge and competencies on which they are able to draw. This is particularly relevant for industries or technologies where knowledge is widely distributed and firms cannot establish or maintain sufficient in-house capabilities. Such "open innovation" approaches, it has been argued, can raise profits, increase speed to market, enable firms to expand their markets and are seen as desirable at times of rapid technological change (Chesbrough and Crowther, 2006).

As Chesbrough has noted, "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology" (ibid). In this sense, the boundaries between firms and their "external" environment become more permeable, with an easier flow of innovations in and out of firms (see figure 4 below). In essence, where knowledge is widely distributed, firms cannot just rely on their own innovative activities: they can and should access patents and processes from other firms, whilst also allowing their own unused innovations to be utilised externally through licensing, spin-offs and joint ventures (Chesbrough, 2003a). Chesbrough's earlier (1996) work also looked at the appropriate organisational form required where innovations could be autonomous or systemic, and whether the capabilities firms need exist internally or externally.

Figure 4. An Open Innovation System



Source: after Chesbrough 2003

In the automotive industry, for example, the innovation process has traditionally been shaped by the vehicle makers and has mostly been undertaken in-house. However, as the range of technologies that are important to success in the industry has expanded in the light of environmental, regulatory and demand-led challenges - ranging from electronics, to digital, to new fuel and power technologies, and to lightweighting – the role of specialist suppliers of knowledge, R&D and components has become crucial for innovations of a more systemic nature. As a consequence of the trends described above, manufacturing in many "traditional" regions are confronted with managing a major transition. The former volume producers in several industries such as automotive have closed plants along with some significant suppliers. However, much of the broad supply matrix is such regions is often still geared to this former volume production and is having to seek new customers and a diversified product range.

Until recently most local policy spending was often geared to the retention of this segment of the industry but over the last five years, or so, a policy shift has occurred in some regions. Now, as well as concentrating on process improvement, private and public actors are trying to develop new generations of technology – e.g. such as low carbon vehicles and autonomous vehicles in old automotive regions. The recent crisis, and the political pressures that have followed, may, arguably, be giving further impetus to these efforts with the promotion of more environmentally friendly vehicles and more sustainable business models.

The Niche Vehicle Network in the United Kinfdom's Midlands is one manifestation of this new direction. Its attempts to develop new technologies through a network of small and medium sized companies can be compared to the open innovation model (Chesbrough, 2003). Trust is a strong element of relations in this Network. The companies are of similar scale and have complementary skills. They thus feel able to be open and share ideas. As such they fit more closely a Granovetter-type "social network model" that contrasts with adversarial interactions prevalent in the industry.

Box 6. Questions for policy makers

Do any of the region's manufacturing sectors lend themselves towards open innovation approaches? How can they assist the region in diversifying?

What role is there for policy in bringing actors together in a discovery process, and in terms of the possibilities of building smart specialisation strategies and industrial policies which are aligned with "high-road strategies"?

What does this mean for resilience and regional industrial dynamics?

The resilience of regional manufacturing refers to its ability to withstand and ride-out, react and respond, and bounce-back from, as well to as anticipate and prepare for disruptive change (Martin, 2012; Pike et al, 2013; Bailey and Berkeley, 2014). Such changes include rapid external shocks such as plant closures, financial crises, extreme weather events, natural disasters and technological leaps as well as "slow-burn" processes such as de-industrialisation, climate change and demographic shifts. Resilience can narrowly defined as the ability of entities or systems to rebound to their previous form and position from a disturbance but researchers recognise that it is "fuzzy concept" with no consensus on its meaning, and roots in multiple disciplines (Pike et al, 2010; Pike et al, 2013; Bailey and De Propris, 2014b).

In exploring the resilience concept, Martin (2012) distinguishes four dimensions of regional resilience: resistance (the degree of sensitivity or depth of reaction to a recessionary shock); recovery (the speed and degree of recovery from a recessionary shock); re-orientation (the extent of re-orientation and adaption in response to recessionary shock); and renewal (the extent to which the regional economy renews its growth path, whether a pre-recession path or a shift to a new path). Udine has shown considerable ability to reorientate and renew in response to past shocks – such as the earthquake of 1976. The recent challenges for manufacturing districts such as those in the region require not only resistance and recovery (on which the city's manufacturing industrial districts have actually performed quite well) but also elements of renewal and reorientation. In this regard, while "resilience" can be seen overall as a useful term, the relevance and value of the term for this particular region and its response perhaps lies less in the "resistance" and "recovery" dimensions and more in terms of "re-orientation" and "renewal".

In this regard, the emergence of new manufacturing models and practices could be a major stimulus for disruptive change, challenging the resilience of existing regional manufacturing centres. Potential benefits include: new business models; opportunities for the geographical relocation of activities; reduced minimum efficient scales of production; more flexible and agile production processes and networks; lower carbon and more sustainable manufacturing systems; and, innovation, knowledge spill-overs and stimuli for upgrading toward higher value-added and higher productivity activities in global value chains to foster regional manufacturing output growth, investment and employment. Conversely, possible costs comprise: increased competition and new market entrants; adverse shifts in factor costs especially energy, labour, raw materials and transport; increased needs for investment in R&D and innovation; the reconfiguration and heightened risks in logistical systems; downgraded and/or redundant growth paths tilted toward lower value-added and less productive activities; and, the contraction in regional manufacturing output, investment and employment. The "adaptive capacity" of regional manufacturing centres is integral to their resilience.

Box 7. Questions for policy makers:

How can the region measure, model and analyse the resilience of regional manufacturing in the face of new models of manufacturing? What kinds of methods, data sources are required?

What factors promote and inhibit the resilience of regional manufacturing in response to new models of re-distributed manufacturing?

What sorts of policies and support activities/services can help build the resilience of regional manufacturing centres and their adaptive capacity within new manufacturing networks?

Towards an industrial policy for regional industrial resilience

The emergence of a new manufacturing model presents potential benefits for EU regions, such as new business models; opportunities for the geographical relocation of activities; reduced minimum efficient scales of production; more flexible and agile production processes and networks; lower carbon and more sustainable manufacturing systems; and, innovation, knowledge spill-overs and stimuli for upgrading toward higher value-added and higher productivity activities in global value chains to foster regional manufacturing output growth, investment and employment. Conversely, possible costs comprise increased competition and new market entrants; adverse shifts in factor costs especially energy, labour, raw materials and transport; increased needs for investment in R&D and innovation; the reconfiguration and heightened risks in logistical systems; downgraded and/or redundant growth paths tilted toward lower value-added and less productive activities; and, the contraction in regional manufacturing output, investment and employment. The adaptive capacity of regional manufacturing centres is integral to their resilience. The resilience of regional manufacturing refers to its ability to withstand and bounce back from disruptive shocks as well as to anticipate and prepare for inevitable changes. For this a regionally-based pro-manufacturing innovation and industrial policy is necessary.

Such a "place-based" approach sees knowledge as critical for effective policy development (Barca, McCann and Rodríguez-Pose, 2012, Barca, 2011). Yet within this perspective, it is recognised that such knowledge is not already known either by the state, firms or local stakeholders. As a result there is a positive role for policy in aiming to stimulate new knowledge and ideas through interactions between local groups (endogenously) and external actors (exogenously) (ibid). Linked to this, the "smart specialisation" approach has been closely linked with place-based approaches to regional development policy, at least in how they have been developed in the European Union. In particular, in terms of regional policy it has been used to emphasise the need to exploit related variety, build regional embeddedness and enable strategic diversification (McCann and Ortega-Argilés, 2011). In so doing, it stresses the need for regional actors (government, firms, universities, research institutions) to collaborate, recognising the current starting point for the region in terms of skills, technologies and institutional governance and then to build on these capabilities rather than trying to start "from scratch".

This approach thus sees the capacity of territories to root their economic activity into the local institutional fabric as being at the heart of their economic success, through the generation, acquisition and exchange of knowledge. Yet such knowledge is in turn uncertain and is embedded in localities and needs to be uncovered through participatory and bottom-up processes to build consensus and trust. Indeed, as noted earlier, the tendency of the "state" is to lack both an understanding and knowledge of local places (it lacks a "sense of community", with a consequent weakness in its capacity to adapt its approach towards local places and mediate local consensus and trust between local actors as well as to mobilise local resources effectively (Hildreth and Bailey, 2013).

This place-based smart specialisation approach has strong parallels with Rodrik's (2004, 2008) perspective of *industrial policy* as a process of discovery requiring strategic collaboration between the private sector and state in unlocking growth opportunities, but set within a framework of multi-level governance so as to enable a process of local collaboration and discovery, while enabling external challenge to local elites engaging in rent-seeking behaviour. So industrial and regional policies which facilitate this process of discovery through strategic collaboration are seen as relevant under place-based / smart specialisation perspectives and require appropriate institutions to engender this.

In fact this is largely how modern, intelligent industrial policy design is conceived of in contemporary debates (see Rodrik, 2004 and 2008), with industrial policy ideally having the quality of "embedded autonomy", whereby it is not captured by firms and sectors, but where, as noted, it focuses on the discovery process, where firms and the state learn about underlying costs and opportunities and engage in strategic coordination. So for example, in the context of reshoring possibilities for manufacturing, it might mean government working with industry to identify key fractures in the supply chain and how to address them. This is no longer about "picking winners" or propping up failing firms or industries but rather, as the IPPR and Northern Economic Futures Commission (2012; page 9) note, for example, about "seeking to identify and support the elements of comparative advantage within the economy that enable innovation and new technologies to take root and companies to grow."

This could entail examining what might a regional industrial strategy might look like, identifying sectoral trends, analysing emerging strengths and opportunities identified, and carrying out analysis of the export potential of key sectors in which the region already holds emergent strengths and which can be built on in a "smart specialisation" sense.

The latter requires regionally-based industrial development strategies promoting "related diversification". Such strategies need to recognise (i) the need to bring together different but related activities in a region and (ii) the differing potentials of regions to diversify, due to different industrial, knowledge and institutional structures linked to specific regional historical trajectories. Rather than "starting from scratch" or applying "one size fits all policies", regional industrial strategies instead require tailor-made policy actions embedded in, and linked to the specific needs and available resources of regions, starting with the existing knowledge and institutional base in that region. These need to capitalise on region-specific assets, rather than attempting to replicate and apply policies that may have worked in quite different places.

To exploit the region's potential based on "related variety", and to broaden and renew the region's industrial structure by helping it branch into new related activities, policy could encourage crossovers between manufacturing industries. This could come via knowledge transfer mechanisms that connect related industries, such as by: (i) enhancing entrepreneurship from related industries (targeting such entrepreneurs would not only increase the likelihood of successful policy, but could also contribute to regional diversification); (ii) encouraging labour mobility between related industries, as it transfers knowledge between industries and may lead to new "recombinations" of knowledge (such labour mobility could also increase the level of human capital, as firms and employees learn from experience in related sectors and in turn helps regional resilience as workers can move between sectors); (iii) supporting collective research collaboration with partners from different but related competences.

Examples of manufacturing sectors that have been able to become smarter and to upgrade locally embedded traditional industries can be found in Sweden as a result of very forward looking innovation policies carried out by VINNOVA. A declining textile cluster in Boros has been diverted from a path of lock-in and transformed into a Smart Textiles system that applies a "triple helix model" to create textile innovations that find application in distant sectors such as the healthcare sector and the environment; such as fabrics that purify water using nothing but the sun as energy source, or materials that can take an

echocardiograph (ECG) or become cool at extreme temperatures. Another example is the attempt to recast the strong tradition in the forestry and process industries in the Örnsköldsvik area from pulp production to the Biorefinery of the Future: an initiative to develop biorefineries based on forest-based raw materials and energy crops in the form of bio-based green products, chemicals and fuels plus new energy solutions from industrial process streams. Finally, the winter tourism region of Åre-Östersund has broadened its offering through the Peak Innovation initiative to include becoming an internationally leading location for winter sports outdoor science research (such as testing and performance measurements), a leading destination for experiential all-year-round tourism and the production of winter sport and outdoors brands of products and equipment.

In line with this approach, for Friuli we would suggest examining a range of set of interventions that can be seen as horizontal since they cut across a number of sectors. These include:

1.skills upgrading and skills matching;

   a. hat sorts of skills and human development needs are required to create and anchor new manufacturing sectors in the region?

2. district based growth agenda coupled with placed-based collaborations;

   a. what is the impact of the new manufacturing model on firm diversity (large vs. small firms), is small beautiful again? How much do firms need to scale up to seize the benefits international markets, virtual markets?

   b. What ensures that local value chains (local outsourcing) are compatible with global markets (distribution and market positioning)

   c. Is sustainability creating new sectors and upgrading existing manufacturing sectors? Are greener local value chains favouring sustainable economic growth?

   d.Where will value be created? Innovation, making, servitising, retail, logistics? What will the value chain look like in some specific industries? How are firms connected along the value chain in the new manufacturing model? Will the value chain be internalised in firms, externalised across firms locally or external?

3. managed internationalisation processes to positively connect local value chains to global commercial circuits (certification, branding)

4. triple helix based technological or creative upgrading (government-university-business) to boost new firm formation and spinoffs through technology transfer; technological upgrading through business-uni collaborations;[1]

   a. What technologies are enabling cluster upgrading in traditional manufacturing sectors in EU regions? What drivers and pushers, as well as mechanisms are in place to activate cluster

[1] To improve links between small manufacturing firms and universities as well as private knowledge providers, the region might look at experience in other regions and countries with publicly funded innovation vouchers. Here small firms themselves select the providers of innovation services. Most voucher systems are limited to regional or national knowledge providers. Some schemes require co-financing by small firms, but the values of vouchers are relatively low, and many such schemes are supported by the EU's structural funds. Such schemes also help in terms of increasing innovation awareness among small firms.

upgrading? What are the drivers and pushers of high tech clusters in traditionally low tech manufacturing regions?

b. What innovation inputs and processes will firms/systems rely on? Is the triple helix model existent and working? How will regional innovation systems interface with national innovation systems and a global technological frontier?

For example, in terms of two of the (manufacturing) "specialisation" areas identified at a regional level:

Agrofood

The agro-food sector is very strong and has a solid presence in the Italian and foreign markets.[2] The strengths of the products are high quality, authenticity, traceability, and embedded intangible knowledge. The Coffee District, the San Daniele District (cured ham, cheese) among others, must maintain the truthfulness of their "brand" that other places are now trying to imitate and create. Innovations can intervene in the packaging, marketing, market positioning. The market growth needs to be associated with securing top end segments where informed, sophisticated and price inelastic consumers understand the value of the product. This avoids damaging price competitive confrontations. This strategy is linked with the transversal intervention of certification and branding. There is an emerging debate on food processing the importance of short value chains for food security and safety following some major food scares in Europe due to untraced ingredient entering international food processing value chains.

Around these core products, product innovations can create novel niche markets with new products or a variety of existing products that draw on the traditional competences but provides some customisation, market segmentations (see current trends of organic foods, gluten free or vegan). Some of these product innovations are linked to adjustments in the design and manufacturing processes that require inputs from, for instance, biotech or chemical engineering expertise. This is where triple helix collaborations can be extremely helpful to connect the industry's tacit knowledge with the more science-driven contributions.

Mechanical and interior design furniture

This area includes strong districts such as in mechanical engineering that have weathered the crisis with already positive export growth rates. Design, customisation, and constantly innovative tailored solutions are key to maintaining current market positions. The furniture segment has a more complex "tree" of strategic decisions driven by the possibility to access both top end markets with strong brands (underpinned by design, new materials, flexible products and customer co-created solutions) as well as the middle quality market reliant of logistics and distribution channels. The possibility of utilising the two market segments at different points in the product life cycle would enable firms to extract value from the different consumers. It would enable cutting edge innovations to be tested in high value markets to be then standardised in lower value segments.

Triple helix collaborations would enable the latest science driven innovations in design, new materials, chemistry or chemical engineering to be introduced in new products. Wood furniture production is strongly related to recent concerns with forest sustainability, energy and recycling. These issues can in themselves become value creation components of products that are capturing the attention of green

[2] The region's agro-food processing clusters could be strengthened in a number of ways: (i) technological upgrading by improving control of the value chain at the processing stage, thereby adding value to agricultural production (e.g. in bottling wine locally); (ii) focusing more on the certification of high quality agricultural products. Policy actions could include supporting marketing strategies and to advertise certified products in other regions and internationally; (iii) linking up with the agro-gastronomic cluster; this might mean promoting agro-gastronomic experiences rather than products as such.

champions. Indeed, sustainability can be sees as more than just a push to adopt more environmentally friendly practises, but rather as the opportunity to create whole new sectors or new markets in existing sectors (see Bailey et al, 2015b). This is an area where new firm formation should be encouraged through collaborations between universities and businesses via spinoffs, incubators and/or co-working spaces.

More broadly, the region has a number of historical, well embedded and resilient sectors and there is a suggestion that it aspires to diversify the regional economy by developing for instance a smart health sector (biotech and bioICT). There is indeed a vast literature suggesting that regional resilience rests on a sector diversified regional economy with a range of technologically connected and unconnected sectors (see Boschma, 2015). So whist initiating new areas of specialisation has its strength, we would flag up two majors considerations in so doing: one is that these new areas will only germinate and propagate if the regional economy creates around them triple helix systems able to pool knowledge from university and business, create a critical mass of firms and have a strong policy steer. Secondly, these new specialisations would benefit from, and would themselves benefit the local economy, if they connected with pre-existing areas of specialisation.

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