The Effects of Cluster Policy on Innovation

Compendium of Evidence on the Effectiveness of Innovation Policy Intervention

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The compendium is organised around 20 innovation policy topics categorised primarily according to their policy objectives. Currently, some of these reports are available.

All reports are available at http://www.innovation-policy.org.uk. Also at this location is an online strategic intelligence tool with an extensive list of references that present evidence for the effectiveness of each particular innovation policy objective. Summaries and download links are provided for key references. These can also be reached by clicking in the references in this document.

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Executive summary

In recent years clusters have become an important component of the policymaker's toolbox particularly in respect to endogenous pressures for growth and innovation. Academic and policy interest in clusters have emerged from the observation that many industries tend to cluster and the ex-post analyses of the economic and innovation performance of a number of high profile clusters. However, despite the popularity of the cluster concept and the widespread use of cluster policy, the question of whether public support of clusters is effective, particularly for innovation, is an open one. Many studies in the literature have focussed on the characteristics of industrial clusters, cluster performance or on how to best support cluster development, but they stop short of the trying to understand the extent to which cluster policy is delivering tangible economic impacts.

This report seeks to address this evidence gap. It first reviews the main arguments underpinning cluster policy. It subsequently focuses on a number of recent experiences in supporting clusters across the OECD, and further highlights the challenges associated with the evaluation of these initiatives and available evidence on their outcomes. It then focuses on the evidence of a number of programmes (16) that are selected for closer scrutiny. The report draws on available cluster policy evaluation exercises and related academic literature to report on the impacts and outcomes, both soft and substantive, of cluster policy.

Illustrative of the diversity of cluster policy, the policies under consideration differ considerably in rationales, objectives and operationalisation. Similarly, the evaluations of the programmes selected differ in terms of their timing, objectives and methodologies used. Nevertheless a number of consistent threads and key observations emerge across the evaluation reports:

a) There is a general finding that cluster policies provide the resources and framework to advance the innovation potential of different interest groups.
b) In terms of the governance, early private sector involvement is important to secure market oriented strategies in the targeted clusters.
c) Clusters require dedicated management teams with a blend of skills and competencies to reconcile the interest of the private and public sector participants.
d) The provision of support services within clusters is an important element for generating long-terms benefits for cluster participants.
e) Public sector cluster investments have been successful in leveraging private funding but this seems to be contingent on the nature of the cluster. High technology clusters appear to be better placed than more traditional industry clusters in attracting private sector funding.
f) There is no clear and unambiguous evidence that over the long term clusters are able to generate strong and sustainable impacts in terms of innovation, productivity or employment

Finally, some broad implications for policy are drawn, in particular in relation to the need for policies to improve their clarity and focus in their choice of objectives and rationales, the need to allow for evaluation early on in the process, the use of flexible and adapted interventions that are realistic rather than a rigid cluster model, together with a more careful targeting and a better balance between a hands-off approach and direct steering of clusters.

1 Introduction

In recent years, clusters have become an object of interest for academics and policy makers alike. Attention to clusters has been stimulated by the emergence of high-profile clusters such as Silicon Valley or industrial districts in Italy. Policy makers both in developed and developing countries have sought similar developments through implementing cluster programmes.

Despite the popularity of the term cluster and the widespread use of cluster policy, the nature of cluster policies and particularly their impacts are less well understood. Nauwelaers and Wintjes (2008) highlight the gap that exists between the notable diffusion of the cluster 'model' and the little progress made with regard to learning in cluster policy making and cluster policy learning. Indeed, many studies within the literature focus on the characteristics of industrial clusters, cluster performance or on how to best support cluster development, but stop short of addressing the actual implementation of cluster policy. The benefits of clusters referred to in the literature relate to studies that examine the effects of clustering when it occurs 'naturally', rather than constituting a direct assessment of cluster initiatives (Duranton, 2011). Particularly overlooked aspects relate to cluster policy implementation (Sternberg et al., 2010), governance processes and their influence on the evolution and performance of clusters (Borrás and Tsagdis, 2008), and the evaluation of the impacts of cluster support (Raines, 2003; Fromhold-Eisebith and Eisebith, 2005; Schmiedeberg, 2010).

This report seeks to address this evidence gap first by reviewing the main arguments underpinning cluster policy. Section two of the report then focuses on recent policy experiences in supporting clustering in a number of OECD countries, highlighting their main characteristics and differences. It further highlights the challenges associated with the evaluation of these initiatives, in particular the diversity in rationales, instruments and implementation forms, and the systemic and indirect nature of the intervention. Section three then focuses on available evidence on the outcome of cluster policy. In particular, the report examines 16 evaluations of regional and national cluster policies, all in developed countries. It draws on available cluster policy evaluation exercises and related academic literature in order to report on the impacts, both soft and substantive, of the selected cluster programmes. We conclude by drawing some general lessons and implications.

2 Conceptual Background

2.1 What are Clusters?

The concept of clusters can be related to various conceptual and theoretical developments around locally embedded groups of firms and other organisations, such as 'industrial districts', 'new industrial spaces' and 'flexible specialisation', 'regional innovation systems' (see, for instance Pyke et al, 1990; Brusco, 1982; Scott, 1986; Piore and Sabel, 1984, Cooke et al, 1997). They are also inspired by scholars exploring the geography of innovation (e.g. work on knowledge spillovers (Audretsch and Feldman, 1996), and the economics of agglomeration (krugman, 1991). However, most scholars link the growth of current interest to Porter's (1990; 1998) analysis of the competitive advantage of nations where clusters are defined as: 'geographical concentrations of interconnected companies and institutions in a particular field' (Porter, 1998, p.197). The definition includes economic actors including specialised input

suppliers, customers, manufacturers of complementary products and related firms, as well as governments and other institutions such as universities, standards agencies, and trade associations.

Most definitions of clusters (see e.g. Enright, 1996; Spencer et al, 2010) include a degree of specialisation in a particular industry (measured by employment), co-location of the specialized industry and other related industries, and scale or critical mass in the cluster. There are however many deep-seated controversies about conceptual and empirical questions of what clusters are and how they can be identified, how they emerge and evolve, why they matter and how they can be used by policy (Pitelis et al., 2006).

Clusters "vary in size, breadth and state of development" (Porter, 1998, p.220) and as a result a number of typologies have been proposed to characterise them. For instance Enright (1996) differentiates between working clusters, latent clusters, potential clusters, and 'wishful thinking' clusters (see also Rosenfeld, 1997). However these are normative classifications, leading Martin and Sunley (2003) to consider them almost meaningless as they imply that virtually every firm could be considered part of a 'potential' cluster. Other typologies of cluster formation include Markusen's (1996) four-fold characterisation of industrial districts, namely: hub-and-spoke, satellite platform, Marshallian industrial district, and state-anchored districts. Gordon and McCann (2000) propose three theoretical cluster models: a 'pure agglomerations' model based on localization externalities, a 'social network model' emphasising exchange of information and collective learning, and an 'industrial complex model' around the formation of local production systems.

Clusters are seen to evolve in a sort of life cycle consisting of embryonic, growth, maturity and decay stages (Rosenfeld 2002, Swann et al, 1998). Hospers et al (2008) note that more often than not, the origin of clusters lie in past economic activities and structures. Strengths in declining sectors are transformed or recombined to exploit emergent niches and new market trends.

2.2 The economic importance of clusters

Since Marshall's (1890) analysis, the advantages arising from geographical proximity have been associated with external economies in the form of specialised labour markets, input suppliers and knowledge spillovers, giving rise to innovation and productivity benefits. Co-location is associated with better access to specialised, high productivity employees with lower search and training costs. At the supply input level, intermediate industries provide downstream firms with local access to specialised materials and components, finance, marketing and business services, as they themselves exploit greater internal economies of scale and benefit from reduced transport costs. In addition, technological externalities arise through shared technological information and knowledge spillovers (Langlois and Robertson, 1996). Other kinds of advantages associated with clusters derive from more favourable market conditions, namely the presence of demanding customers, greater rivalry and complementarities in products and technologies (Porter, 1998).

There is a sizeable literature dedicated to case studies of successful regional clusters and industrial districts (including Silicon Valley, see Saxenian, 1994), the assessment of which is beyond the scope of the current report. A more limited number of studies have tried to empirically demonstrate the benefits of clustering on growth and productivity. For instance,

Spencer et al (2010), using a data set for 300 industries in 140 city-regions in Canada, found that industries located in areas with critical mass of related industries tend to display higher incomes and rates of growth compared with those located in non-clustered settings. In a comparative study of clustering in the US and UK computer industries, Baptista and Swann (1999) found that firms in strong clusters tend to grow faster. The study by Feser et al (2008) on the Appalachian technology clusters delivered mixed results. While they found some evidence that clustering is associated with new business formation in some technology industries, there was little evidence to support a link between clustering and employment growth.

In relation to the benefits of clusters on innovation, a number of scholars have also analysed whether firms in clusters are more or less innovative than non-clustered firms and the relative importance on innovation of localisation and urbanisation economies, namely whether benefits occur within industry or across related industries in a particular location. Baptista and Swann (1998) analysed the innovations introduced by 248 UK manufacturing firms during 1975 and 1982 and compared clustered (defined on the basis of absolute regional employment in a firm's own industry) with non-clustered firms. They found that strong employment in the own industry in the home region raises a firm's likeliness to innovate. The effect of strong employment in other industries, in contrast, does not show to be significant, indicating the possibility that congestion may outweigh the benefits from diversification within clusters. By contrast, Beaudry and Breschi (2003) found in a similar study (but with data for UK and Italy) that clustering alone is not conducive to higher innovative performance. Using European patent data as indicator of firms innovative activities, they found a positive significant effect on innovation from locating in clusters densely populated by other innovative firms but a disadvantage of the presence of non-innovative firms in the same industry. They therefore conclude that benefits from clustering "arise only in clusters that are already densely populated by innovative firms and have a large accumulated stock of knowledge" (Beaudry and Breschi, 2003; p.34).

Regarding the effects of the proximity of firms in other industries, evidence is inconclusive and differs in both countries. In a longitudinal study of the Canadian biotechnology industry during the 1990s, Aharonson et al (2008) also found that the ability of firms to benefit from clusters was not uniform, with 'uninventive' firms with more limited internal and external resources being less likely to benefit compared with their inventive counterparts.

On balance, scholarly work seems to suggest that clustering has a positive effect on innovation. However such positive influence tends to be restricted to a limited set of industries, at certain stages of development, in certain places and under particular conditions (Martin and Sunley, 2003). R&D intensive industries, and those more reliant on tacit knowledge, tend to benefit more from collocation (Audretsch, 1998). It is difficult however to compare results of different studies given the different definitions of clusters adopted (particularly in relation to cluster boundaries). Such differences lead Martin and Sunley (2003; p.23) to conclude that "it seems impossible to support or reject clusters definitively with empirical evidence, as there are so many ambiguities, identification problems, exceptions and extraneous factors". Duranton (2011) is even less sympathetic with the evidence of clustering benefits. He considers that the literature rarely capture the 'pure' effect of clustering (keeping total employment constant) and thus overestimate the magnitude of clustering effects. Causation may not even run from

clustering to high local productivity and wages but instead from the latter to the former (Duranton, 2011).

While there are many potential benefits associated with clusters, there are also some possible downsides. Overspecialisation has been associated with long term lock in, inability to adapt and therefore greater vulnerability vis a vis external shocks (Grabher, 1993). OECD (2009) notes how the economic benefits from clusters in certain locations may be offset by economic costs or activity losses in other locations. Clustering can also be associated with certain disadvantages such as congestion and competition effects both in input and output markets (Swann et al, 1998) and could also lead to raising the cost of real estate, as well as the cost of specialised labour (Baptista, 1998). At the aggregate level, whether the advantages outweigh the negative aspects is not easy to determine (OECD, 2009).

2.3 Cluster policy in perspective

2.3.1 The rise of cluster policies

Cluster policies have been widely used since their emergence in the early 1990s, its practice extending from developed to developing countries and economies in transition (Ketels et al, 2006). While there are no official statistics of the number and types of cluster type interventions worldwide, the Global Cluster Initiative Survey identified about 500 cluster initiatives, mostly in Europe, North America, Australia and New Zealand (Sölvell et al., 2003).

The Danish, Dutch, and Finnish governments were among the pioneers in setting up programmes with strong SME components (Andersson et al, 2004). Human capital and innovation issues have been strongly supported in cluster policies of countries such as Austria, Australia, Canada, Finland, France, Germany, New Zealand, Norway, Spain, Portugal and the United Kingdom (Isaksen and Hauge, 2002). In Italy, cluster promotion is embedded in the country's tradition of SME support within industrial districts.

Some countries, Austria and the Netherlands for instance, have more explicit cluster policies, either as integral part of their economic strategy or as a tool for promoting competitiveness in SMEs (Isaksen and Hauge, 2002). The introduction of cluster policy in France is more recent, and has become an essential element of regional innovation policy particularly with the launch of the *Pôles de compétitivité* initiative. In the 1990s the Department for Trade and Industry in the UK endorsed the idea of clusters. A national cluster mapping exercise took place and clusters were promoted as key element in the regional economic strategies of the newly created regional development agencies. Andersson et al, (2004) note additional differences in the adoption of cluster policies. While China has mainly pursued broker policies related to science parks and incubators, Thailand for instance explicitly promotes SME cooperation. In Japan, early R&D-support programmes for SMEs have been replaced with initiatives to support innovation within clusters (Andersson et al, 2004).

The cluster concept has been particularly adopted in the context of multilateral policy cooperation. The promotion of the concept under the auspices of international organisations such as OECD has greatly contributed to its diffusion. The OECD's Committee for Scientific and Technological Policy and its Working Party for Technology and Innovation Policy embraced the concept from the early 1990s. Later on, organisations such as the World Bank and UN institutions such as UNIDO and UNCTAD incorporated the clusters idea in the context of

development for developing countries (Andersson et al, 2004). The European Commission has also enthusiastically embraced the cluster concept, particularly in relation to the implementation of regional policy and the development the Lisbon Agenda. In particular, it has been active in supporting mapping exercises such as the European Cluster Observatory and promotes knowledge exchange and networking between cluster initiatives (e.g. through the Europe INNOVA initiative or the European Cluster Alliance funded under the PRO INNO Europe initiative).

2.3.2 Rationales for cluster policy and the role of the public sector[1]

Policies to create or support clusters have been justified the desire to capture the cluster benefits referred to earlier, including knowledge spillovers, skills and tacit knowledge (through labour pools), supply chains, and other public goods effects (including social capital and reputation). Some cluster policies are marketed to gain the attention of, and to improve the conditions for, foreign direct investment (FDI). For instance De Propris and Driffield (2006) consider that cluster policy to strengthen local competencies should be a precondition for the attraction of quality FDI. Policies to promote clusters typically have an implicit (and sometimes explicit) justification in addressing market, system and public failures. Market failures are associated with underinvestment in knowledge and technology due to the presence of externalities, information asymmetries, or network effects. Systemic failures emanate from the fact that innovation comes about from the interaction between the different agents, and failures therefore arise were those connections between actors are poor or not sufficiently conducive to knowledge generation. Similarly, cluster policies may also be justified with perceived governmental failures, such as institutional lag in certain regions or poor performance of current programs, leading to the hope that new cluster policies will address these.

These rationales are not new and can be placed at the boundaries of industrial policy, regional policy and innovation policy. In this sense cluster policy is an amalgamation of separate trends in more traditional policies and it is difficult to isolate cluster policies from other policy areas (Boekholt and Thuriaux, 1999; Raines, 2003; Nauwelaers, 2003). Within *industrial policy* (including SME policy) interest in clusters has to be placed in the last two decades in the context of an alleged shift from support to a narrow set of industries and actors ('national champions'), and infant industries, and towards the support of broader key sectors as key drivers of competitiveness, networks of SMEs, the restructuring and upgrade of declining sectors, and the promotion of inward investment (OECD, 2007). For Boekholt and Thuriaux (1999), it constitutes a shift from supporting sectors to addressing wider 'value chains' and from direct financial support to indirect facilitation[2]. An increased interest in clusters has also been the result of an evolution in the characteristics and assumptions underpinning *technology policy*, particularly the influence of ideas around systems of innovation and the triple helix (Etzkowitz and Leydesdorff, 2000) and a consequent shift from supporting individual R&D projects and towards addressing systems and networks of innovation (Dodgson and Bessant, 1996; Smits,

1 Parts of this section and section 2.3.3. draw from Uyarra, E. and Charles, D. (2010) Practical benefits of innovation-related policy instruments at the regional and local level. Unpublished report for the EU-OECD Innovation Project.

2 Hospers et al (2008) question this view. They argue that, rather than constituting a clear break from old industrial policy, cluster policies similarly involve 'targeting' certain activities and are therefore not neutral. Clusters implicitly or explicitly involve a form of targeting but in general 'space-neutral' industrial and innovation policies inevitably have uneven regional impacts (Sternberg, 1996).

2004). Finally, within *regional policy* the use of cluster policies has been linked to the idea of the 'innovation paradox' afflicting so-called lagging regions (Oughton et al, 2002). The recent interest in clusters has been influenced by a perceived failure of past policies (particularly EU structural intervention in less favoured regions) focused on hard measures such as infrastructure development in, and the need to shift support towards institutional development and intangible elements such as networking and social capital via the use of 'soft' measures such as clusters (Morgan 1997).

Based on the dominant rationale, Nauwelaers (2003) identified three different cluster policy models: the Mega Cluster, the Local Network Cluster and the Knowledge-Based Cluster, prioritising industry competitiveness; regional institutional thickness; and innovation respectively. In practice however, most policies tend to adopt a combination of models and objectives. Path-dependent policy histories, i.e. which policy area is embraced first and more strongly, and other institutional path-dependencies often explain the diversity in the dominant adopted rationales and the interpretation and application of the cluster concept in different countries and regions (Sternberg et al, 2010).

How important is cluster policy in the formation of clusters?

It is important to remember, however, that many benefits of clusters occur naturally, without policy intervention. The influence of policy, while important, is often indirect, driven by policies such as infrastructure, research, education and training rather than policies directed at clusters per se. As noted by OECD (2009; p.26), "a frequent mistake made by policy makers and analysts is to think that clusters are synonymous with deliberate policies or deliberate cooperation in formal networks". It is worth noting that most of the instances of innovative clusters referred to in the literature, not least highly celebrated cases such as Silicon Valley, have emerged without specific policies to foster networking or cluster behaviour (Sölvell et al, 2003, OECD, 2007). Van der Linde's (2003) cluster meta-analysis, covering 733 clusters in 49 nations, identified just one instance, the electronics goods cluster in the Hsinchu Science Park, where a competitive cluster was established primarily due to a conscious government action to attract it. In a worldwide survey of clusters by Enright (2000), the role of policy was seen mainly as 'unimportant' by respondents in terms of their contribution to the development of the cluster. Most clusters have tended to evolve instead from initial, largely spontaneously generated clustering, followed by more conscious policy-support efforts (Porter, 1998; Andersson et al, 2004).

Creation of new clusters vs support to existing clusters

Unsurprisingly then, a strong controversy surrounds the capacity of the public sector to 'create' clusters. Porter (1998: p.89) recommended that governments should, working with the private sector, "reinforce and build on existing and emerging clusters rather than attempt to create entirely new ones". For Roelandt and den Hertog (1999), the government should adopt a catalyst or brokering role in cluster development rather than taking direct lead. Aragón et al (2011) distinguish cluster policy rationales according to the level of development of the targeted clusters. If no particular agglomeration of activities or strength in the productive structure exists linked to the cluster being promoted, the rationale for intervention is questionable except for potential synergies with other existing strengths in the productive structure. If an agglomeration exists but institutional elements are lacking to ensure cooperation and benefit from positive externalities, policies may seek to enhance social capital, promote collaboration across the clustered firms and institutions. However attention needs to

be paid to the institutional context in which the policy is introduced and to the long-term nature of the policy effects. Finally, if an agglomeration exists and the institutional elements enabling externalities are present, i.e, it is already a well-functioning cluster, policies may risk crowding out activities that would have occurred within the cluster in any case. Continued support are often due to policy inertia or even policy capture, for as Porter (1998; p.84) notes, "as the cluster expands, so does its influence with government and with public and private institutions".

Feser (2008) considers that despite these nuanced considerations, building (or 'activating') clusters has become the dominant rationale in cluster policy, in the expectation that it would naturally contribute to raising productivity, boosting innovation and increase welfare. Directly nurturing clusters (often according to normative ideal-types) however brings in a number of risks. It may for instance overstate the capacity of the public sector to pursue such strategy, focus attention toward interventions that promise immediate impacts on the cluster, or unintentionally lead to regional economic and policy lock-in. Policy lock-in may occur when institutional structures adapt to particular industrial specialization, diminishing the public sector ability to adapt to new economic circumstances. Against this dominant rationale, he proposes that a more advantageous option is to use the cluster concept as a means to leveraging innovative synergies among business to improve the implementation of innovation policy, regardless of whether a discrete spatial cluster emerges as a result.

Borrás and Tsagdis (2008) also make a distinction between a narrow and a broad approach to cluster policies. Whereas a narrow approach involves direct cluster intervention by public authorities at one level of governance, the broad approach would reflect the systemic, multi-actor and multi-level nature of cluster policy by considering the broader set of activities influencing clusters, namely "the set of direct and induced initiatives for enhancing the cluster capabilities and adaptability" (p.20). However, such 'policies for clusters' (as opposed to cluster policy) view has rarely permeated cluster policy design or cluster policy evaluation.

Finally, precisely how to nurture or support clusters is unclear and contested, and Porter's model of competitiveness is not a good guide to policy. Questions arise for instance about which rationales and which policies are associated with each part of the diamond? What government level is best suited or has sufficient competences to deal with these policy issues? How can all the four parts of the diamond be improved? How can negative feedbacks or tensions across policies be dealt with? Finally, adherents of Porter appear not to take into account articulation and implementation of policies, for "every intervention exacts and opportunity cost in human, financial and political capital" (Feser, 2008; p.192).

2.3.3 Cluster policy interventions: design, implementation and instruments

As the above discussion suggests, the promotion of clusters can mean very different things in different contexts. Sometimes they may not even be labelled as such, but as local production systems, competitiveness poles, centres of expertise, industrial and technology districts (Nauwelaers and Wintjes, 2008). Traditional policy measures also sometimes relabelled as clusters (Sölvell et al, 2003) and sometimes network policies and cluster policies are used interchangeably. Cluster policies may be designed to pursue objectives of industrial and SME policy or research and innovation policy. Programmes may also differ according to the national institutional configuration, the level of government involved, and the nature of government intervention (Enright, 2003). They can also vary in terms of the types of sectors, firms, and territories targeted, the identification and selection of the targeted clusters, the policy

instruments used and the institutional context and actors' constellation of cluster programmes. These aspects are further elaborated below.

Borrás and Tsagdis (2008) note that a relatively neglected aspect in the literature relates to the institutional and governance configurations underpinning cluster policies. Sternberg et al (2010) argues that structural and institutional differences between nations and regions, and in particular the country's degree of administrative centralization and the role of the state, will determine the approach to cluster policy. Drawing from the idea of 'varieties of capitalism', they link the differences in the design and implementation of cluster policies to the national institutional environment and regional policy path dependencies. For instance, in the US the government generally has a hands-off attitude and maintains an arm's length relationship with industry while trying to provide a conducive business environment, while in a coordinated market economy like Germany, collective action takes place through tripartite relationships between the state and associations representing the business sectors, and trade unions. They note that while the US system provides a more flexible framework, it lacks strategic coherence and concrete action to promote clusters. In Germany, by contrast, cluster promotion presents a stronger top-down impetus and more strategic coherence, although, unlike the US, it often fails to mobilize the private sector to join in.

In relation to the *level of government* responsible, particularly in countries with a decentralised or federal system, cluster programmes are fundamentally a regional policy initiative. In other cases, responsibility is shared between the national and the regional levels in relation to the selection of funding of the programmes, for instance in the case of the French *Pôles de compétitivité*. In Canada, even though sub-national governments have implemented strategies to support clusters, the main programme with an explicit cluster strategy is delivered at the national level by the Canada's National Research Council (NRC). The BioRegio and InnoRegio programme in Germany are also examples of joint work between the federal and the regional level, with the former playing the role of facilitator and the latter actively managing the programmes. In the US, the policy instruments and resources to promote clusters and economic development are generally the realm of state policy (OECD, 2007). Authorities at the regional and local level tend to be more aware of the problems of the locality and are allegedly better placed to adapt policies to specific regional circumstances (Boekholt and Thuriaux, 1999). They may however lack the holistic view, the competences, or the capacity to act on the right policy levers that cluster development requires (Enright, 2003; Duranton, 2011). Last but not least, sometimes clusters may be supported in cross-border regions, for instance the Medicon Valley cluster in the Öresund region spanning the Copenhagen metropolitan area in Denmark and southern Sweden.

Policies also differ in the way clusters are *identified and selected for support*. Identification can be conducted through quantitative and qualitative methods, and in a top-down and bottom-up manner (OECD, 2007, p.78). Top down identification may involve different methods to assess concentration of activities; quantitative methods include the use of detailed industry, location and economic statistics to map concentration; input-output data; and firm-level information from surveys while qualitative approaches to cluster identification tend to be based on expert knowledge (for methodological bottlenecks in cluster analysis see Roelandt and den Hertog, 1999). The task of identifying clusters can also be delegated to a lower level of governance in a bottom-up manner. Sub-national governments and agencies can identify the more prominent clusters to support, and embed them in their regional innovation or economic development

strategies (OECD, 2007). Alternatively, it may involve bottom up self-identification of clusters in response to specific eligibility criteria. There are advantages and disadvantages associated with bottom up and top-down selection. The former may translate into small and loosely connected collections of similar or related firms being selected, often reflecting policy aspirations rather than reality (Martin and Sunley, 2003), while engineered or top-down approaches may face greater difficulties to build social capital and develop linkages and a shared vision (Andersson et al, 2004).

In terms of the *cluster selection mechanisms*, targets of cluster policy may be designated (non-competitive) or selected through open competition (competitive). Competition to select the highest quality or most suitable projects has been used for instance in the Vinnväxt programme in Sweden and Germany's cluster programmes BioRegion and InnoRegio (OECD, 2007). In other cases, a top-down approach has been employed, whereby funds have been allocated according to specific criteria (e.g. Finland National Cluster Programme). In practice, selection processes are often based on a combination of statistical methods and negotiated approaches.

Cluster policy inevitably involves a form of 'targeting' and selectivity, favouring certain activities and geographical areas (Hospers et al, 2008). Policy makers thus face a trade-off between supporting leading activities, which is likely to increase regional disparities by concentrating support in particular areas, or delivering broader support, which risks diluting resources and undermining impacts. Many cluster programmes have emerged as a response to a need to restructure key industries, for instance in the Basque Country, and were later on extended to other industries. Or they have initially targeted core clusters, only to increase later on the clusters supported to include less advanced regions (such as the Pôles de compétitivité in France) (OECD, 2007). When deciding which industrial areas to support, policy makers tend to pursue either an 'offensive' policy of stimulating high-tech clusters (e.g. biotechnology, nanotechnology), or a 'defensive' one aimed at preserving traditional activities (e.g. textiles, automotive) (Hospers et al, 2008). An example of the former is the German BioRegio contest, which constituted an attempt by the Federal Government to jump-start Germany's biotech industry (Sternberg et al, 2010). A common pitfall however is to pursue clusters in high tech sectors in areas lacking the capabilities and conditions for such activities (Boekholt and Thuriaux, 1999; Hospers et al, 2008). Policy makers also tend to suffer from a 'me-too' attitude, seeking to support the same clusters everywhere (Boekholt and Thuriaux, 1999; Andersson et al, 2004). Local policy makers may also be tempted to focus on new and more 'visible' projects rather than the development of their own productive capabilities (Duranton, 2011).

Cluster policy instruments

Policies under the 'cluster' banner or informed by the cluster approach use a variety of instruments, in fact they are a form of "umbrella policy" that can include any of the instruments that fall under the 'parent policies' (technology, industrial, regional) mentioned earlier. Studies on cluster policy tend to describe a menu, or toolbox of instruments for cluster development commonly used in clusters and that can be adapted according to their own needs (types of clusters, level of technology stages in the cluster lifecycle, spatial configuration etc.). So typically it would include a combination of instruments such as R&D funding, setting up of intermediaries, venture capital funds, competence centres, support to training activities, networking and identity building (see table 1).

Nauwelaers and Wintjes (2008) distinguish between three types of cluster instruments, aimed at influencing cluster's environment, facilitating synergies and supporting projects. Similarly, OECD (2007) differentiates between instruments directed at actors' engagement, provision of collective services and promotion of collaborative research. Andersson et al (2004) differentiate between instruments aimed at improving internal cluster dynamics or at improving the external cluster environment. The specific combination of support instruments would vary according to the objectives and stages of development of the targeted cluster. For instance collaborative R&D are more common in cluster programmes targeting innovation and commercialisation, and include instruments such as commercialisation support, financing for spin-off firms and venture capital firms, etc. Targets and instruments would also need to evolve over the cluster life cycle (Brenner and Schlump, 2011) in order to adapt to new and evolving cluster needs, for a cluster that is emerging would have different needs compared to a mature one.

Beyond these broad types of instruments, OECD (2007) observes a trend from the adoption of smaller scale initiatives to promote SME networks to broader, more growth oriented programmes for national competitiveness; and an increasing focus on innovation both in the orientation of policies and the prioritisation of innovation related instruments. Recent approaches have also tended to adopt a more evolutionary view of clusters, suggesting the need to foster knowledge spillovers between related sectors in order to allow 'related variety', for instance via platform policies, structured on the basis of shared and complementary knowledge bases and competences, labor mobility and the promotion of extra-regional links (Asheim et al., 2007). Cooke (2012) advocates a 'post-cluster' approach centred on fostering innovation through stimulating cross-cluster 'transversality'. However, there is little evidence of the implementation, let alone evaluation, of such approaches.

Table 1. Instruments promoting clusters

Engage actors	Collective services and business services	Collaborative R&D
Identify clusters (e.g. mapping studies) Support networks/clusters (awareness raising, networking, etc.)	Improve capability of business (spec. SMEs) Increase external linkages (FDI and exports) Skilled labour force	Increase links between research and industry Commercialisation of research (IPR, tech transfer support) Access to finance and spin-offs

Source: based on OECD (2007)

Cluster policies also vary in terms of the *cost* of the intervention. They generally do not command large resources (although sometimes they do), but they are often expected to mobilise additional matching funds from other public or private entities. In this case public investment acts a leverage to attract large amounts of private investment in technological capabilities (Boekholt and Thuriaux, 1999). Cluster promotion is one of, and often developed in conjunction with, many other programmes to promote regional innovation, so it is difficult to disentangle the resources used in cluster support from other types of regional support.

In terms of the *actor constellation* in cluster policies, cluster policies vary in terms of the mix of public/private sectors and the type of support institutions. Sölvell et al (2003) identify four main categories of actors that are generally present and active in a cluster initiative, namely companies, governments, the research community and financial institutions. Out of all the

clusters they analysed, around 27% originated from industry and a small number (5%) from the university sector. It was identified that, once the cluster initiative is set up, companies tend to be the most influential parties steering clusters (in 70% of the cases). The responsibility for the management of clusters generally lies with separate organisations (Isaksen and Hauge, 2002) whose role may vary considerably. These are generally non-profit associations, but can also be university representatives or local government, or a consortium or mix of public and private actors.

Table 2. Characterisation of cluster policies

'Parent' policy	Clusters may be more or less influenced by: - Industrial policy - Regional policy - Technology policy
Interpretation of cluster	The intervention can adopt a broad or a narrow view of clusters, and aim at creating or supporting existing clusters
Cluster initiative	Clusters may be: - Government-driven efforts to foster clustering (top-down) - Instigated, funded and governed primarily by private actors (bottom-up).
Role of government	e.g. light-touch, catalytic, supportive, interventionist
Targets	Clusters may target: - Smalls vs large firms within clusters - Core regions, less favoured regions, all regions - Leading vs restructuring sectors
Cluster identification and selection	- Top-down vs Bottom-up - Quantitative vs. qualitative methods - Competitive vs non-competitive
Instruments	- Cluster policies may use a variety of instruments such as: - Actors engagement - Collective services - Collaborative research
Cluster organisations	- Non-profit associations, - University representatives or local government, - Consortium or mix of public and private actors
Resourcing and timing	- Engagement of actors with modest budget - Heavy investment for longer period - Possibility to mobilise additional matching funds
Level of governance	- Local level - National programme - Shared between national and regional level - Regional programme

Source: based on Charles and Uyarra (2010)

2.4 Cluster policy evaluation

Thorough evaluations of cluster programmes are rare, as highlighted by meta studies on cluster policies (Andersson et al 2004; European Cluster Observatory[3]; OECD, 2007; Sölvell, 2008). The challenges associated with evaluating cluster policies have been a source of recent interest in the academic and policy communities (Diez, 2002; Raines, 2003; Fromhold-Eisebith and Eisebith, 2008). Some of these key challenges are reported below.

Given the diversity of cluster objectives and the hybrid nature of the intervention, a key challenge facing cluster policy evaluation is establishing the outcome the evaluation should focus on (Schmiedeberg, 2010). Gallie et al (2010) identify several possible levels of cluster policy evaluations, namely: the effectiveness and suitability of the intervention (actions and results in relation to objectives, organization of the programme, participation, governance, no of projects, etc), the results of specific projects, or the impact of cluster intervention on regional economic outputs and innovation or the performance of clustered firms (profitability, productivity, R&D expenditure, innovation). Evaluations of the impacts of the cluster policies on regional or firm level outcomes face the challenge of trying to disentangle the effects of the policy from the natural evolution of clusters (additionality). As Andersson et al (2004) notes, cluster policy evaluations rarely go beyond efficiency in use of given resources to assess economic impact, or consider interactions and synergies in the performance of different actors.

An additional difficulty relates to the object of the evaluation, namely the definition and boundaries of clusters. Drawing the boundaries of clusters to assess impacts is methodologically and conceptually challenging. Too narrow definitions based on geographical or sectoral boundaries may not capture cross-sectoral linkages and spillover effects on firms outside the cluster. Conversely, broadly defined clusters can lose "conceptual precision, especially when they incorporate politically driven policy agendas" (Henry and Pinch, 2006; p.117).

Data availability associated with the definition of the cluster is a key challenge for evaluation and conditions the choice of methodologies used (Schmiedeberg, 2010). Frequently used measures such as science, technology and innovation statistics are limited in their ability to capture systemic relations within the cluster (forward and backward linkages, knowledge sharing, etc). They rely on traditional industrial classifications, which tend to under-represent service industries and emerging sectors (which are precisely they ones policy makers are more interested in). In addition, indicators are often not available at the required level of geographical disaggregation (Arthurs et al, 2009).

The problem of attribution is also significant when evaluating cluster policies. The nature of the policy makes the identification of causal relations that can be interpreted as impacts of the intervention a difficult task (Schmiedeberg, 2010). As a 'soft' policy, the emphasis of cluster policy is more on fostering a general atmosphere conducive to co-operative relationships between agents (Aranguren et al, 2011). The institutional embeddedness and the context-specific nature of implementation pose significant challenge for assessing the impacts of cluster policy (Diez and Esteban, 2000; Sternberg et al., 2010). Cluster policy is a complex, multi

[3] Most of the country reviews of cluster policy undertaken by Oxford Research AS on behalf of the EC (European Cluster Observatory http://www.clusterobservatory.eu/) report that for most national programmes "no evaluation has yet been done".

instrument policy, and the different interventions may interact, even conflict with each other. Further, the development of clusters is influenced by a diversity of factors, whose relative importance is difficult to identify, and which are beyond the reach of cluster policy. Non-cluster policy instruments may have a positive or negative impact on the target cluster (Duranton, 2011, also Sternberg, 2003: 359). In turn, cluster policy intervention is likely to have intended and unintended effects, and may even conflict with other local public policies influencing clusters. There is a tendency to neglect this highly complex multi-level, multi-actor and temporally distributed character of policy mixes influencing clusters, both in policy analysis and evaluation (Flanagan et al, 2011; Borrás and Tsagdis, 2008). Furthermore, evaluations of cluster policies often focus on single tools, rather than adopt a systemic approach to evaluation.

The challenge of attribution is aggravated by the fact that, more often than not, cluster programmes do not identify the specific market failures they seek to address. Additionally, while the effects of cluster policy are likely to materialise only in the long term, often not enough time is lapsed between the implementation of the policy and the evaluation.

Finally, Fromhold-Eisebith and Eisebith (2008) note how political or corporate interests that often dominate cluster schemes can also act as institutional impediments to honest evaluation of results. Evaluations may be used merely for 'internal' purposes and not made public. This challenge is captured by Sternberg (2010; p.1078), by stating that "while the infant nature of cluster promotion has served as an excuse for non-evaluation for a while, some initiatives have meanwhile mature5d and are subject to commissioned evaluations[..]. However, this is guided by politics and administration, and hence no substitute for a more critical academic appraisal". Needless to say, the policy evaluation culture is very different in different countries.

2.4.1 Evaluation approaches and methods

Evaluations can be ex ante, intermediate or ex post, and they can be a one-off exercise or be part of a continuous monitoring of the programme. As mentioned earlier, evaluations can choose to focus on end results (e.g. economic impacts on the region), or they can centre on processes and intermediate results (number of projects, collaboration, etc). They can also use a variety of methodological approaches. Schmiedeberg (2010) provides an overview of methods for cluster policy evaluation, including policy input oriented methods (such as participatory evaluation), case studies, econometric models (such as before-after comparison, with/without comparison, difference-in-difference approaches), systemic approaches (such as input-output models, network analysis and benchmarking) and cost-related approaches (such as cost-benefit analysis), the choice of which would rely on the purpose of the evaluation, the structure and scope of the programme, but also time, financial and capacity constraints. She notes however, that "using only a single evaluation method will provide a very limited view on the cluster policy programme" (ibid, p.404).

In a meta-study on innovation policy evaluation, Technopolis (2011) identified that participatory evaluation is the most commonly used approach in evaluations of cluster policies, involving the collaboration of all the stakeholders and their active participation in the analytical evaluation process (see Diez, 2001, for a discussion on the advantages of a participatory approach for evaluating cluster policy). They also noted that cluster evaluations do not tend to adopt a very diverse set of methods, normally relying on case studies and descriptive statistics derived from survey and monitoring data, and a much more occasional use of other quantitative methods, such as econometric methods, bibliometrics, or social network analysis (see Giuliani

and Pietrobelli, 2011, for a methodological discussion on the advantages of using SNA for the evaluation of cluster policy).

3 Specific analysis of selected cluster initiatives

3.1 Scope and characteristics of selected cluster programmes

For the purposes of this review, only those initiatives were selected for which evidence (either grey or academic literature) exists on the impact of the intervention in question. In other words, only evidence related to the impact of deliberate policy efforts for cluster promotion was selected[4]. While there is considerable literature on clusters and the impact of clusters, relatively less available literature is dedicated to the impact of cluster policy intervention, and the quality and accessibility of this material is uneven. In a number of cases, evaluations were identified but they were either not available (perhaps confidential) or not readily usable used to language barriers. When possible however, some were translated into English.

Evidence related to 16 cluster programmes was selected for closer scrutiny. The policies under consideration differ considerably in rationales, objectives and operationalisation (see table 3). Most programmes are a combination of several policy streams, and generally combine science and technology policy with the promotion of strategic industries. A number of programmes explicitly draw from Porter´s cluster model as rationale for intervention, Porter himself being involved in the identification of clusters in a number of programmes (e.g. the UK, Finland or the Basque Country). There are few examples of clusters addressing a single policy goal, and the programmes that are purely science and technology or industrial policy are the exception.

Most programmes also offer a menu of instruments, directed at promoting engagement and networking, provision of collective business services, and/or funding collaborative research. A number of countries have more than one cluster programme that differ in objectives, targets and mix of instruments, perhaps aiming at different states of the cluster life-cycle. As such, they are meant to complement each other, although this is not always the case.

The programmes also differ in when they were launched with some such as the Basque Cluster Programme starting as early as 1991 with the most recent being the French Pôles de compétitivité in 2005. Some of the programmes were promoted by national governments while others such as the West Midlands clusters in the UK or the Bavarian State Government Cluster Initiative were designed and implemented at the regional level.

A number of clusters programmes do not have a clear sectoral or regional focus, while others target 'leading' or high-tech clusters. This is important when comparing findings, as some programmes would tend to attract firms that would naturally be more innovative, while in other cases such as the French LPS, the selected clusters may instead belong to sectors in relative decline. In other cases however, only one sector is targeted (Bioregio). The way in which clusters are selected is not always explicit. A solely top-down selection is rarely used, rather targeted areas tend to be chosen on the basis of dialogue or self-selection. A number of

[4] Known databases such as ERAWATCH-Trend Chart database and the DG Regio database of policy support, European Cluster Observatory, OECD online document repository, and Google® were employed to identify such evidence. Academic evidence was also drawn from Google Scholar and the Web of Science using keywords such as clusters, cluster policy, evaluation, and impact.

initiatives use a competitive approach to attract potential clusters, although sometimes the criteria for selection is not clear-cut.

The number of clusters supported also differs. The large number and consequent diversity in some of the clusters makes it difficult to draw conclusions or establish general findings applicable to all the supported clusters. For this reason some of the evaluations only focus on a reduced number of clusters (Basque, Finnish, Swedish).

There are substantive differences in budgets too with France's Pôles de compétitivité programme of 1.5 billion Euro (approx £1b) representing both the upper extreme and the budget of 3.6 million Euro for its Local Production Systems budget, the lower end. Programmes mainly aimed at continuous engagement activities have relatively low funding, while other programmes offer more substantial funding for collaborative R&D or infrastructure investment. Some programmes include provisions for co-financing or leveraging of additional funds of the public and private sector. Similarly, some programmes are broken down into several funding rounds of up to 4 years whereas others offer longer term funding of up to ten years (such as Vinnväxt). In some cases a too short timeframe has been found not to align with the expecations and goals of some of the programmes.

Table 3. Selected cluster programmes

Policy/ Initiative	Country /Region	Year started	Period / status	Rationale/ policy stream	Target sectors / regions	Selection mode	Instruments	Value	No of clusters	Programme Description
Arena programme	Norway	2002	On-going	Regional & industrial policies	All regions and sectors		Engagement of actors around key projects	n.a.	47	To strengthen the capacity of regional business environments for innovation and value creation
Barcelona Knowledge Cluster	Spain (Barcelona)	2000		Industrial policy	Leading sectors mainly ICT	Top down	Infrastructure	€120m	1	Economic regeneration
Basque Cluster Programme	Spain (Basque)	1991	On-going	Industrial policy	All sub-regions/ key regional sectors	Dialogue	cooperative projects related to technology, quality management & internationalisation	n.a.	12	To improve the competitiveness of firms and the region
Bavarian State Government Cluster Initiative	Germany/Bavaria	1999	1999～2001	STI, industrial & regional	High technology sectors	n.a.	Collaborative R&D	€1.45b	5	To link science, business and finance to foster innovation and development in Bavaria
BioLondon	UK (London)	2003	2003～2007	STI & industrial policies	London/ biotech		Incubators, specialist facilities, company mentoring, access to funding	£37m	1	To Developing London as one of the leading innovation bases in the UK in Life Sciences
BioRegio/ BioProfile	Germany	1995	1995～2000 1999～2004	STI & Industrial policies	Leading regions/ biotech	Self-selection / competitive	Collaborative R&D	€ 190m	4? 1	To strengthen Germany's position in this area of technology, seen as a key technology and driver of economic growth for

Policy/ Initiative	Country /Region	Year started	Period / status	Rationale/ policy stream	Target sectors / regions	Selection mode	Instruments	Value	No of clusters	Programme Description
										knowledge-based economies
Centres of Expertise	Norway	2005	2006～2016 (3 contract periods)	STI & regional & industrial policies	All regions and sectors	Self-selection / competitive	Collaborative R&D, commercialisation assistance, incubators,	NOK 72m (€0.6m) /yr	12	To strengthen innovation activity in the clusters with the largest potential for growth and a clear international orientation in Norway
Danish cluster programme	Denmark	2006	On-going	STI & industrial policies	All regions/sectors	Competitive	Collaborative R&D, business support services	n.a.	22	To boost innovation in Danish business and industry
Finnish National Cluster Programme	Finland	1997	1997～2001	STI & regional policies	No regional focus / large sectors of the economy	Self-selection/ competitive	Collaborative R&D projects	Average € 12.5m / cluster per year	8	To generate new innovations, businesses and employment'
French Local Production Systems	France	1999	1999～2005	Industrial & regional policies	All regions / all sectors	Self-selection / competitive	Facilitation, audits, studies and diagnostics, and to a more limited extent, commercial initiatives or innovation	€ 3.6m		To provide support to groups of SME type firms, located in the same area and belonging to the same industry.
French Pôles de competitive-té	France	2005	2005～2007	STI & regional & industrial policies	leading sectors ('international')/ all regions and sectors ('regional')	Self-selection/ competitive	financial support for joint R&D projects between enterprises and research centres	€1.5bn	67	To stimulate innovation and competitiveness amongst firms and within territories.

Policy/ Initiative	Country /Region	Year started	Period / status	Rationale/ policy stream	Target sectors / regions	Selection mode	Instruments	Value	No of clusters	Programme Description
Japan Industrial Cluster Project	Japan	2001	2001～2005 2006～2010	STI & industrial policies	All regions / leading sectors	Identified by METI regional officers	Support for: R&D, start-ups, marketing, management, and human resources	110b yen	19	To create industry-academia-government networks throughout the country
NRC Technology Clusters	Canada	2000	2000~2008 (3 rounds)	STI & regional policies	All regions/ high technology sectors	Dialogue	Collaborative R&D, specialised R&D services and infrastructure such as incubation	CAN$ 550m	11	To bring government, academia and the private sector together to improve innovation, skills and learning.
Vinnväxt	Sweden	2002	On-going 2007～2010 (3 rounds)	STI & Industrial policies	Leading regions / high growth sectors	Self-selection / competitive	Collaborative R&D	€30m	12	To promote sustainable regional growth by developing internationally competitive research and innovation environments
West Midlands	UK	2002	2002～2008	Regional & industrial policy	Sectors key for regional growth and employment	Top-down	Product development; market entry; networks/partnerships; skills	£120m	10	Support firm innovation; modernise and diversify industrial base
Yorkshire Clusters	UK (Yorkshire)	2002	2002～2011	Regional & industrial policy	Sectors key for regional growth and employment	Top-down selection	Product development; market entry; networks/partnerships; skills	£130m	7	Support regional growth and employment; also innovation and competitiveness

Similarly, the evidence gathered on the impact of such programmes (see table 4) differs as a result of the diverse nature of the evaluations in terms of their timing, objectives and methodologies.

In relation to the time in which the effects were evaluated, most evaluations were conducted during the course of the policy or shortly (within 2-3 years) after its completion. By contrast the Bioregio programme was evaluated some ten years later, which made it feasible to assess economic impacts. A number of evaluations have indeed highlighted the difficulty of trying to measure impacts given the short time lapsed for impacts to take effect. Mid-term and ex-post evaluations attempted to include an assessment of longer term impacts, such as employment, growth of firms and innovation.

All evaluations addressed relevance and efficiency of the programmes, including some management aspects and details on investment. A number of evaluations have considered the programme relevance in relation to the broader innovation support environment (policy mix) of the country or region, although generally they have focused only on the programme or on a particular instrument within the programme. Most evaluations have centred on analysing the performance of the programme in terms of *intermediate* effects such as increased collaboration and networking, as well as other types of 'soft' outcomes. It is worth noting that most of the evaluations have been commissioned by the public authorities managing the programmes, in some cases to justify follow-on funding. Many evaluations, particularly some covering the interim stages, concentrated on the management and relevance of the programmes rather than impact.

Finally, they have all adopted quite different methodological approaches. In many evaluations, the methodology of choice was qualitative and simple statistical analysis of survey data targeting cluster participants. The presentation of the evidence is in many cases descriptive in nature (particularly formally commissioned evolutions) and lacking a clear description of the methodology followed. Other studies are methodologically more robust, using for instance regression analysis with a control group to measure the effects of the intervention.

We highlight in the following paragraphs some key points emerging from individual studies with respect to issues of collaboration, management and governance, entrepreneurship and innovation, levered private sector funding before moving on to look at longer term impacts.

Table 4. Main evidence

Policy/ Initiative	Source of evidence	Time of evaluation	Type of Evaluation	Focus of the evaluation	Methods
Arena programme	Jakobsen, E.W. and Røtnes, R., (2012) Econ Pöyry and DAMVAD (2011)	Interim	Formal	Relevance Achievement Efficiency	Expert interviews Survey Update baseline study
Barcelona Knowledge Cluster	Viladecans-Marsal and Arauzo-Carod (2011)	Ex-post	Academic study	Regeneration, development of ICT knowledge sector	Econometric study
Basque Cluster Programme	Iturrioz et al, (2006)	Continuous and ex-post	Academic study	Effectiveness Competitiveness	Annual reporting Questionnaire Econometric

Policy/ Initiative	Source of evidence	Time of evaluation	Type of Evaluation	Focus of the evaluation	Methods
					study
Bavarian Cluster Initiative	Falck et al (2010)	Ex-post	Academic study	Innovation	Econometric study
BioLondon	DTZ (2008)	Interim	Formal	Progress Achievements Effectiveness	Desk research Impact Analysis Interview of Business Beneficiaries Assessment - value added
BioRegio/ BioProfile	Staehler et al (2006)	Ex-post	Formal	Value added Impact	Desk research Survey - biotech firms Analysis - indicators Expert interviews
Centres of Expertise	Jakobsen, E.W. and Røtnes, R., (2012)	Interim	Formal	Relevance Achievement Efficiency	Expert interviews Survey Update baseline study
Danish cluster programme	DAMVAD (2011)	Expost	Formal	Collaboration & R&D performance	Econometric study
Finnish National Cluster Programme	Pentikäinen, T, (2000)	Interim	Formal	Effectiveness Additionality	Case studies Survey analysis
French Local Production Systems	Fontagnéy, L. et al (2011),	Ex-post	Academic study	Productivity Externalities	Econometric study
French Pôles de compétitivité	BCG and CMI (2008)	Interim	Formal	Effectiveness Sustainability	Desk Reviews Expert interviews Quantitative survey
Japan Industrial Cluster Project	Nishimura, J., and Okamuro, H (2011)	Ex-post	Academic study	Collaboration & R&D performance	Econometric study
NRC Technology Clusters	NRC (2010)	Midterm	Formal	Relevance Effectiveness Performance Leverage	Literature reviews Discussion groups Expert interviews Case studies

Policy/ Initiative	Source of evidence	Time of evaluation	Type of Evaluation	Focus of the evaluation	Methods
Vinnväxt	Cooke et al (2010)	Midterm	Formal	Efficacy Achievements Sustainability	Review reports Interviews
West Midlands Clusters	EKOS (2010)	Interim	Formal	Performance	Stakeholder Interviews Business Benefic. Survey Case Studies Statistical analysis Impact Analysis
Yorkshire Clusters	Yorkshire forward (2008)	Interim	Formal	Performance Efficacy Relevance Sustainability	Stakeholder Interviews Business Benefic. Survey Case Studies Statistical analysis Impact Analysis

3.2 Key findings from the case study cluster evaluations

This sections considers the key findings from the cluster studies identified in section 3.1. Two sets of findings are considered. First, findings related to cluster operations and processes, including: management and governance, levered funding and support services (Section 3.2.1). Second, findings related to the influence on collaborations and partnerships (3.2.2). Finally, findings related to longer term outcomes on innovation and other outcome measures (section 3.2.3).

3.2.1 Cluster operations and processes

Management and governance

Only a few evaluations have dealt with the working of the cluster programme and assessed issues such as cluster selection, periodicity, appropriateness of policy tools and adaption. For instance the evaluation of the Norwegian cluster programme notes that the selection of clusters is not very clear-cut and suggested a clearer division of labour with the Arena programme in relation to the type of clusters it ought to focus on (emerging vs more mature), with the two programmes (NCE and Arena) ideally providing adapted and coordinated assistance along the life cycle of the clusters. It also recommended a better coordination with the broader 'policy mix', so that collaborative R&D and innovation projects with long-term potential can be funded outside of the NCE programme. The evaluation of the NCE also highlighted the ability of the programme to adapt to feedback due to its flexibility, and the introduction of follow-up procedures in order to improve and increase the efficiency of project follow-up and enable learning across individual projects. The report pointed to various shortcomings of the cluster

programme design and implementation including the limited coverage of a number of key industries such as the telecommunications, base metal, chemical and pharmaceutical.

Most evaluations however place considerable emphasis on the management of clusters. The evaluation of the Vinnväxt clusters acknowledged the positive role that cluster management played in building networks of connections. However it was also recognized that in this particular case, while the management had performed effectively managers appeared to be severely stretched. This resulted from the tension between the management's role as facilitator of cluster activities versus the more limited project management function. The evaluation recommended that the focus of the management team should on facilitation rather than the project management activities on which they had been engaged.

The facilitation role seems to be of particular significance for cluster growth and development. This is a highly specialized role as it includes types of competencies beyond those required for project management. Not only do facilitators have to interact and communicate effectively, they have to create and generate enthusiasm among the different enterprises and knowledge actors in order to sustain involvement and ensure the credibility of the cluster. Based on survey evidence drawn from 132 participating enterprises within the Arena programme, the Norwegian evaluation showed the importance of the personal characteristics of the cluster facilitator in making the cluster project's activities relevant to the participating enterprises. Respondents were asked about cluster managers' competence, ability to act as a unifying force and their credibility and legitimacy in dealing with the different stakeholders. While there were some differences in responses, in general they were highly correlated and managers received favourable evaluation results.

Another issue that emerged in some evaluations is the relative independence of the management team and the implication for the cluster success. In the case of BioLondon, the leadership/management resided with the London Development Agency. However the evaluators felt that in order for this cluster to move forward, there needed to be dedicated leadership team to facilitate that development within a wider and more complex context of strategies and priorities. A similar point about the ownership of the management function emerged in the Finnish clusters. In that case, the evaluation questioned the management of clusters by government ministries and raised the possibility that other types of organisations might be better suited to facilitate inter-sectoral and innovative networking and stimulate private sector involvement.

Some evaluations called for private sector interests to be represented at the governance level in clusters. This was the case in the Vinnvaxt evaluation which argued that clusters needed increased levels of private sector participation at the board level as they matured. While during the start-up phases clustering initiative benefits from having strong public sector direction, there is a risk that strong public sector involvement can crowd out the private sector influences on the strategic development of the cluster. Furthermore with businesses taking a lead the full range of issues confronting cluster businesses can be more comprehensively addressed.

Another aspect of management, performance management, was raised in the evaluation of the Yorkshire clusters. Evaluators found that the lack of a systematic central collation of project monitoring information that could be used as a management tool hindered effective decision making. There was no central database of companies assisted and this made it virtually

impossible to track duplication of support or to understand the packages of support that were of greatest help to companies achieving benefits and impacts.

Levered Funding

One objective common to most cluster policies is to utilise the public sector funding to leverage private sector resources. Several of the cluster evaluations included this issue in their reports. The Yorkshire clusters for example, managed to lever a further £71m worth of private sector investment although this represented just about half of what was originally targeted by the cluster plan.

The evaluation of the Canadian cluster programme found that NRCs direct regional investment $342m in the cluster initiatives between 2000-01 and 2007-08 resulted in the leverage of $330m dollars in investment from other sources of which 20 percent came from the private sector. This contrasts with the Finnish case, in which the involvement of the private actors was found to be generally low: The Wood Wisdom cluster managed to leverage private funding equivalent to 10% of total public funding and 5% of overall funding while for the Well-being cluster only 3% of total funding came from private sources.

In other cases as in Germany's biotechnology sector, the BioRegio and – to a lesser extent – BioProfile initiatives proved to be a strong attractor for private sector (venture capital) investment. The evaluation evidence suggests that not only did the BioRegio competition contribute to the biotech industry boom in the mid to late 1990s, it led to increased levels of venture capital funding. BioRegio firms were shown to have received venture capital investment at a level 60 percent higher than the average in firms that did not receive funding from the two programmes.

Quality of support services

The availability of support services within clusters generates positive effects on firms particularly for small firms that do not have the critical mass and competence to generate these services internally.

Three of the cases report on the importance of support system within the cluster. The Vinnväxt evaluation found that processes for technical innovation and mentoring support to be of considerable importance. Each of the clusters had well- structured support systems to assist SMEs in the development of new technologies, new products and new processes. Moreover the utilization of financial grants is enhanced through comprehensive mentoring support. While the former can act as the inducement, long-term benefits could well arise through the mentoring support systems.

Within the Yorkshire clusters, businesses reacted positively to support services. Firms in the advanced metals sector reported that among the key strengths associated with project involvement were access to new technologies and machinery as well as the expertise and experience of consultants. Food and Drink cluster companies rated the advice and knowledge available highly while Chemical cluster businesses saw the quality of training facilities as a key strength and commented positively on quality of service and organisational skills of staff.

For the Canadian NCR technology clusters, interviews also revealed a positive perception of stakeholders of business support services, such as mentorship, business planning and

networking. An important contribution for the development of firms was the setting up of Industry Partnership Facilities which aimed to provide office space to tenants, access to NRC equipment and expertise, IT infrastructure, meetings rooms, and business services.

3.2.2. Collaboration and 'soft' impacts

Most evaluations have sought to 'measure' the influence of the programmes on the number of collaborative ventures by cluster members or by some form of qualitative assessment based on interview with different stakeholders.

In the Vinnväxt programme, the evaluation found that management teams of each of the clustering initiatives succeeded in building a wide range of connections within their clusters. Further, within each cluster businesses were openly engaging collaboratively, drawing on their complementary capabilities. Participating in cluster activities clearly provide scope for building such opportunities. In the Yorkshire clusters, 35 percent of businesses in a survey of 320 recognised that the most frequent benefit arising from cluster involvement was the establishment of new business contacts. This is quite similar to the findings from the West Midlands evaluation where 30 percent of a sample of 933 businesses identified collaborative activities (improved networks and partnerships) as being the principal benefit derived from participating in the clusters. In particular West Midlands firms increased collaborative working with Universities or HE institutions from 16% to 35%; with commercial laboratories/R&D enterprises from 7% to 20% and with government research institutes from 3% to 10% as a result of the cluster projects.

Expert interviews and the survey evidence from more than 1,000 biotech companies and research facilities in Germany also confirm that the collaborations initiated because of BioRegio and BioProfile programmes would not have otherwise come about. These include both industry research collaborations and cross regional collaborations. Such collaborations as the latter are important for the exchange and sharing of "best practices" and the influence on policy extends to European level with several German bio-regions being represented on the EU Council of European BioRegions initiative. This not only serves to strengthen communication between clusters but facilitates benchmarking, learning and sharing of knowledge.

In some cases, the additionality of the programme in terms of generating additional collaboration is even less clear cut. For instance in the Finnish case, the type of actors involved in collaborations (mainly universities and municipalities) and the relatively small participation of private and not for profit organisations leads to questions as to whether they were opportunistic partnerships set up to attract funding for projects that would have been pursued anyway. A similar issue can be raised in respect to the Yorkshire and West Midlands clusters. Evaluations examined deadweight or non-additionality associated with the implementation of the respective cluster policies.[5] This is in effect the sum of benefits that would have happened without the interventions. For the Yorkshire clusters, this was estimated to be 27 percent of the cluster support while in the case of West Midlands it was estimated to be around 44 percent of gross attributable sales.

[5] Both of these evaluations were conducted on the basis of the Impact Evaluation Framework which provides guidance on the approach to evaluating impact for regional development agencies. See BIS (2009)

Besides direct collaboration, the Arena and NCE evaluations in Norway reported significant soft impacts. Both programmes were considered successful in creating a common identity for the participating actors. The cluster label was seen to provide greater visibility and status, in turn bringing positive effects such as increased attractiveness for potential investors, new businesses and potential employee. Indeed, more than half of the interviewed participants reported an increased status on the business environment. Another intangible outcome was in the form of increased mutual trust and greater synergies, identified by at least two thirds of the surveyed participants. However, it was also noted that the programme tended to select already collaborating groups, again raising issues about the ability of the programme to generate new synergies.

Furthermore, the Arena programme showed that the quality and intensity of participation mattered. Not unsurprisingly, the more actively actors participate in the projects, the bigger the effects they achieve from collaborative projects.

3.2.3. Longer term outcomes

One of the underlying rationales for public investment in clusters is that they bring about increased levels of innovation and competitiveness of cluster based firms with positive employment and income consequences for regional economies. In this section evidence on the emergence of longer terms impacts identified in the studies is reviewed.

Innovation and Entrepreneurship

The evaluation of the BioRegio/BioProfile policies found that they had a significant impact on the development of the commercial biotechnology sector in Germany. Indeed, the number of biotech firms more than doubled between 1997 and 2002. Moreover the increase in the number of firms in the BioRegio regions outpaced that in the remainder of Germany. Overall, 57% of biotech companies were located in one of the 7 winning regions with the remaining 14 bioregions accounting for 43%. Further about 62% of the patent applications from biotechnology companies came from the 7 winning regions.[6] One of the issues that the evaluators were unable to address at the time was the extent to which the changes were sustainable. This was primarily due to a lack of data and a time horizon that was too short to facilitate meaningful econometric estimation. The evaluators however did comment on the relative international significance of the developments. While the German biotech sector had obviously benefitted from the programmes in terms of business start-ups, advances in product pipeline and in venture capital funding, the evaluators recognised that German biotech companies and products did not play a leading role on the world markets as many of its firms were small or micro firms that generate low revenues. Thus, even though it appeared that Germany had caught up with European competitors, a considerable gap still existed with the US in terms of commercial biotechnology.

Compared to the relatively simple statistical analysis undertaken by the formal evaluation, a recent paper by Engel et al. (2012) used econometric methods to understand the innovation and economic impact of the BioRegio and BioProfile initiatives during the treatment and post-treatment periods by analysing two measures of R&D performance, the number of biotech

[6] Care must be taken with interpreting this as a measure of success as selected regions may have been the most prolific patenters previously.

patent applications and the number of public R&D projects developed using a difference-in-difference estimation procedure with data for 426 German NUTS-3 districts. The analysis compared the outcomes of participants from the winning regions against non-winning participants. The result confirmed that BioRegio winners and (to a lesser extent) BioProfile winners outperformed non-winning participants during the treatment period in that they registered relatively more patents and were involved in more public R&D projects than other biotechnology firms elsewhere in Germany. However, in contrast with such positive effects, Engel et al. (2012) did not find significant outcome effects of public R&D grants for the BioRegio winners in the post-treatment period. Such a result suggests that the success of the BioRegio programme may only have been of a temporary nature although there was some evidence of positive long-term effects for collaborative R&D projects.

Applying a broadly similar methodology, Viladecans-Marsal and Arauzo-Carod (2011) examine the extent to which Barcelona's city council was successful in developing a knowledge based cluster in the city's Poblenou district as part of a redevelopment and modernisation strategy implemented in 2000. Their study focused on changes in the numbers of knowledge based firms before and after the policy initiative as the principal measure of success. To analyse whether the policy had a favourable outcome, they compared the proportion of knowledge based firms in the Poblenou district with similar proportions drawn from three other districts in Barcelona. Using a difference in difference estimator and controlling for fixed year effects, local area fixed effects and local area specific time trends, Viladecans-Marsal and Arauzo-Carod (2011) found a small but statistically significant increase in the share of knowledge based firms of between 1.3 and 2.1 percent depending on which comparator group was used in the analysis although the increase in firm numbers appeared to have occurred at the beginning of the initiative and stagnated subsequently.[7]

Falck et al. (2010)[8] evaluate econometrically the Bavarian High Technology cluster policy introduced in 1999. The goal of this policy was to foster innovation and regional competitiveness of the Bavarian state through the provision of joint research facilities. Following a two part strategy, they first compare the innovation performance of firms in target industries with similar firms in other German states, before and after the policy was introduced. They then include in the previous analysis a control group drawn from Bavaria. Such a difference-in-difference-in-differences design compares changes in the innovation performance of target-industry firms across states that are unrelated to the policy to changes in all target-industry and non-target-industry firms' innovation performance within Bavaria. The study used three different measures of innovation and found that depending on the innovation measure considered, the policy increased the likelihood of a firm innovation in the target industry by between 4.7 and 5.7 percent and further that the introduction of policy measure led to a decrease in R&D expenditure by 19.4 percent. This latter result they argue, does not reflect a negative aspect of policy but suggests instead that with the policy firms were able to develop innovations at lower costs.

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7 Viladecans-Marsal and Arauzo-Carod (2011) extend their analysis to examine the extent to which cluster amenities were decisive in the location decision of knowledge based firms. The results show that location economies being a significant factor in location decisions but that the role played by Marshallian externalities (input externalities, labour pooling and spillovers) was inconclusive.

8 See also Falck (2008) for an earlier analysis

In contrast to the above, and on the basis of a more qualitative assessment, the Vinnväxt clusters in Sweden appeared not to be able to deliver in terms of innovation. At the mid-term evaluation, that is 6 years after the initial investment, evaluators were concerned to find that the three clusters they reviewed were only developing a handful of new products and few new firms with the potential to compete in international markets. More generally they felt that the clusters were failing to build on their inherent strengths. Part of the reason for this they concluded, was that cluster activities were widely spread and initially developed to service a domestic market. Thus one option for change would be to adopt a long term strategy and concentrate on intra-cluster specialisation to discover where clusters had high growth niche opportunities and place greater emphasis on export development and internationalisation.

In the evaluation of the NEC programme in Norway, the projects' self-reported activities showed a clear increase in the number of innovation projects. The evaluation however found that this self-reported increase in innovation activities did not match the official R&D reporting of companies. The programme may therefore have had an effect in triggering greater experimentation and new collaborative activities for innovation. However, the evaluation admitted the need to better understand the connection between the participation of firms in cluster programs and their innovation activities.

The Industrial Cluster Policy (ICP) in Japan focused around SMEs, was predicated on the idea that cluster projects were more likely to achieve increased innovative outputs. In particular, that participating in a cluster especially one in which a core national university is a member, is likely to provide access to increased knowledge flows, facilitate transfer of tacit knowledge and reduce uncertainty, through better access to local communication and collaboration with other partners. Nishimura and Okamura (2011) examined the effects of participation in the cluster on patent applications and the role of collaboration with national universities. Based on a unique dataset of 229 SMEs involved with university industry partnerships between 2002 and 2004 of which 57 belonged to clusters, they estimated a negative binomial regression model in which the number of patent applications is regressed on several independent variables including number of employees, R&D intensity, number of university projects, age of firm and dummy variables to capture whether the firms collaborate with national universities, whether they conduct collaborative R&D and whether they cooperate with the same or neighbouring region. A key finding from this analysis was that participation in a cluster project alone had no significant effect on firms' R&D productivity and further, that local firms participating with partners outside the cluster appeared to show higher level of R&D productivity. Such a result suggests that, unlike the local cluster spirit of the ICP, in order to improve efficiency it is important to construct a wide ranging collaborative network within and beyond clusters defined at the local level.

Economic effects of cluster policies

In order to measure economic effects, some evaluations have drawn from self-reported survey questions. For instance, approximately half of the respondents of the surveyed participants of the Norwegian NCE programme said that they had experienced growth in turnover due to activities that were partly or fully under the auspices of NCE. Moreover, self-reported growth in turnover was estimated to be in the range of 1-4%. Additional statistical analysis suggested that participating enterprises in the NCE programme had experienced strong growth in value creation and productivity compared to Danish and Norwegian enterprises both before and after participating in the programme. This may suggest that the NCE programme attracts enterprises

that already have potential for growth. The lack of a robust control group makes the interpretation of these findings difficult in terms of additionality and attribution. Iturrioz et al. (2006) similarly surveyed members of the Basque paper cluster in relation to the perceived impacts of cluster membership. Around 80% of the cluster members reported that cluster activities had an influence on their competitiveness, although only 10% considered that impact to be high or very high. Self-reported impacts were particularly low in the areas of internationalisation and innovation and high in projects related to the environment. Other studies used a control group to understand the same effects across all the clusters in the Basque country. Aramburu et al. (2010) examined the intermediate role played by cluster initiatives. They applied a 2-stage model to a sample of 1779 industrial firms to analyse the relationship between belonging to a Cluster Association, the development of innovation-oriented activities and the impacts on labour productivity. Their results indicate a positive link between cluster membership and innovation oriented activities as well as a positive indirect effect on productivity growth associated with these activities.

The evaluation of the Pôles de compétitivité in France, which took place within two years of its implementation, involved a comprehensive assessment of the effectiveness of the public support and an individual assessment of each of the 71 clusters. The design of the evaluation aimed firstly to provide broad guidance for decision making about clusters policy and propose new strategic directions; and secondly, to evaluate the performance of each of the poles in terms of such issues as strategy, governance, R&D projects, territorial roots, management skills, involvement of SMEs and sustainable development. Based on an analysis of documentary sources, interviews, and meetings with the actors and organisations concerned, as well as a qualitative and quantitative survey carried out by means of questionnaires, the principal conclusion of the evaluation was that the clusters were performing sufficiently well in most cases and recommended continuing with the broad policy (Gallie et al., 2010). In respect to the individual clusters, the evaluation recommended a three-tier classification based on three key areas (strategy, governance, and the capacity to develop R&D projects). The key finding was that 39 clusters had fully attained the objective of cluster policy, 19 had partly attained the objectives and needed to make improvement while 13 needed to make fundamental changes. Overall, 80% of the clusters either totally or partially attained their objectives.

While the longer term impacts of the the Pôles de compétitivité are yet to be analysed in a systematic way, a recent paper, Fontagnéy et al. (2011), examined the nature of selection process to determine to what extent the authorities were 'picking winners'. They employed a sector-location coupling and investigate econometrically whether, for any given particular sector, the selection process was grouping more efficient firms. Further, given that only some firms in a sector-location coupling would seek membership of the cluster organisation, they investigated whether member firms were more efficient that other similar firms in the same sector-location. In the regression analysis they used firms' (and sectors) export performance as the dependent variable, introduced a sector dummy, and classified firms by whether they were in worldwide, potentially worldwide or national competitiveness clusters as defined by the French government.

The results of the regression showed that the 1994 (before the policy) export performance of firms in prioritized sectors/areas was on average better than firms of the same sector located elsewhere by as much as a multiple of 5.84 in term of export value in the case of worldwide clusters. In effect the policy subsidised firms with an export premium. A firm level analysis

adds further confirmation that after controlling for size and productivity the export premium declined substantially particularly in the top two clusters categories. Beyond these characteristics firms in these clusters did not appear to have export advantages. Rather surprisingly, national level clusters appeared to have a significant and positive export premium suggesting that this category of firms benefitted may be benefiting from export spillovers or have specific abilities beyond individual productivity or size that could lead to them being potential future champions.

While drawn on the basis of a different evaluation method[9] the relative 'success' of the Pôles de compétitivité in France contrasts sharply with the earlier Local Production Systems (LPS) policy. A recent academic study of manufacturing firms (Martin et al., 2011) sought to establish whether the LPS cluster policy resulted in improving firm competitiveness by quantifying the impact of the policy on firms' total factor productivity, employment and exports. They analysed a sample consisting of 345 LPS firms (those receiving the subsidy) and a matched set of non-LPS firms drawn from a population covering 94 continental French départements and 341 employment areas using a difference-in-difference econometric model. They used a 'difference-in-difference' approach to compare enterprises with similar characteristics that were participants and non participants in the program. Overall, the regression analysis showed that LPS firms experienced a 4 percent decline in total factor productivity (TFP) relative to non-LPS firms, and the negative relationship between the subsidy and TFP persisted and was significant even after controlling for industry and region effects. Moreover, the analysis was not able to discern any statistically significant relationship between the LPS policy and firms' employment.

An aggregate level analysis to examine the wider impacts of the policy came to similar conclusions as the firm level analysis. No impacts were found for industry-area TFP or industry-area employment and while there was an impact for exports, the magnitude and significance was sensitive to the estimator and sample suggesting that spillover effects of the cluster policy were not very important.

Following a similar methodology, a study of the Danish cluster programme by DAMVAD (2011) produced quite different results. They assessed 1,225 companies that participated in innovation networks between 2003 and 2008. Controlling for other factors influencing growth in labour productivity (the study does not specify which ones), the regression analysis showed that participation increased the probability to innovate by more than 4.5 times one year after participation compared with the control group. While 8.3 percent of the participating firms were innovative one year after participation, this number was just 1.7 per cent for the control group. They also have a higher (four times higher) likelihood of R&D collaboration one year after participation. The evaluation also found that participating firms significantly increased their probability of participating in other programmes compared to similar non-participating firms two and five years after the period. The results are interpreted as the programme enhancing learning capabilities, in turn boosting knowledge creation and knowledge sharing, namely it helped companies to move up the 'knowledge ladder'.

As a more long term outcome, the issues of either employment or income impacts were not considered or addressed in the majority of the evaluations. However in the BioRegio/BioProfile case, the evaluation found that the compound annual growth rates of employment in the

[9] The Pôles de compétitivité was effectively based on a scorecard method of assessment.

BioRegio (11.8 percent) and to a lesser extent BioProfile (3.3 percent) was higher than in other biotech regions (2.4 percent). In the UK the evaluations showed that the Yorkshire clusters appeared to be meeting targets for economic growth and employment. Taking into account direct, indirect and induced impacts, the impact assessment results showed that output in the region increased by an estimated average of £498m per annum between 2005 and 2008 and employment increased by 7,775 full time employees over the period as a result of the support provided through the cluster priority projects. In the West Midlands, the evaluation found that 6647 jobs were created or safeguarded gross value added in the region was of the order of £853m. While an impact assessment was attempted for BioLondon, in view of the embryonic nature of that cluster, the assessment showed that there were positive but marginal effects on employment and new firm creation.

3.3 Lessons from the case studies

This section discusses lessons and insights from the case studies for policymaking. Both lessons on the management, governance and impacts of the programmes, as well as general insights related to the evaluations of the programmes are considered.

For most of the selected studies, the evaluations occurred within a relatively short period of the scheme's launch when few effects are likely to be observed. Success of a cluster policy may not be observable for a considerable period of time. Consequently, the evaluations have tended to focus on the management of the programmes, relevance of activities and targets against objectives. Less focus was placed on results, intermediate or long term impacts, both on the cluster, the cluster members or the region as a whole.

Few evaluations have questioned the rationale of the programme vis-a-vis other national or regional policies, the choice of clusters or the way they have been targeted. One exception is the evaluation of the Finnish programme, which argued that a number of key industries in Finnish context were not well covered by the programme. In another case the Norwegian NCE evaluation noted that, while the program's main emphasis was on strong and mature clusters, some emerging clusters have also been awarded NCE status, creating confusion vis-a-vis other support programmes.

However one aspect considered in the evaluations is the need for continuous support and the potential mismatch between the short-term programme funding timeframes and the largely long term aims. This raises questions about the long term sustainability of the networks and collaborations established. In other instances programmes have raised the importance of adapting support instruments to the diversity of clusters, or the evolution of the cluster. While there has been little consideration to the adaptation of policy support to the evolving needs of the clusters, some evaluations have highlighted the need for adaptation and flexibility in implementation and instruments choice and the suitability of in-built feedback and assessment mechanisms to enable this.

Most evaluations report on a number of programmes and participation of public and private actors in funded projects and activities. Less attention is paid to the issue of additionality, namely whether the programme led to additional projects or networks; this tends to be self-reported and therefore does not constitute a robust indicator. It may conceal opportunistic behaviour of firms, seeking to participate as a way to obtain support for projects that they

would have pursued anyway, as with the Yorkshire clusters. Furthermore, monitoring based on counts of cluster members may not be indicative of active participation.

In terms of governance, evaluations indicate that ensuring private sector involvement early leads to more effective strategies. Leadership is also important (both public and private) to ensure that the cluster actors can innovate so that the cluster evolves with market changes. In general, implementation and management of the programmes seem to require dedicated management teams with a blend of skills and competencies to reconcile the interest of the private and public sector participants involved in the clusters.

Some clusters have been successful in leveraging private funding but this seems to be contingent on the nature of the cluster. High technology clusters such as BioRegio in Germany or the NRC Technology Clusters in Canada seem to be better placed than more traditional industry clusters in raising private sector funding. No impact has been reported in terms of attracting or leveraging foreign direct investment.

Overall, there was no clear and unambiguous evidence that over the long term clusters are able to generate strong and sustainable impacts in terms of innovation, productivity or employment.

These findings have to be seen in the light of the limited sound evidence available on the impacts of cluster policy. Formal evaluations of clusters, to the extent they are publicly available, are varied in scope, breath, and methodologies used. Many of the evaluations made extensive use of qualitative methods, questionnaire surveys, descriptive statistics and monitoring data. Quantitative methods (outside of the academic evaluations) have been less frequently utilised probably due to the difficulty of quantifying impacts and establishing causal links between policy and firm and cluster performance. Thus the diversity of programmes and the differences in the way the evaluations have been conducted render any meaningful comparison across these exercises a difficult task. Finally, and as with any other policy instrument, there is uncertainty about which aspect is actually responsible for any observed effect. In this instance, it is difficult to assess whether results are attributable to the combination of instruments in the cluster, to a particular key instrument (e.g. business services, R&D collaboration), or to the way the programme is implemented. The actual impact may depend as much on the way the policy is conducted/ implemented as on whether the rationale for its use is correct or not.

4 Conclusions

Academic and policy interest in clusters has emerged from the observation that many industries tend to cluster and the ex-post analysis of the economic and innovation performance of a number of high profile clusters. The propensity to cluster of many industries is arguably neither a sufficient guide for policy nor a strong rationale for intervention, once the potential downsides and political risks are factored in. This notwithstanding, the cluster model has proved to be a seductive proposition for policy makers, and has been used extensively as a means to foster innovation and competitiveness in a variety of national contexts.

Cluster policy is a multi-dimensional, multi-instrument policy, informed by a mix of rationales. The development of clusters therefore means different things in different places. Differences in cluster initiatives are a product of not only different objectives, instrument choice and

implementation styles, but also context specific institutional configurations, policy path dependencies and different types of government intervention.

The variety and frequent lack of clear objectives in cluster policies poses a not inconsiderable barrier to effective evaluation. Indeed, and despite the popularity of cluster policy intervention, evaluation exercises associated with them are rare. When available, they are more focused on the efficiency of the programme than the impact of clusters. Moreover, evaluations tend to focus on explicit (and more visible) policies to support clusters (narrow view) rather than on the influence of non-cluster policies at the same or other levels of governance that can have an even more significant impact on the targeted clusters. They rarely take into account policies such as planning, transport or human resources, which can have an even greater impact on the development of most clusters than specific cluster support programmes, thus limiting the possibilities for policy learning.

This report considered a number of cluster policy evaluations to reflect both on the range of the evaluations and on the outcome of the evaluations. Most evaluations are undertaken with a view to measuring some element of performance, be it at the level of the region, or the firm or indeed the cluster organisation. Methods, instruments and indicators vary considerably from case to case as these are defined in relation to agreed objectives. The evaluation studies on which this report is based are a case in point. The clusters ranged from single initiatives to groups of initiatives, from a district, city or regional programme to a country's programme and from high technology to low technology sectors. Moreover, as well as employing different mixes of methodologies, the evaluations covered various time periods over the cluster life cycle, interim, mid-term and ex-post. In such circumstances it is difficult to establish commonalities.

Nevertheless we did find a number of consistent threads across the programme evaluations. In a number of cases, cluster programmes have provided a suitable framework to mobilise resources and actors towards advancing the innovation potential of the target regions and sectors of activities. Secondly, most clusters include the provision of a variety of business support services e.g. assistance for technical innovation and mentoring support, which in many cases have been found to have an important bearing on the productivity of the clusters, particularly for SMEs. Thirdly, one of the main objectives of cluster programmes is the promotion of collaboration among firms and other actors in the clusters. A number of evaluations have reported that the intervention led to collaborations which may not have occurred without the intervention. Whereas in some cases, a strong effect in terms of additional networking and synergies has been identified, in other programmes this is not so clear cut.

Fourthly, implementation aspects and in particular the presence of certain key competences in clusters managers have been found to be key to the success of the intervention. In particular, the managers' ability to act as network facilitators or brokers able to increase the active participation and engagement of the cluster members, particularly firms, is key. Indeed, one consistent message is that private sector involvement in governance structures has a positive outcome on the strategic direction. Early private sector involvement is important to secure market oriented strategies in the targeted clusters. This involvement also significantly helps leverage private sector funding. A number of the public sector cluster investments have been successful in leveraging private funding, however this seems to be contingent on the nature of the cluster. High technology clusters appear to be better placed than more traditional industry clusters in attracting private sector funding.

Last but not least, there is no clear and unambiguous evidence that clusters policy is able to sustainably deliver innovation outcomes; or improve levels of entrepreneurship and employment or firm productivity and competitiveness. To date, not many studies have been conducted that try to assess the sustainable impacts of the intervention in terms of innovation, productivity or employment and existing studies are inconclusive.

While recognising the variety and context specificity of cluster support, some broad implications for policy can be drawn. Firstly, cluster policies should improve their clarity and focus with respect to their rationales and chosen objectives. More often than not, a clear policy rationale is missing, or limited to some vague references to theory (e.g. Porter's model, systems of innovation). The precise objectives and the criteria to evaluate the programmes are often defined ex post and applied retrospectively. Interventions should instead be designed with evaluation in mind. Secondly, there is not a one-size-fits-all way to support clusters that is applicable to all regions, all sectors and all times. Policy makers should therefore avoid adopting a fixated model of agglomeration for all industries, and perhaps use cluster theory instead as a `mode of inquiry' and a flexible methodology to inform policy design as suggested by Feser and Luger (2003). Instruments should be coherent with the chosen objectives, appropriate to the target clusters and flexible enough to enable adaptation to the changing needs of the clusters and to on-going feedback and policy learning. Thirdly, interventions should be realistic. Policy makers are often tempted to focus on more 'visible' forms of intervention rather than building on existing strengths, or may be pressured into selecting too many clusters or into backing losers. Modest, tailored support may be a preferable option to over-ambitious programmes when opportunity costs and the risk of government failure are factored in. Related to this, and in the light of the identified importance of competences and management styles (including monitoring and evaluation) for the success of cluster support, it is important to ensure that the right capacities are there at the chosen level of intervention. Similarly, the capacity of policy makers to influence the policy levers that are more likely to enhance competitiveness of the selected clusters should not be overstated. Fourthly, it is important to acknowledge that all forms of cluster support involve a form of targeting. Directly or indirectly, they privilege certain activities over others. As opposed to the desire of policy to directly target activities that are expected to flourish, the evidence shows that the reality of innovation and economic development is far messier and more difficult to manage. At the same time, all interventions will have an uneven impact in terms of sectors, types of firms and geographical areas. Policy makers therefore need to strike a careful balance between a hands-off approach and direct steering, and instead "push the system gently toward favored structures that can grow and emerge naturally" (Arthur, 1999; p.108).

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Appendix

Table 5. Policy Evaluation Studies

Policy/Initiative	Source	URL
Arena programme	Jakobsen, E.W. and Røtnes, R., (2012), Cluster programs in Norway – evaluation of the NCE and Arena programs, Menon Publication Econ Pöyry og DAMVAD (2011), *Evaluering av NCE-programmet.* Econ-report 2011-36 [Evaluation of the NCE program – contains English summary]	http://ekstranett.innovasjonnorge.no/NCE_fs/Clusters%20programs%20in%20Norway%20-%20evaluation%20of%20the%20NCE%20and%20Arena%20programs%20Jan%2012.pdf http://www.regjeringen.no/upload/KRD/Rapporter/Evaluering_NCE_2011.pdf
Barcelona Knowledge Cluster	Viladecans-Marsal and Arauzo-Carod (2011) , Can a knowledge-based cluster be created? The case of the Barcelona 22@ district. Papers in Regional Science, DOI: 10.1111/j.1435-5957.2011.00383.x	http://onlinelibrary.wiley.com/doi/10.1111/j.1435-5957.2011.00383.x/abstract;jsessionid=EA13BF46DF3B90C3088E912DFA304C37.d03t01
Basque Cluster Programme	Iturrioz, C, Aranguren, M J, Aragón, C, Larrea, M, , (2006). La política industrial de cluster/redes mejora realmente la competitividad empresarial?: Resultados de la evaluación de dos experiencias en la Comunidad Autónoma de Euskadi. Ekonomiaz, 60: 10-61.	http://www1.euskadi.net/ekonomiaz/taula4_c.apl?REG=775
Bavarian Cluster Initiative	Falck, O., Heblich, S. & Kipar, S., (2010). Industrial Innovation: Direct evidence from a cluster-oriented policy. Regional Science and Urban Economics 40(6), 574-582	http://dx.doi.org/10.1016/j.regsciurbeco.2010.03.007
BioLondon	DTZ (2008) BioLondon: London's Life Sciences Strategy and Action Plan: Interim Economic Impact Evaluation: Final Report	http://www.lda.rroom.net/Documents/BioLondon_Londons_Life_Sciences_Strategy_and_Action_Plan_Interim_Economic_Impact_Evaluation_12610.pdf
BioRegio/ BioProfile	Staehler, R., Dohse, D., and P. Cooke (2006) Evaluation der Fördermaßnahmen BioRegio und BioProfile, Federal Ministry for Education and Research	http://www.e-fi.de/fileadmin/Evaluationsstudien/Evaluation_der_Foerdermassnahmen_BioRegio_und_BioProfile.pdf
Centres of Expertise	Jakobsen, E.W. and Røtnes, R., (2012), Cluster programs in Norway – evaluation of the NCE and Arena programs, Menon Publication Econ Pöyry og DAMVAD (2011), *Evaluering av NCE-programmet.* Econ-report 2011-36 [Evaluation of the NCE program – contains English summary]	http://ekstranett.innovasjonnorge.no/NCE_fs/Clusters%20programs%20in%20Norway%20-%20evaluation%20of%20the%20NCE%20and%20Arena%20programs%20Jan%2012.pdf

		http://www.regjeringen.no/upload/KRD/Rapporter/Evaluering_NCE_2011.pdf
Danish cluster programme	DAMVAD (2011) The impact of cluster policy in Denmark—an impact study on behaviour and economical effects of innovation network Denmark. Danish Agency for Science, Technology and Innovation	http://en.fi.dk/publications/2011/the-impact-of-cluster-policy-in-denmark
Finnish National Cluster Programme	Pentikäinen, T, (2000), Economic Evaluation of the Finnish Cluster Programme, Working Paper 50/00, VTT, Group for Technology Studies	http://www.cnel.gov.pt/document/economic_eval_finnish_cluster_programmes_.pdf
French Local Production Systems	Fontagnéy, L., Koenigz, P., Maynerisx, F. and Poncet, S. (2011), Analyzing selection into subsidized clusters: The French policy of competitiveness clusters	http://perso.uclouvain.be/florian.mayneris/pdc.pdf
French Pôles de compétitivité	BCG and CMI (2008), Evaluation Des Poles De Competitive	http://competitivite.gouv.fr/documents/archivesAncienSite/pdf/synthese_BCG-CMI_evaluation_des_poles_de_competitivite.pdf
Japan Industrial Cluster Project	Nishimura, J., and Okamuro, H (2011), R&D productivity and the organization of cluster policy: an empirical evaluation of the Industrial Cluster Project in Japan, the Journal of Technology Transfer, 36:117–144	http://dx.doi.org/10.1007/s10961-009-9148-9
NRC Technology Clusters	Portfolio Evaluation of the NRC Technology Cluster Initiatives	http://www.nrc-cnrc.gc.ca/eng/evaluation/technology-cluster-initiatives.html#1
Vinnväxt	Cooke, P., Eickelpasch, A., and Ffowcs-Williams, I. (2010), International evaluation of Robotdalen , Skåne Food Innovation Network and Uppsala BIO, VINNOVA - Swedish Governmental Agency for Innovation Systems	http://www.vinnova.se/upload/EPiStorePDF/vr-10-16.pdf
West Midlands Clusters	Ecos Consulting Ltd 2010, Evaluation of AWM's Cluster Programme 2002/03-08/09, Part 2 Beneficiary Analysis	http://webarchive.nationalarchives.gov.uk/+/http://www.advantagewm.co.uk/Images/Clusters%20Part%202_tcm9-18763.pdf
Yorkshire Clusters	Yorkshire forward (2008) Evaluation of Yorkshire Forward's Investment in Cluster Initiatives: Final Report (Revised)	http://www.yorkshire-forward.com//sites/default/files/documents/Cluster%20Evaluation%20Report%20with%20Appendices.pdf

Manchester Institute of Innovation Research

The Manchester Institute of Innovation Research (MIoIR) is the research centre of excellence in the Manchester Business School (MBS) and The University of Manchester in the field of innovation and science studies. With more than 50 full members and a range of associated academics from across the University, MIoIR is Europe's largest and one of the World's leading research centres in this field.

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