An International Comparison of National Clusters

Paper presented at the 41st Congress of the European Regional Science Association
August 29 - September 1, Zagreb, Croatia.

Abstract:

Whereas most theoretical studies about clusters focus on innovative micro clusters, empirical studies often analyse meso clusters, which consist of sectors instead of firms. These meso clusters are much easier to analyse empirically than micro clusters are, and they may reflect processes at work in innovative micro clusters. The present article compares meso clusters in different countries. The main conclusion is that the results are incomplete: although the clusters found suggest existing micro clusters, not all clusters are identified. The most important inter sectoral linkages are found, but the results are not good enough for international analyses and for analysing innovation.

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Introduction

Articles about clusters often show a difference between theoretical research and empirical research: most theoretical analyses focus on micro clusters of firms that co-operate and diffuse knowledge, whereas most empirical analyses focus on meso clusters of sectors that have a buyer-supplier relationship. Earlier research concluded that these meso clusters should not be used to analyse innovative micro clusters, since the different cluster concepts lead to different clusters, both theoretically and empirically (Hoen, 2000). An international comparison of meso clusters, however, may yield important insights into the differences in the way sectors work together in various countries, which may explain divergent patterns of specialisation or even different economic growth rates.

Micro clusters and meso clusters

Although a lot of literature about clusters exists[1], no agreement has been reached about the exact meaning of the concept. According to the Concise Oxford Dictionary, a cluster is "a close group of things."[2] In an economic context, however, the 'things' as well as the link that makes them 'close' vary between articles and theories. Porter (1998) defines a cluster as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities." Unfortunately, he adds to the confusion of the exact meaning of the cluster concept by redefining a cluster in the same article as "a system of interconnected firms and institutions the whole of which is greater than the sum of the parts."

A common element in most definitions of an economic cluster are the linkages between firms. For example, Roelandt and Den Hertog (1999) note that "economic clusters can be characterised as networks of strongly interdependent firms (including suppliers) linked to each other in a value-adding production chain." Most definitions in the theory about clusters seem to agree to some extent that the 'thing' in clusters are firms (or institutions) that are 'close' to each other due to interdependencies between these firms. Furthermore, most authors stress the importance of innovations in clusters. These clusters of firms will be called 'innovative clusters' or 'micro clusters.' Empirical analyses, however, often use clusters of sectors that are connected by buyer-supplier relations. These

clusters will be referred to as 'meso clusters.' Empirically, innovative clusters are difficult to deal with, since innovation, cooperation and linkages between firms are almost impossible to measure. Empirical analyses based on micro clusters often use qualitative methods such as expert interviews or surveys. These methods easily lead to results that are, to a large extent, arbitrary. Meso clusters, however, are relatively easy to identify, since input-output tables readily provide a framework for identifying meso clusters of sectors based on buyer-supplier relations.

Although the concept of a meso cluster differs substantially from that of an innovative cluster, it is often assumed that a relationship between the two exists. DeBresson (1996) shows that the pattern of diffusion of innovations between sectors strongly resembles that of the elements in an input-output table. Hence, the latter can be used as a proxy for the former, which means that meso clusters provide a framework that indicates how micro clusters might be composed. It seems likely that firms that work together derive their connections from sectors that work together. Porter (1990) also notices that cooperating firms may often already work together in a buyer-supplier relation. In that case, linkages in an input-output table may be used to find a general framework of relations between sectors that reflects roughly which firms are likely to work together. Innovative clusters then exist within meso clusters.

Besides the relatively easy empirical identification, three reasons exist that make it interesting to study meso clusters instead of micro clusters. First of all, most policy measures are aimed at creating generally favourable conditions rather than at stimulating specific firms. Stimulating innovative clusters entails the risk of slipping into stimulating specific firms, which may disturb the market mechanism in an economic system. Hence, policy measures should aim at creating possibilities that can support an entire sector rather than a specific firm. Second, the cluster concept may be useful in presenting the main results of sectoral studies. Results of analyses at the sectoral level are often very disaggregated. Furthermore, the results of a single sector also depend on the cooperation of this sector with other sectors. Difficulties in interpreting the outcomes of sectoral studies arise because of the large amount of details, and because the results are displayed out of a context. Clusters provide for the context and they make it possible to aggregate the sectoral results in a meaningful way. Finally, meso clusters can also be used for international comparative analyses. Clusters show which sectors cooperate in different countries, thus

showing differences between technologies used or between the goods produced. After all, a sector that produces food and buys its inputs from the agricultural sector will produce different goods than a sector that produces food and buys its inputs from the chemical sector. Although the present article is a first step in such analyses, it is limited to finding meso clusters in different countries and comparing differences between countries with respect to the clusters found and the sectors included in these clusters. Some indicative remarks are made, which may be able to explain the most interesting differences. A comparison of the effects of the clusters in different countries, the differences between the processes at work in the clusters, and economic variables such as export position and profitability, are postponed for future research.

Still, analyses based on the identified clusters can be performed only if the cluster identification method yields useful results. Although the results are generally robust and in many cases plausible, the outcomes of even strictly quantitative cluster identification methods are often to a large extent arbitrary (Hoen, 2000). By comparing the meso clusters of different countries, the present article shows that the outcomes are in many cases also incomplete. Hence, we must conclude from the analysis in this article that meso clusters based on the presently available input-output tables are useful neither for analysing innovations nor for attempting international analyses. They do show, however, the most important linkages between sectors.

The data used

Before presenting the results of the cluster analysis, we discuss the data used in the analysis. As mentioned before, the method used is based on input-output tables. By identifying clusters with the linkages in the input-output tables,[3] we see a picture emerging of the sectors that work closely together. Hence, for the analysis we needed a consistent set of input-output tables of different countries. The tables should be expressed in the same sector classification and should preferably be based on the same year. The OECD issues a set of input-output tables that comes close to these needs (OECD, 1995). However, the OECD input-output tables are expressed in a rather aggregated sector classification, and not all data are available for the same year.

Since the analysis of Dutch data showed that the identified clusters are robust with

respect to time, we must assume that the different years for which the input-output tables are available do not cause a major problem. Hence, it is possible to compare the results of different countries for different years. The level of aggregation poses a more serious problem. The Dutch data showed that aggregation generally leads to fewer clusters. Clusters identified with aggregated data remained present in the analysis on less aggregated data. Hence, at the very least the aggregated data show the most important clusters of a country. It is assumed that this conclusion holds for other countries as well.

The OECD sector classification distinguishes 35 sectors (see Appendix 1). Table 1 shows the countries for which input-output tables are available. It also indicates to which year in the period 1985-1990 these input-output tables refer. The cluster identification method developed earlier (see Hoen, 2000) will be applied to the countries in Table 1 (for each country in the year indicated).

Table 1 Countries and years of available OECD input-output tables

Country	symbol	year
Australia	Au	1989
Canada	Ca	1990
Denmark	De	1990
France	Fr	1990
Germany	Ge	1990
Italy	It	1985
Japan	Jp	1990
The Netherlands	Nl	1986
United Kingdom	UK	1990
United States	US	1990

Which clusters are found in which countries?

Table 2 shows the results of the cluster analysis. The rows indicate the clusters that have been found. The columns show the countries in the analysis. An x is used to indicate that the cluster in the row was found in the country in the column. In some cases, a combined cluster was found, which is indicated by a large x. For example, in Germany the cluster ‘Mining and energy’ appears, which is indicated by a large x that crosses both the clusters ‘Mining’ and ‘Energy’. Table 2 shows only the names of the clusters; the sectors included

in the clusters are displayed in Appendix 2.

Table 2 Meso clusters in different countries

	Au	Ca	De	Fr	Ge	It	Jp	Nl	UK	US
Agro-food	X	X	X	X	X	X	X	X	X	X
Mining	X	X	X							
Energy										
Construction	X	X	X		X	X		X	X	X
Metal				X	X	X			X	
Business services		X				X		X	X	X
Chemical							X			X
Paper, transportation and		X								
Vehicles				X						
Social					X					
Electronics							X			

Some clusters appear in only one country. Not surprisingly, Japan finds an electronics cluster—a cluster that does not appear in any other country. France finds a cluster that has vehicles as its main product. In Germany, a cluster called 'social' is identified, which includes the sectors 'paper, paper products and printing' and 'community, social & personal services.' This may suggest that the last sector uses or issues many paper products.

Often, the same cluster is found in many countries. For example, every country has an agro-food cluster. The presence of this cluster in every country may reflect the fact that no country likes to depend totally on other countries for its food supply. Another explanation is the relatively large trade protection that often still exists for agricultural products. In most countries, the core of the agro-food cluster consists of agriculture and food processing industries. In Canada, Italy, Japan and the United States, the agro-food cluster also includes the sector 'Restaurants & Hotels.' This may reflect the preference for citizens of these countries to eat in restaurants. Whereas in other countries consumers buy their food and prepare it at home, it may be more the custom for citizens of the aforementioned countries to buy their food in restaurants; this means that restaurants buy the food from the food processing industries, which sell it to the final users. This is also suggested by the ratio of consumption of products of the sector 'Restaurants and Hotels'

to consumption of products of the sector 'Food beverages and Tobacco,' which is relatively large in the United States, Italy and Canada.[4] Finally, in Canada the sector 'Wood products & furniture' also appears in the agro-food cluster, which indicates that Canada is relatively specialised in this sector.

The construction cluster shows interesting differences between the countries as well. In most countries, the cluster 'Construction' consists of the sectors 'Construction' and 'Non-metallic mineral products.' Canada and the United States, however, appear to use construction techniques that rely heavily on metal products, since these countries include the sectors 'Construction,' 'Iron & steel' and 'Metal products' in the construction cluster. Japan finds all four sectors in its construction cluster.

Although it seems likely that the clusters in Table 2 will have counterpart micro clusters in the countries indicated, the results appear to be incomplete. For example, France is the only country in which an automobile cluster seems to exist, whereas similar clusters should probably be found in Germany, the United Kingdom, the United States and Japan as well. Likewise, Japan cannot be the only country with an electronics cluster, although this cluster type is sure to exist in Japan. Finally, the results indicate that the Netherlands does not have a chemical cluster. Earlier analyses already showed that this cluster does not show up in the Dutch results if the input-output table is too aggregated. The Dutch chemical cluster may be aggregated in one sector, in which case it is never identified as a cluster. This means that the chemical clusters in the United States and Japan produce different products than the Dutch chemical cluster, since these countries do find more than one sector aggregated in the chemical cluster.

Part of the problem is caused be the high level of aggregation of the data. For international analyses, however, it is hard to find a better data source. Since some countries do have more detailed data, we could improve the results by including only these countries. We could also extend the analyses with more qualitative analyses. Each solution has a price, since it involves leaving out countries, spending a lot of time finding better data, or setting aside the strictly quantitative method and using a method that may lead to more arbitrary results.

Conclusions

The analysis shows that countries differ with respect to the identified meso clusters. Sometimes, different clusters are found in various countries, and sometimes the same cluster consists of different sectors. This is an indication that innovative clusters differ per country as well, which may help explain differences in innovativeness of countries and differences in economic growth rates. However, the results of the analysis show that the usefulness of the cluster approach is limited. Among other things, the cluster identification method does not find all clusters present in a country. The relationship between meso clusters and micro clusters appears to be a one-way street: if a meso cluster is found, the country will have one or more counterpart micro clusters, whereas a certain micro cluster does not necessarily have a counterpart meso cluster. This implies that the method is still not good enough for international analyses. An earlier analysis already showed that meso clusters should not be used to analyse micro clusters directly. Hence, the results of the cluster identification method represent the beginning of an analysis and not the end; they must be extended with more detailed analyses such as in-depth studies or analyses based on micro data. In spite of this negative conclusion, the method can be used for two purposes. First, it indicates which clusters are present in a country. Second, it shows the most important inter sectoral linkages of a country. Although other techniques exist for finding linkages between sectors (such as key sectors and multipliers), most of these techniques can only answer the question for one sector at a time, whereas cluster analysis directly shows the location of the most important inter sectoral linkages in the economic system as a whole.

References

Antonelli, C., 1999, *The Micro dynamics of Technological Change*, Frontiers of Political Economy, vol. 23, New York and London: Routledge.

DeBresson, C., 1996, *Economic interdependence and innovative activity: an input-output analysis*, Cheltenham: Edward Elgar.

Hoen, A.R., 2000, Clusters, welke clusters?, *Economisch Statistische Berichten*, nr. 4277, pp. 859-861.

Krugman, P., 1991, *Geography and Trade*, Cambridge MA.: MIT Press.

Krugman, P., and A.J. Venables, 1996, Integration, specialisation, adjustment, *European Economic Review*, vol. 40, pp. 959-968.

OECD, 1995, *The OECD Input-Output Database*, Paris: OECD.

Peneder, M., 1999, Creating a coherent design for cluster analysis and related policies: The Austrian "TIP" experience, in: OECD, *Boosting Innovation: The Cluster Approach*, Paris: OECD.

Porter, M.E., 1990, *The Competitive Advantage of Nations*, New York: Free Press.

Porter, M.E., 1998, *On Competition*, Boston: Harvard Business Review.

Roelandt T.J.A., and P. Den Hertog, 1999, Cluster analysis and cluster-based policy making: The state of the art, in: OECD, *Boosting Innovation: The Cluster Approach*, Paris: OECD.

Schmutzler, A., 1999, The new economic geography, *Journal of Economic Surveys*, vol. 13, no. 4, pp. 355- 379.

Van den Boom, E. and D. Sonak, 2000, Interview Cees van der Hoeven,, *Economisch Magazine*, nr. 4, September, pp. 52-54.

Appendix 1: The OECD Sector Classification

1	Agriculture, forestry & fishing
2	Mining & quarrying
3	Food, beverages & tobacco
4	Textiles, apparel & leather
5	Wood products & furniture
6	Paper, paper products & printing
7	Industrial chemicals
8	Drugs & medicines
9	Petroleum & coal products
10	Rubber & plastic products
11	Non-metallic mineral products
12	Iron & steel
13	Non-ferrous metals
14	Metal products
15	Non-electrical machinery
16	Office & computing machinery
17	Electrical apparatus, nec
18	Radio, TV & communication equipment
19	Shipbuilding & repairing
20	Other transport
21	Motor vehicles
22	Aircraft
23	Professional goods
24	Other manufacturing
25	Electricity, gas & water
26	Construction
27	Wholesale & retail trade
28	Restaurants & hotels
29	Transport & storage
30	Communication

31 Finance & insurance

32 Real estate & business services

33 Community, social & personal services

34 Producers of government services

35 Other producers

36 Statistical discrepancy

37 Total

Appendix 2: The identified clusters

Country:	Cluster:	Sectors included in cluster:
Australia, 1989	agro-food	1, 3
	mining/ energy	2, 9, 12, 13, 25
	construction	11, 26
Canada, 1990	agro-food	1, 3, 5, 28
	paper, transportation and other manufacturing	6, 29, 35
	mining	2, 9, 13, 34
	construction	12, 14, 26
	business services	31, 32
Denmark, 1990	agro-food	1, 3
	mining	2, 9
	construction	11, 26, 32
France, 1990	agro-food	1, 3
	vehicles	12, 21,
	metal	14, 15
Germany, 1990	agro-food	1, 3
	mining	2, 25
	construction	11, 26
	metal	12, 14
	social	6, 33
Italy, 1985	agro-food	1, 3, 28
	construction	11, 26
	metal	12, 14, 15
	business services	27, 29, 31, 32
Japan, 1990	agro-food	1, 3, 28
	chemical	7, 10
	construction / metal	11, 12, 14, 15, 26
	electronics	16, 18

the Netherlands, 1986	agro-food	1, 3
	mining	2, 7, 9, 25
	construction	11, 26
	business services	27, 29, 31, 32
United Kingdom, 1990		
	agro-food	1, 3
	mining / energy	2, 9, 25
	metal	12, 15, 21
	construction	11, 26
	business services	27, 29, 31, 32
United States, 1990	agro-food	1, 3, 28
	chemical	7, 10
	mining / energy	2, 9, 25
	construction	12, 14, 26
	business services	27, 32

Notes

1. See, for example, Krugman (1991), Krugman and Venables (1996) or Schmutzler (1999) for clusters in the ‘new economic geography,’ or Antonelli (1999) for clusters in the ‘new economics of knowledge.’

2. Quoted in Peneder (1999).

3. The method starts by eliminating all elements that are not large enough. If enough elements are eliminated, the remaining elements form a framework that automatically divides the sectors into clusters (see Hoen, 2000).

4. A similar conclusion is drawn in Van den Boom and Sonak (2000).