



Managing in the Triple Helix – from a University perspective

CASE: Department of Dairy and Food Science,
The Royal Veterinary and Agricultural University in Copenhagen

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Abstract

The paper focuses on some of the aspects of changes within the management at the Danish Universities in the last decade in a Triple Helix perspective. It does so by presenting a CASE *Department of Dairy and Food Science (MLI) at The Royal Veterinary and Agricultural University in Copenhagen (KVL)*.

The background for choosing MLI is

- The paradox of the Danish Food Export, where dairy products are value added and where meat products are not;
- That MLI can be seen as a dynamic research unit;
- That MLI has grown with respect to number of research results (papers, patents etc.) as well as number of researchers and research areas, that the growth can be seen in a knowledge management perspective.

The Knowledge Management perspective is combined with the Triple Helix perspective via a interpreting of the Knowledge Spiral. It is then suggested that a general growth model should include research as well as other structures indirectly.

Keywords: Research Management, Knowledge Management, Food Science, Growth.

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1. Introduction

The management of the university departments in Denmark have changed radically during the last decade. The changes have given the head of department a clear managerial role and thereby given her/him possibilities to act as a research manager. This has opened possible strategic connection to industry as well as to other research units and government. The government initiated the changes of the managerial rules at the universities in the beginning of 1990'ties¹. The changes can be seen as one element of the development of the *Danish Triple Helix*.

Denmark is and has been a net exporting country of food for more than 100 years. Food can, as other commodities, be either raw material or value-added commodities. Value-added export commodities generate a larger impact on society growth and wealth than raw material export². Denmark has a tradition of exporting value-added products made out of milk and not-value-added products out of meat. This structure is connected with the education of food-technicians and research within milk and other foodstuffs. But it can also be viewed in other perspectives such as structure of the Danish food industry and the governmental research policy.

Within the last ten years the Department of Dairy and Food Science, The Royal Veterinary and Agricultural University in Copenhagen (MLI, KVL) has not only grown with respect to number of students, researchers, cooperative research projects, and external funding; the department has also initiated a new food-technician-education line focused on meat products. The department is chosen as case in this paper because of this growth, because it can be regarded as dynamic research environments acting actively within the Triple Helix.

The Triple Helix can be regarded as a non-stable system that captures the connections between the three entities or elements of a growing knowledge system in which the elements interact. The three basic entities are: **University, Industry and Government.**

The focus of the paper is on the managerial role of a university department, where the strategy includes collaboration with industry as well as government.

In Section 2 the new role of the research management at the Danish universities within the Triple Helix settings are discussed. This is followed by a general description of the Danish dairy and meat export and of the research within Dairy and Meat Science in Denmark, where the story of the last ten years of MLI is presented in Section 3. In Section 4 the focus is on Triple Helix and

¹ The government has announced a reform in October 2002, but it is at this point of time not clear, what differences this will induce.

² This is often in focus when the economics of developing countries are discussed.

transformation and growth of knowledge; in this the idea of Triple Helix is connected with the knowledge spiral. The paper ends with a number of remarks in the last section, Section 5.

2. The Role of the University Research Manager in the Triple Helix perspective

The University Managers

The university research manager in a Triple Helix context has to deal with internal management as well as external management at a number of levels. The role of the university managers differs in different countries as well as within different fields of science; the focus in this paper is the development of the Danish *university manager - role* during the last decade.

Ten years ago the university manager was often silent, invisible, and the role could be described as non-existing as one could say there was no such thing as a manager. Projects had contact persons, departments had heads, and studies had directors, but often their positions were pure staffage: The contact persons had to discuss every issue with members of the project staff as well as head of departments and leader of the studies had to ask the department/study board every time important decisions were made. The head as well as the board of departments and directors of the studies were elected among the faculty³ and often only little attention was put on the elections, because the general idea of the democratic structure of the university was based on 1) autonomy of every researcher and 2) that all important decisions had to be discussed among all members of the staff - and not only the board. This reduced the roles of the directors and heads to pure administrative roles. But behind the structure of 'no or silent leadership', leaders did emerge on more informal base: some became informal leaders because they were regarded as the best researchers, others because they were capable politicians.

The rules on management of the universities changed in 1992⁴, after then the head of department as well as the leader of the studies were given more direct managerial power. They had the formal managerial rights within the election period. The formal changes lead to changes at some departments, as well as a new awareness on management arose. But still one can find a few university departments in Denmark with invisible heads, as well as one can find university researchers that would agree that there should be no active management of universities because every researcher should have the right and freedom to decide their research subject, methods, ways of publication as well as teaching (Langberg and Lauridsen, 2001; Lauridsen, 2002; and unpublished material from 'Universitetsforskerundersøgelsen' AFSK 2000/2001).

³ Faculty used in the meaning *scientific staff*, not as a translation of the Danish *fakultet*.

⁴ All Danish universities are state universities, the changes was a consequence of change of rules at the government level.

Research management in general and research management particularly at universities have been widely and intensively discussed within the last five years in Denmark. This discussion is partly based on the growing number of university students, the change of the universities from 'elite' to 'mass', the growing internationalisation; and the growing awareness of management tools within the public sector in Denmark, i.e., introduction of management concepts as New Public Management (as all Danish universities belongs to the public sector), Total Quality Management, Human Resource Management, and Benchmarking⁵.

A majority of the research managers at the Danish universities have not received any formal training in management when they are elected to the positions as managers or appointed as project managers. This is even the case among managers of some of the most dynamic research units in Denmark (Graversen et al. 2002; see below).

The growing awareness of managerial knowledge as integrated part of the knowledge that a university researcher should have could be paralleled with the growing awareness of teaching knowledge that rose during the 1980'ties. This has increased the interest on knowledge management as well as the interest on the well-managed research environments, including an interest on *dynamic research environments* and other subgroups of environments.

Dynamic research environments at Universities in Denmark

The Danish Council for Research Policy (Danmarks Forskningsråd) identified fifteen research units at universities and government research institutes in Denmark as *good examples of dynamic and innovative research environments* in autumn 2001. The units were studied by a group of researchers from The Danish Institute for Studies in Research and Research Policy and a report ready in spring 2002 (Graversen et al.2002).

Surprisingly the study revealed that the management style at the units was much the same regardless of the context (university vs. government research institute) or the main subjects (e.g., humanities vs. medical science).

The characteristics of the dynamic research units were:

- They all had clearly formulated research strategies and/or objectives
- The research projects were focused
- The researchers worked in teams
- The research environments were internationally integrated, e.g., a number of units had English as working language

⁵ Forthcoming report from AFSK on research management in Denmark by Kamma Langberg.

- The research environment had more often than other similar research units close relations to private firms (measured in number of PhD-students (co-) financed by firms and/or grants from private firms)

The research managers at the dynamic units were characterised by:

- They were or had been very active and recognized at an international level and in an international context
- They were respected by the researchers at their units as well as researchers outside the unit
- They were focused on basic as well as applied research
- They were focused on the social environment at the research unit
- A number of them were or had been involved in research policy making at a local as well as a national level

The researchers at the dynamic units were generally younger and more often female than other researchers; but surprisingly they spend almost the same amount of hours a week at work as other researchers and they have similar opinions on research. They had more often been working abroad in international research environments.

A number of other research units in Denmark can be characterized in the same way.

The dynamic university units can either be regarded as well performing units, i.e., best practices that other research managers at university units could learn from; or they can be regarded as dynamic as a consequence of their remarkable managers.

If the dynamic units can be regarded as *best practices* then other research managers could learn from them. This could mean that university departments should be more focused, e.g., use more effort in developing research strategies and that teamwork should be supported. It could also mean that head of departments should place more attention on international relations, on relations to the private sector as well as on the research policy. In the short run this may conflict to the scientific career of the head of department, and it may be seen as a support to a system without elected managers at the university; but then it must be noted that the study was made in a university system with elected managers, and that it was seen as a core competence that the research managers were recognized researchers at an international level.

The University awareness of the Triple Helix

At most Danish university environments an awareness of the Triple Helix possibilities is found. In some of those environments positive interaction exists between the research units and the society (local firms and local authorities), and it is obvious to the researchers that research can be inspired and financed by organisations outside the university. This has been reported from interviews of managers and researchers in 'dynamic' research units (Graversen et al., 2002) as well as from a survey of all university researchers in Denmark, where some results are shown in Figure 2.1 and 2.2.

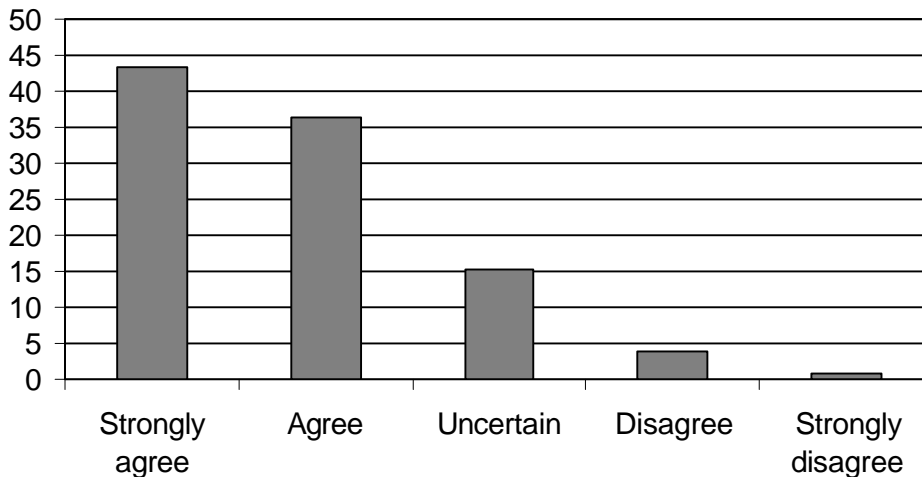


Figure 2.1 Answers from university researchers in Denmark to the statement: *All researchers ought to collaborate with researchers from other scientific areas/other institutes in projects at least sometimes*

Source: Langberg and Lauridsen (2001)

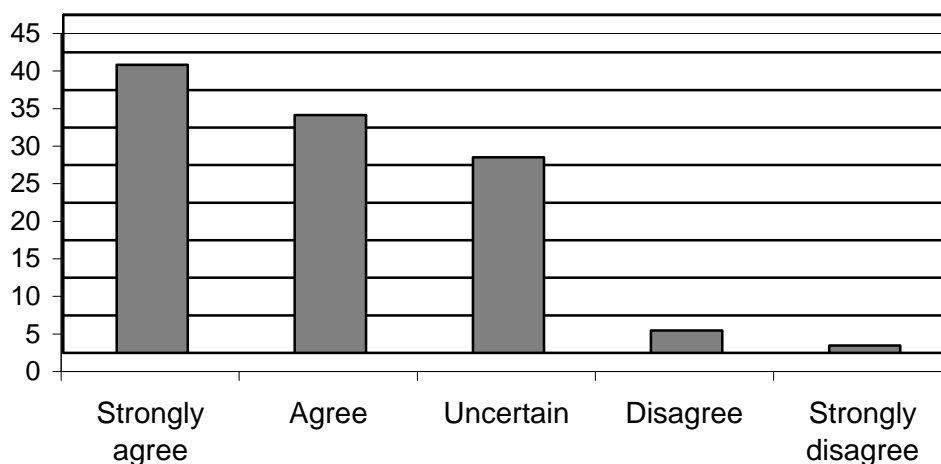


Figure 2.2 Answers from university researchers in Denmark to the statement: *It is scientific inspiring to collaborate with researchers from outside the universities e.g. researchers from governmental research institutes or the private sector*

Source: Langberg and Lauridsen (2001)

The figures show that the university researchers in Denmark in general are ready to collaborate with the industry. This positive awareness does not imply that they have the experience or the education to do so.

3. The Danish Dairy and Meat Export & Dairy and Meat Science in Denmark

As other minor open economies Denmark has a relatively large foreign trade: the value of the Danish export is approximate 30 percent of the Danish GDP (import and export is at the same level). Approximate 12 percent of the total export is related to agriculture. This figure can be compared to the fact that only 3,5 percent of the working population is working with agriculture - still the export of agriculture product have an important economic role in the society⁶.

Butter & bacon have been Danish export commodities in more that 100 years and are Danish export commodities today. Approximate 90 percent of the Danish butter production and 85 percent of the production of pig meat are exported.

As seen in this section there is a paradox. The Danish export of dairy product consists mainly of cheese and is general 'value-added' as showed in Figure 3.1; where the largest part of the Danish export of meat products is 'raw material', meat without any added value as showed in Figure 3.2.

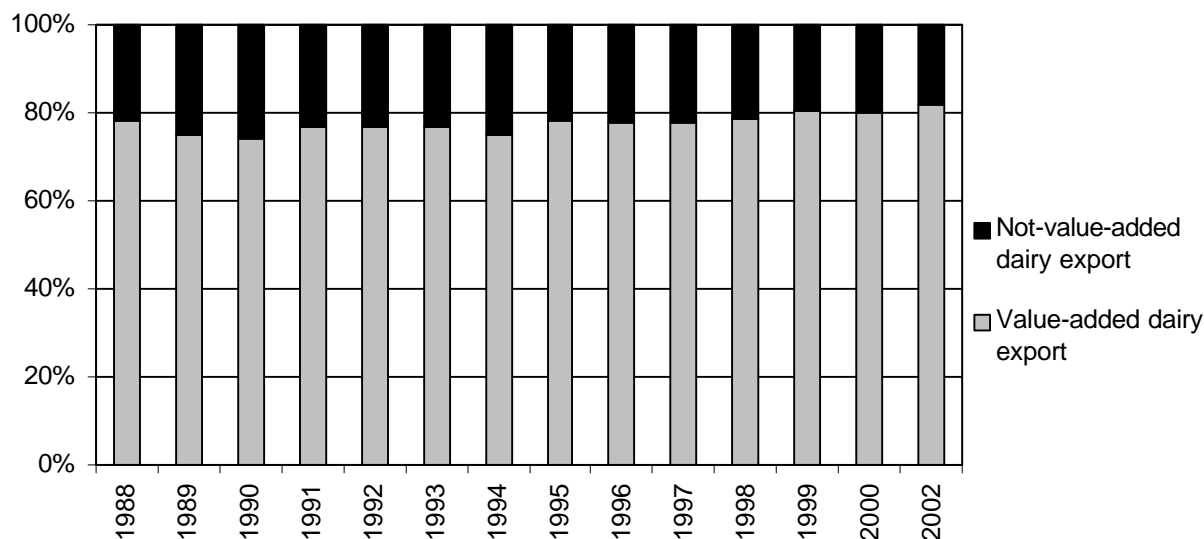


Figure 3.1 The Danish dairy export from 1988 to 2001 divided into Not-value-added and value-added export. Measured in value. Source: Figure 3.1A in appendix

⁶ Approximate figures from 2000. Source: Danmarks Statistik (Statistics Denmark) Tiårsoversigten 2001.

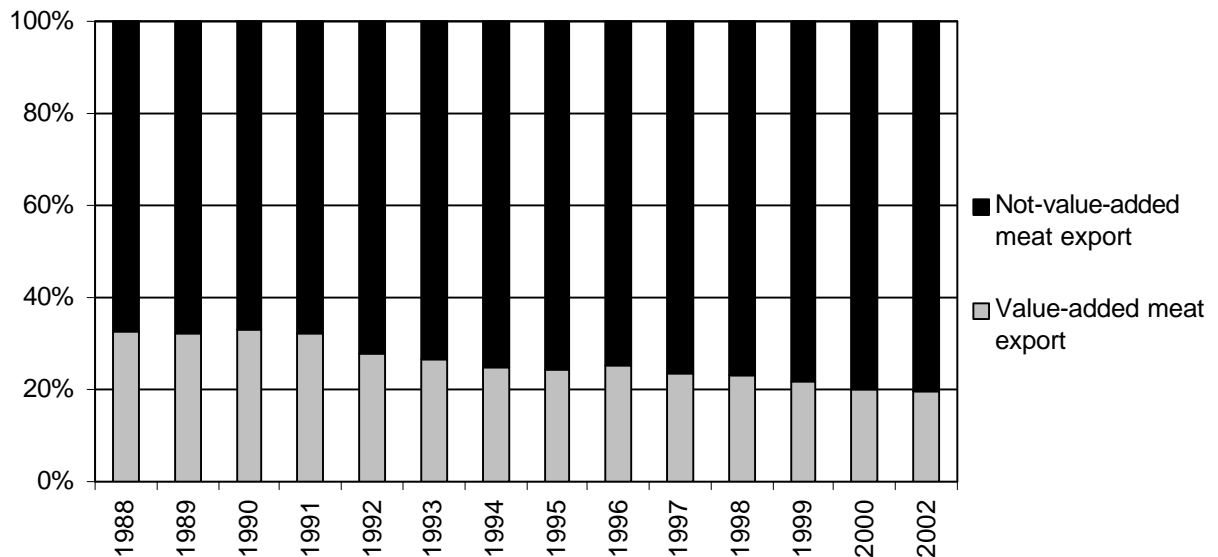


Figure 3.2 The Danish meat export from 1988 to 2001 divided into Not-value-added and value-added export. Measured in value. Source: Figure 3.2A in appendix

The export of food can be seen in a number of perspectives. First the food export can be seen as a function of supply from the Danish food industry and the demand of food in others countries as seen in Figure 3.3, where both supply and demand are functions of quality and price.

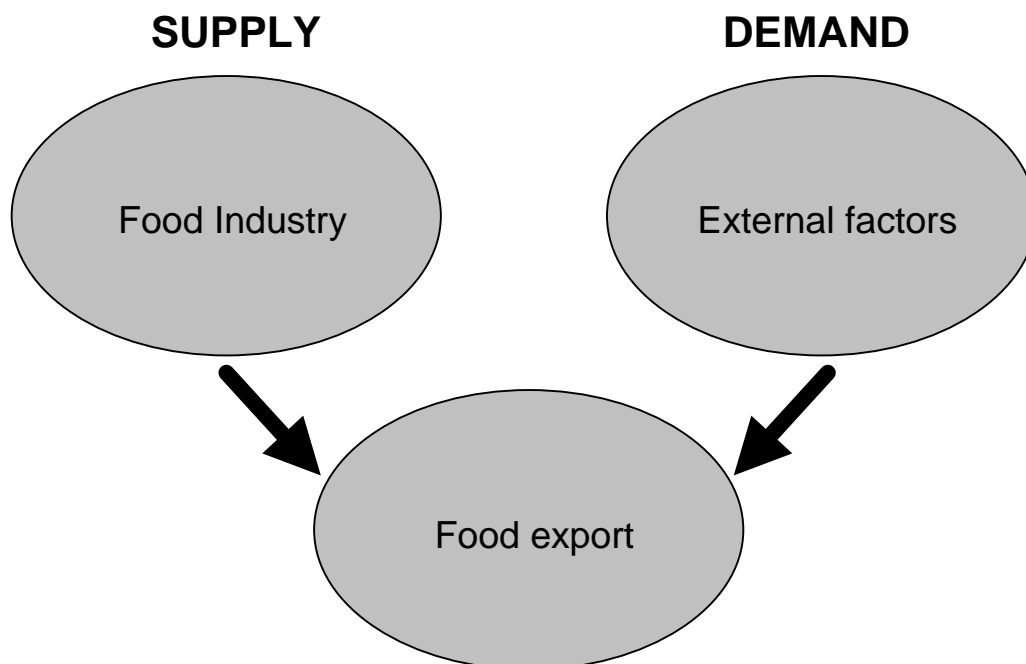


Figure 3.3 Determinants of the Food export

The central element with regard to research is the food industry because research can change price and quality of the products. Figure 3.4 captures the connections between the food industry and others players in Denmark.

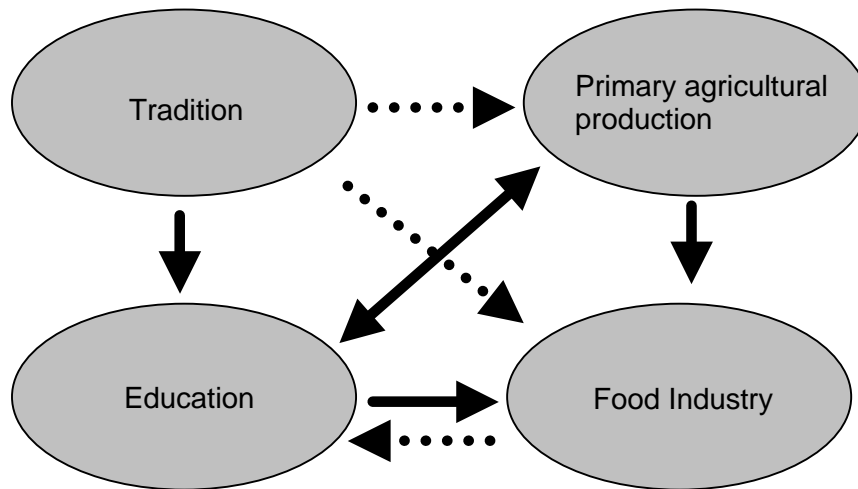


Figure 3.4 Connections between the Food Industry and others players in Denmark

The difference in the situation for the dairy and the meat products cannot be explained by difference in organization of the farmers: all farmers in Denmark join the same sort of organization and they have faced the same kinds of changes in distribution-chain. It might be noted that most of the industrial food sector has been co-operative in a long period.

The difference in value-added and not-value-added might be connected with differences in the education and R&D in the two sectors:

- Even that a long tradition of education related to agriculture is found in Denmark, the agricultural university was founded in 1856 and the education 'dairy technician' started in 1921; there were until the 1990'ties no such thing as a 'meat technician' in the Danish education system
- According to the Danish R&D-statistics⁷ the number of researchers as well as the total expenditure used for research and development in the *private* dairy- and meat-sector shows that the R&D within the dairy-sector is several times larger than the R&D within the meat-sector.

The food technology-industrial complex includes other forms of food than dairy and meat as beer, plants and ingredients, the research on dairy and meat is to some extent connected to that.

The research within the public sector on food technology is primary based at the universities: *The Royal Veterinary and Agricultural University* in Copenhagen (KVL) and *Technical University of Denmark* (DTU) and the Government Research Institutes *Danish Institute of Agricultural Sciences* (DJF) and *Risoe* (Risø)

⁷ Not published material. The number of companies is so small that the figures are not to be published.

The research within the private sector is partly made at the Danish Meat Research Institute (Slagteriernes Forskingsinstitut, DMRI) and partly at a number of private firms as Chr. Hansen A/S, Danisco and Carlsberg.

The research within food technology has been supported by a number of public research programmes in Denmark as well as in EU. The research is also supported by private funds as Danish Dairy Board (Mejeriernes Forskning Fond)

One of the key actors at the food technology scene in Denmark today is Department of Dairy and Food Science (MLI).

**CASE: Department of Dairy and Food Science,
The Royal Veterinary and Agricultural University in Copenhagen⁸**

The Department of Dairy and Food Science, The Royal Veterinary and Agricultural University in Copenhagen (MLI, KVL) is chosen as case, because it can be regarded as an example of an university department that manage within a Triple Helix settings.

MLI can be characterized as a dynamic research unit with respect to international reputation, management style and growth of research results (papers, patents) within the last 15 years. The research and education environment started as a number of minor departments at KVL, that were merged into one strong unit, MLI, in the beginning of the 1990'ties⁹.

The growth of MLI was initiated by a small visionary group of researchers (two professors and the later head of department) in the beginning of the period. They succeeded in getting internal funds from KVL as well as they succeeded in getting grants from other sources. The initiatives included a prospective collaboration project with Technical University of Denmark (DTU) under the name Centre for Advanced Foods Studies (LMC) as well as formulation of a new education line: food technicians from KVL.

The education of food technicians is partly based on the success of the dairy technicians from KVL. From 1992/1993 the basic education line was integrated in the collaboration project with DTU - and today the food technicians can either choose the general line 'food technology' or specialize

⁸ The case study is based on: information from the Danish R&D statistics, information on the homepage of MLI www.kvl.mli.dk, a qualitative interview with the head of department in autumn 2001, and on a web based survey among the researchers in autumn 2001.

⁹ This was a general trend at KVL as well as at other Danish Universities.

in dairy or meat. The latest improvement is the internalisation of the education line as a part of the collaboration with Swedish Universities.

MLI consist of 7 research units or groups, and a common facilities unit. Researchers from MLI work in LMC, on of the so-called 'centre without walls' (based on KVL as well as on DTU), as well as they work together with researchers from other public research institutions and private firms. More than 100 academic researchers work at the department.

Four of the research group crosses the lines of different food products, where three groups are focused at the different food products:

- *The Food Chemistry Group* is a central partner in the EU-project 'Bioback' (see below) 20 research projects of different size are listed under the group out of these 5 are focused on meat and 4 on dairy products.
- *The Food Fermentation Group* (Food Microbiology) was established in **1994** when funding for the first project was obtained. The group has received funding from Danish Dairy Board, DANIDA (The Danish International Development Assistance, Danish Foreign Ministry), The FØTEK programme (a Danish research programme) and EU. The group is working together with researchers from Scotland as well as Germany.
- *The Food Technology Group* was founded in **1992**. The group work with new exploratory, multivariate spec-troscopic methods of observing nature and processes are non-destructive, rapid and environmentally friendly compared to the traditionally used univariate and slower physico-chemical methods - called FoodMetrics.
- *The Sensory Science Group* was started in the beginning of the 90'ties by researchers at KVL who were working with sensory science in connection with other research projects. In **1996** the first professor was connected to the research area and it was formally founded.
- *The Dairy Technology Group* is working within a long Danish research tradition on milk and cheese. *The Meat Science Group* and *The Plant Product Group* are newer pendants to it.

As seen three of the research units where either founded or 'upgraded' with a full professor within a short period. This was a result of the primary support from internal funding at KVL followed by a number of grants and other forms of support.

The communication story behind the success can be described as a number of 'echoes' or responses of the primary vision:

Step one: Formulation of the initial vision within the research group

Step two: Communication of the vision out of the research group

Echo one: 'Echo' from the management at KVL - initial funding

Step three: The funds used to support a research group -> research results (papers etc.)

Step four: Communication of the research results and new visions out of the group

Echo two: Grants from the outside

Step five: The funds used to support a research group -> research results (papers etc.)

Step six: Communication of the research results and new visions out of the group

etc.....

Every research group or unit has to produce research results as papers or patents in order to keep the 'echoes' going. At the same time the group often has to manage within a complex structure of not only substantial character but also of different rules, where *the BIOPACK project* can be used as an example of the complex structure of both the research and research management:

"BIOPACK is a new concept in food packaging. This will involve new approaches to the use of oxygen scavengers, preservatives encapsulated in cyclodextrins (CDs) incorporated into PLA (polylactic acid) and PHB (poly 3- hydroxy- butyrate) as active protective agents in this biobased system. In the first instance, this new proactive packaging will be targeted at the problem of considerably improving quality and safety of cheeses. The objective is to extend the shelf-life of cheese from 2-3 months up to 9 month. BIOPACK will aim to be cost-competitive and a successful concept could help to expand the market for hard and very hard cheeses considerably, especially through providing a new packaging, which makes increased exports from Europe possible. This could be of major economic benefit to cheese producers directly and farmers indirectly in many regions of Europe. The BIOPACK principles will also be exploitable for the packaging of other foods".¹⁰

Researchers from MLI, KVL are working together with researchers from other organizations: namely the other partner of LMC: DTU; researchers from Risoe, a Governmental Research Institute via a centre without walls 'The Danish Polymer Centre' and private firms from Denmark, Finland, The Netherlands, Belgium and Hungary.

As seen above managing in this case involves knowledge of a number of scientific areas and thereby knowledge of a number of researchers from different schools in different countries as well as it involves knowledge of collaboration with the private firms. It is also clear that the connections

¹⁰ From the homepage www.mli.kvl.dk

are not solely Danish but European, i.e., MLI is managing in a local Danish Triple Helix and well as in a European one.

MLI can be described as a very dynamic research department, but MLI has one serious problem: it is difficult for the management to plan the future because of the great amount of external funding.

In general the proportion of external funding of R&D expenditures at Danish universities is 35 percent, at KVL it is 40 percent, and at MLI it is 55 percent¹¹. It was found that 'dynamic research units' in general had a larger degree of external funding than others (Graversen et. al. 2002).

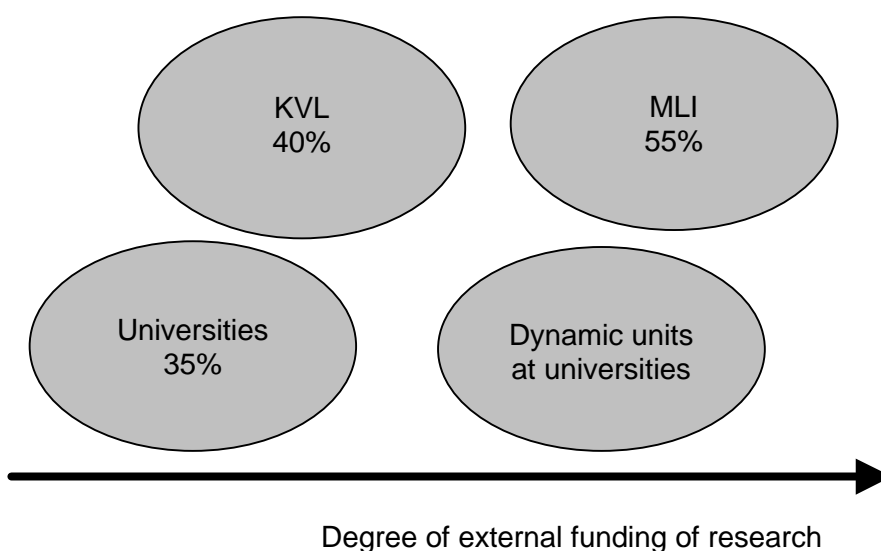


Figure 3.5 The degree of external funding at Danish Universities, at KVL, at MLI and at *dynamic units*

According to the head of department the great amount of external funding causes that too much time is spend on applications; it causes uncertainty in the planning of research projects; it causes uncertainty among the researchers, and they may or in some cases have to leave MLI, because of lack in employment. According to the researchers she is right: 77 percent of them agree in that *"The department is too dependent on external funding"* and 85 percent agree on *"There are too few permanent positions at my department"*. On the other hand they are found of their jobs: 72 percent agree on *"This is my dream job"*¹².

But the problems with the large amount of external funding can be seen as a consequence of the way the department expanded: it started from a position with a few visionary researchers that were able to communicate internal as well as external that they could help to solve a general societal problem with research as well as with education of technicians to the industry; and they

¹¹ According to the Danish R&D statistics.

¹² The figures comes from a web based survey addressed to all researchers at MLI.

succeeded. But the success was and is depended of the external funds, and therefore a growing amount of research produced is needed if to keep the budget.

This is a general structural problem within the Danish universities: researchers with new visions have to communicate internal and external in order to start the projects. Then they have to consolidate, at this stage they need a larger amount of internal funding, i.e., the same amount as others, which cause problems partly rooted in the traditional managerial structure at the Danish universities.

4. The Triple Helix - from a University perspective

A key issue in the functions of the Triple Helix is the knowledge flow between the three entities: the research system (in universities and government research institutes), the political system (government) and the private sector (industri). This flow is based on knowledge within the three entities, i.e., knowledge produced as well as knowledge circulated within the entities.

In this section the growth of the knowledge base is connected with invention based on research, and transformation of knowledge in the framework of the knowledge spiral (Nonaka et al. 1998)

The presentation of the knowledge flow in a single organisation is presented and the framework is widened to a number of sub organisations within a larger organisation as an university; then the knowledge flow is combined with the ideas of the Triple Helix as well as the idea is connected with ideas of economic growth.

The Knowledge Base and the Knowledge Spiral in (research) organizations and networks

Knowledge can be regarded as tacit or explicit knowledge. Where explicit knowledge is knowledge that the holder of the knowledge is aware of, tacit knowledge can be thought as knowledge that the holder of the knowledge possesses or even uses without notice. The distinction between the two forms is not clear, and it can be argue that that there is a continuum between the two (Howells, 2002) as well as it can be argued that the two types are mutually complementary and only the explicit knowledge can be formally measured.

Knowledge can be embedded in single individuals, in organisations, and different forms of medias incl. different forms of technology.

The knowledge of an organisation consists of knowledge embedded in the single individuals as well as knowledge embedded in the different structures or rules within the organisation. A key

issue for the knowledge management in organisations is the *transformation of knowledge* from one individual to others, from the 'structure' to the individual, from individual to the 'structure' in such a form that the knowledge is available or embedded in the processes different places in the organisation. If this transformation process is systematically supported the knowledge base of the organisation will, according to Nonaka et al. (1998), grow.

Nonaka et al. assumes that new organizational knowledge is created by human interactions or exchange among knowledge workers that possess different types of tacit and explicit knowledge. This social and epistemic interaction process are focused on four nodes of knowledge transmission:

- **Socialization:** from individual tacit knowledge to group tacit knowledge
- **Externalisation:** from tacit knowledge to explicit knowledge
- **Combination:** from separate explicit knowledge to systemic explicit knowledge
- **Internalisation:** from explicit knowledge to tacit knowledge

The four nodes can be seen as the background for the knowledge spiral, that may be started with a *socialization process*: in a socialization process tacit knowledge is exchanged between the group members in such a way that their attitudes converge. This tacit knowledge can then be enlighten by *dialog*, in this case the knowledge is described and thereby made explicit in the *externalisation process*. The externalisation process makes *linking with explicit knowledge* from other individuals or other organisations possible and provides the base for the *combination process*, where explicit knowledge of different kind is combined. This new combined knowledge is then transformed into internalised tacit knowledge by *learning by doing* in an *internalisation process*, where *field building* supports the knowledge transformation in the *socialization process*. The circular transmission movement increases the knowledge stock in each tournament. This is seen in Figure 4.1

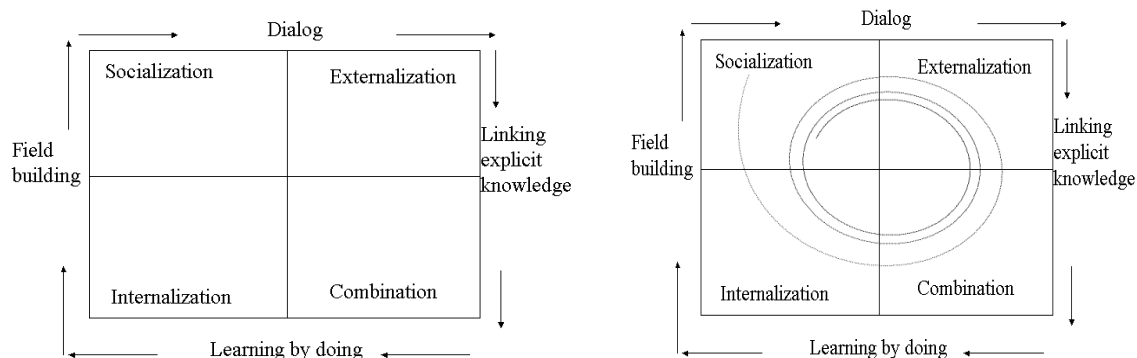


Figure 4.1 Nonaka et al's knowledge spiral

Source: Nonaka et al (1998) and own drawing.

It is shown (Jacobsen et al. 2001; Graversen et al. 2002; Morris 2002; Kalpazidou Schmidt 2002) what is already known by most university researchers, that the internal communication at university departments, centres, networks, and other units is essential for the level and quality of research projects. Among other elements internal communication provides the researcher with important feedback to preliminary results as well as it provides questions and solutions to specific problems. The mastering of the research communication tradition with critiques and discussion as a central part is one key competence that universities transfer to students.

The Knowledge Spiral Model focuses on several processes and combines the development of both tacit and explicit knowledge in a way that fits descriptions of dynamic and innovative research environments.

- Dynamic research managers often focus on informal ways to establish knowledge flow as 'coffee tables' areas, where researchers meet when they collect their coffee or the placement of post boxes in a central room, etc., activities that can be regarded as an active support to the informal *socialization process*.
- Formal meetings or workshops within specific time intervals where research and/or problems are presented are present at dynamic units; this can be regarded as a support to the *socialization process* as well as the *dialog* between the researchers.
- The ongoing process of *combining* own research with other research and knowledge that are presented as papers on conferences, published in articles or books, is regarded as a central part of the research process at dynamic units that focus on presenting research results to the external world
- The experiments and the different learning activities of the university includes in a number of cases *learning by doing activities*, where students and guest researchers are invited to join the experiments
- The training of Ph.D.-students in dynamic units includes transformation and combination of explicit knowledge documented by the dissertation and papers as well as it transforms and internalises tacit knowledge

An active university research environment includes a number of larger and minor knowledge spirals and their interactions as seen in Figure 4.2.

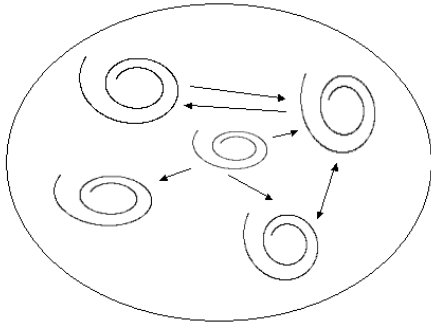


Figure 4.2 Knowledge spirals within universities and there interactions

When firms integrate external knowledge from universities they can do it in several ways: either in the *socialization process* when a university candidate enters the organization as a knowledge worker or in a *combination process* where external knowledge can be combined with internal knowledge. It is regarded as essential to the later kind of integration of knowledge that the organisations all ready possess some knowledge in order to absorb knowledge in form of papers and/or patent (Graversen, 2002). This initial possessed knowledge could be the knowledge of the staff members with university degrees. This is seen in Figure 4.3.

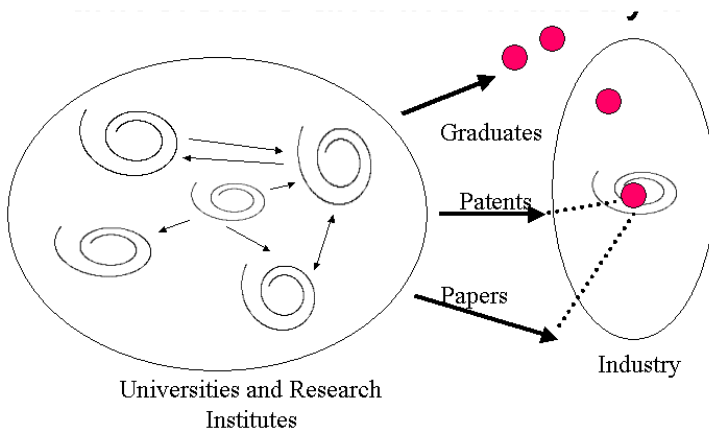


Figure 4.3 Knowledge spirals in universities and research institutes and there relations to industry

But networks and direct collaboration between university environments and private firms can change the knowledge flow is such a way that knowledge is also transformed from the industry to the university. This could be traditional feed back on research ideas but it could also be information on market behaviour or possible research ideas based on demand on knowledge. In those cases the knowledge spiral of organisations could be knowledge spirals of network - network between industry and universities. This picture is seen in Figure 4.2.

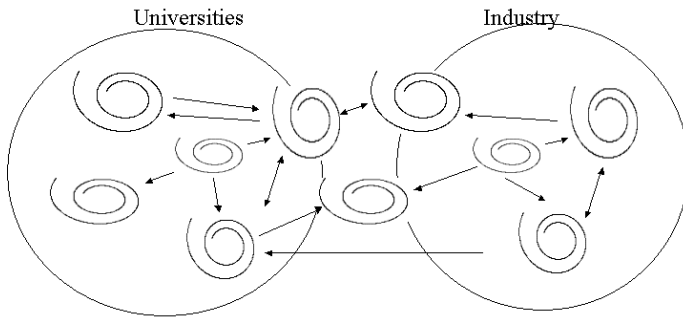


Figure 4.4 Knowledge spirals in universities, in industry, in networks between universities and industry and their interactions

If the third part of the Triple Helix, the Government (or policy level) is added to this picture Figure 4.5 arises.

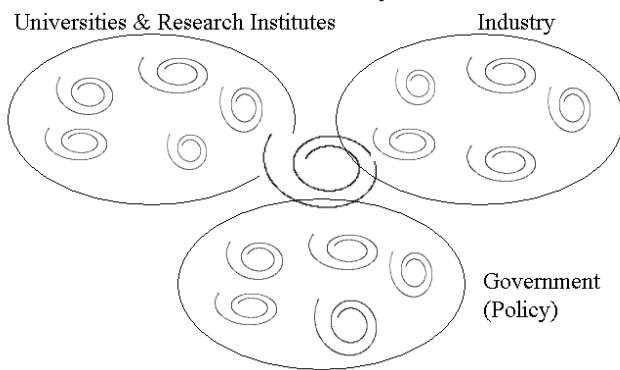


Figure 4.5 Knowledge spirals and the Triple Helix

Where the initial initiative, the start of the knowledge flow between universities and a single firm could be the employment of a staff member with a university degree other first steps must be found in order to investigate the underlying reasons for the knowledge flow.

When the knowledge flow problem is seen from the perspective of the university manager, the first step after the formulation of the *research vision* is the communication of it to someone capable of supporting the vision with resources. In the MLI-case this *primary communication* was internal to the head of KVL (the rector). The *echo* or the responds of the communication was extra resources to the department that provided the mean for the next steps: further research, further communication and the establishment and strengths of knowledge networks.

Then the research vision together with research results supported the communication and the knowledge networks in creating resources for the next steps.

Economic growth, a growing knowledge base and research

The knowledge base is the base for development of new products and it can be argued that the growth of the knowledge base therefore is the base of economic growth in single firms as well as in society as a whole. It can also be argued that a growing knowledge base supports economic growth, because the growing knowledge base adds human capital to the staff.

A part of the growth of the Knowledge Base is created by *research*, research that later is embedded in staff members as well as technology and other structures as seen in Figure 4.6

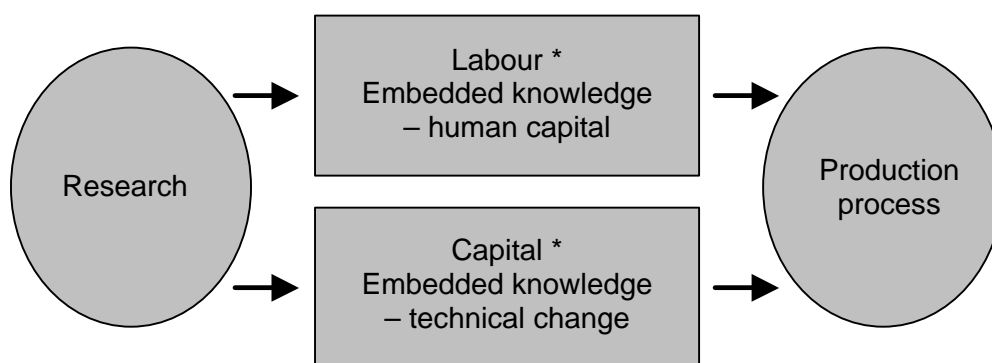


Figure 4.6 Research, the knowledge base and the production process

This perspective enters a possible change of the well-known basis for theory of growth and thereby possible new analysis of economic growth:

If the basis is the Classical Solow Growth Model, where production is a function of the amount of labour and capital:

$$\text{Production} = f(\text{Labour}, \text{Capital})$$

where Romer (1990) added Technical Change:

$$\text{Production} = f(\text{Labour}, \text{Capital}, \text{Technical Change})$$

Then the changed formulation of the production function could be

Production = f(Labour[embedded knowledge], Capital[embedded knowledge])

where

Labour[embedded knowledge] is the number of workers combined with information on human capital, education system, etc.

Capital[embedded knowledge] is amount of capital, investment in capital, etc.

and where the function could include interaction effects as seen:

Production = f(Labour[embedded knowledge], Capital[embedded knowledge]) = $A * L^a C^{\beta} (L * C)^{\gamma} e$

where both L and C are regarded as functions of research transferred:

$Labour[embedded knowledge]_{t+1} = L(Labour[embedded knowledge]_t, research_t, research_{t-1}, research_{t-2}, research_{\dots})$

$Capital[embedded knowledge] = C(Capital[embedded knowledge], research_t, research_{t-1}, research_{t-2}, research_{\dots})$

This model has a number of implications:

- The Romer (1990) model can be regarded as a special case of the model.
- It implicates that the 'value' of labour and capital seen from the side of the production process is affected by research as well as the model indicates that it is not the research as such that enters the production function but the implications of it.

5. Conclusive remarks

The research management and thereby the role of the research managers at the Danish universities has changed from almost invisible management to dynamic management during the last decade, new changes have been announced at the political (state) level.

During the decade more emphasis has been placed on research management as well as on special groups of units, among those a group that can be described as *dynamic*.

The central entities in the Triple Helix are research, the private sector and the government.

The growth of number of researchers as well as research results from *Department of Dairy and Food Science, The Royal Veterinary and Agricultural University in Copenhagen* (MLI, KVL) can be seen in a Triple Helix perspective because the growth of MLI has been connected with a growth in collaboration project with the private sector as well as governmental programme at the national as well as the international level.

MLI can also be described as a dynamic research unit (seen in a Danish context) because of the management style and results.

The Triple Helix can be seen from a number of perspectives; if the perspective is taken from the university side (or other public research institutes), one important issue is the knowledge growth and the knowledge flow within the university at unit or department level as well as the knowledge flow between entities within the university. If this knowledge flow can be expanded to the private (industry) sector as well as to the government sector the knowledge flow can be regarded as a part of the explanation of the growth of the economy within the Triple Helix.

The lessons according to growth from the MLI case were:

- Interest in the research subject was the primary
- Handling the internal communication at the university was essential for the success
- Handling communication and contracts with industry is essential
- Handling communication and contracts with the Danish government as well as the EU is essential

An important part of the growing knowledge base is based on research, research that is embedded as knowledge in the human as well as in the technical capital. Which may lead to a reformulation of the traditional growth models.

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Appendix

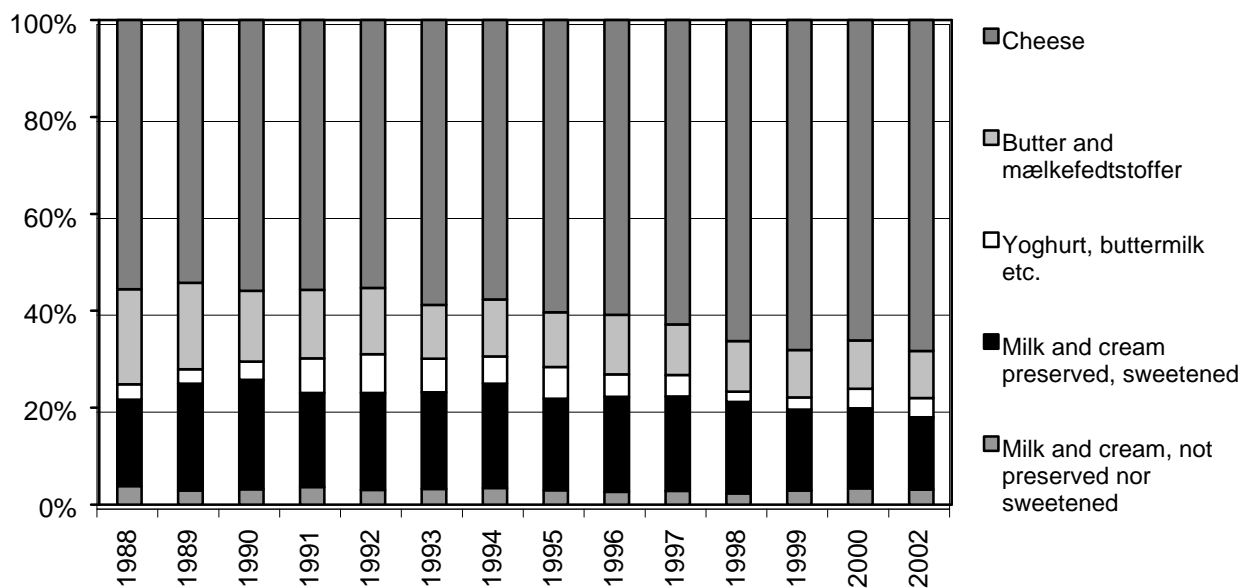


Figure 3.1A The Danish Dairy Export 1988 - 2002. Measured in Value.

Source: Statistics Denmark, on-line databank.

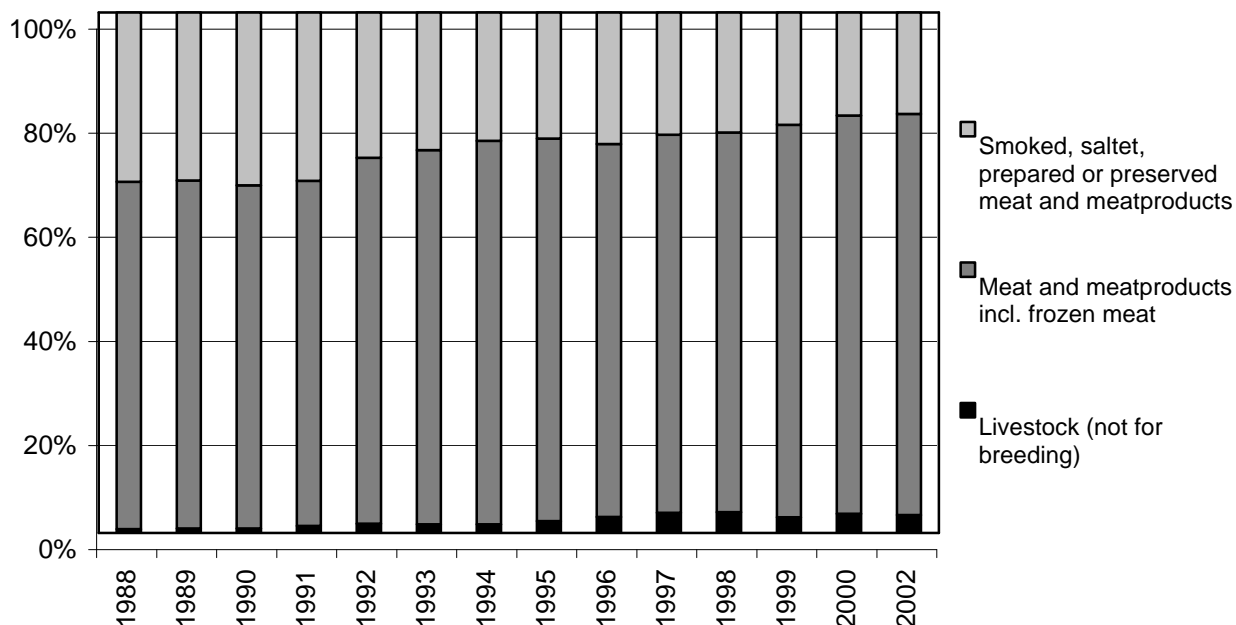


Figure 3.2A The Danish Meat Export 1988 - 2002. Measured in Value.

Source: Statistics Denmark, on-line databank.