Developing a knowledge economy in Scotland: Lessons from the operation of the LINK Programme

by Margaret Cuthbert, MC Economics Ltd

Introduction
The devolution settlement has produced a division of powers between the Scottish Parliament and Westminster that cuts across the boundaries of certain key policy areas. One such area is the development of the knowledge-based economy. Here, powers on trade and industry, finance, the economy, and employment are reserved to Westminster. Relevant powers that are devolved are education and enterprise. Given this division, it is appropriate to ask how effectively the government’s strategy to create and develop a knowledge-based economy in Scotland is operating, and whether there is effective co-ordination between reserved and devolved powers in this area. This article examines this question by studying the operation of one of the government’s main instruments for the development of the knowledge economy, namely the LINK programme.

Our findings are that Scottish industry’s involvement in the LINK programme is low, both in terms of what might be expected given the size of Scotland’s high and medium high technology sectors, and in terms of its university participation in the programme. A number of potential reasons for this low participation are put forward here. It is clear that there are a number of contributory factors, of which the main is the low number of firms in Scotland carrying out R&D. However, we suggest that the current division of powers between the two governments does not necessarily assist the development of a knowledge economy in Scotland, and that changes are required to improve the situation. Some possible changes are considered.

The knowledge based economy
A useful definition of a knowledge economy was given by the Department of Trade and Industry, 1998, “A knowledge-driven economy is one in which the generation and exploitation of knowledge play the predominant part in the creation of wealth”.1

Traditionally, neo-classical economics recognised only two factors of production: labour and capital. Knowledge, productivity, education, and intellectual capital were all regarded as exogenous factors: that is, falling outside the system. New Growth Theory regards technology (and the knowledge on which it is based) as an intrinsic part of the economic system. In this sense, knowledge is the third factor of production in leading economies (Romer, 1986; 1990)².

The knowledge economy is generally regarded as comprising the following three elements: the building of the science research base, the production of well qualified professionals and technicians, and a good interaction between firms and the science base to ensure that firms maximise their opportunities to become fully competitive. It is generally agreed that any policy focusing on one of these ingredients independently of the others is likely to have limited success in improving a country’s competitive standing. Each stage needs to be working properly, from the generation of ideas to the final sale of the products and services. “Investment in basic research is just one part of the cycle. Knowledge must flow out of the science base into products and services.”³

The commitment by UK and Scottish governments to the knowledge economy
In the UK, the government’s aim is “to invest in the science base, with measures to open up channels to allow scientific know-how to flow beneficially through to society, into business and jobs.”⁴ This is not only a UK policy, but is one which is being actively pursued for Scotland by the Scottish Executive which has stated clearly its commitment to providing a supportive framework for the development of a knowledge based economy in Scotland.⁵ ⁶ Its reports point not only to the need to support university based research but also to measures to improve skills and new firm formation, and to the benefits of concentrating on crucial industrial sectors where Scotland already has business and academic strengths. These include healthcare and life sciences, oil and gas, telecommunications, opto-electronics and semiconductors, software and related e-business.

In pursuing its policy, the Scottish Executive directly spent £74 million on science, engineering and technology (SET), and a further £136.7 million through the Scottish Higher Education Funding Council to support the HEI research base.⁷ But to make its policy succeed, there has to be good use made of the funds which are reserved, that is, remain under the control of UK government departments. In total, UK government on SET in 2000-01 was £6,969 million. We note that 79% of the budget of the Department of Trade and Industry (DTI) is reserved. The reserved budget on SET is important to Scotland first, because of its size, but also because DTI responsibilities cover some of the most important programmes encouraging industry R&D. Among these, LINK is recognised as the principal mechanism for promoting pre-competitive research between industry and the research base.
LINK provides general support and funding by government for collaborative R&D projects involving industry and the UK research base: (research institutes and higher education institutions). It was first introduced in 1988. Essentially, based on the findings of think tanks on where industry might be going in the future, (the Foresight Panels), decisions are made by the LINK Directorate on key areas in UK industry where pre competitive research is needed. Academics and industry are invited to form partnerships and submit projects which the LINK programme will consider for funding and support. It is then hoped that this support will encourage industry to invest in further work and that this will lead to commercially succesful products, processes, systems and services.

LINK covers five broad areas. These are electronics/communications/IT, food/agriculture, biosciences/medical, materials/chemicals, and energy/engineering.

LINK programmes are currently sponsored by a range of government departments - depending on subject area. Within each of the above areas, there are several programmes, and within each programme there are then calls for specific projects, each of which can be sponsored by additional government departments and/or research councils. The role of the sponsor is an important one:

First, it allows an individual department or group of departments/research councils to be part of the decision making process in determining which topics will go ahead under LINK. Second, applications are submitted under the programme by partnerships of universities, research institutes and companies. The lead partner is usually a university, and if the academics have difficulty in finding an industrial partner, they are likely to ask for some assistance in so doing from the sponsors. Sponsors play an important role, therefore, both in influencing the area of research and in helping to find industrial partners.

LINK has proved to be a fairly successful vehicle for stimulating and supporting pre competitive research. The evaluation of the Enhanced Engineering Materials programme, for example, showed that the £10 million investment by government generated benefits to industry of £200 million. Particular benefits to companies taking part in LINK include:

- Opportunities for networking and sharing ideas with experts from many fields.
- Publicity and raised profile for the firm

**LINK’s operation**

The need for a programme such as LINK is evident in Scotland. The latest published figures by the DTI on business enterprise research and development for manufacturing production as a percentage of gross value added are for 1997 and show Scotland's percentage as 1.9% relative to a UK figure of 5.1%. ONS statistics on business expenditure on R&D as a percentage of GDP show Scotland at 0.6% in 1998 compared with a UK average of 1.2%. And, in expenditure statistics on R&D performed in UK businesses in 1998, Scotland’s share of R&D expenditure is 3.2%. All of these indicators show evidence of a serious lack of R&D in Scottish industry.

How then has LINK worked in Scotland and assisted pre competitive research in industry in Scotland?

For the present research, the Department of Trade and Industry have provided information that they have collated on the operation of LINK. The number of collaborations, that is the number of times individual institutions, firms, etc., have taken part in LINK programmes, are as follows:

**Table 1: LINK Collaborations by location (i.e. collaborator times their projects)**

<table>
<thead>
<tr>
<th>Type of collaboration</th>
<th>UK known</th>
<th>Scotland known</th>
<th>Scotland as % of firms of known location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large enterprise</td>
<td>1399</td>
<td>800</td>
<td>8.4</td>
</tr>
<tr>
<td>foreign owned</td>
<td>467</td>
<td>259</td>
<td>2.3</td>
</tr>
<tr>
<td>Small/medium enterprise</td>
<td>1155</td>
<td>622</td>
<td>4.4</td>
</tr>
<tr>
<td>foreign owned</td>
<td>111</td>
<td>69</td>
<td>1.8</td>
</tr>
<tr>
<td>Enterprises, size unknown</td>
<td>705</td>
<td>591</td>
<td>12.5</td>
</tr>
<tr>
<td>All Enterprises</td>
<td>3837</td>
<td>2341</td>
<td>4.5</td>
</tr>
<tr>
<td>Higher education institutions</td>
<td>1484</td>
<td>0</td>
<td>146</td>
</tr>
<tr>
<td>Other research base</td>
<td>542</td>
<td>38</td>
<td>60.2</td>
</tr>
<tr>
<td>institutions</td>
<td>21</td>
<td>16</td>
<td>1.2</td>
</tr>
<tr>
<td>Charities</td>
<td>245</td>
<td>130</td>
<td>6.2</td>
</tr>
<tr>
<td>Other bodies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6129</td>
<td>2525</td>
<td>280.7</td>
</tr>
</tbody>
</table>

The first thing to note from Table 1 is the very large number of "not-knowns" with regard to location. From the DTI's point of view this appears to be reasonable: "We do not hold information centrally on where projects originate nor where their research is carried out. LINK aims at scientific excellence so geographical factors are irrelevant". While this point of view may be appropriate to the DTI from a UK standpoint, the Scottish Executive should ideally have this information to adequately discharge its industrial policy.

The advice given by the DTI in working with the above data was to subtract the not-knowns from the UK figures. "This assumes we are no less likely to know if a collaborator is Scottish than if it is from anywhere else in the UK. This seems a fair assumption".

Following this advice in calculating percentage share, we estimate that Scotland has 4.5% of enterprise collaborations where the geographical location has been recorded. Given that Scotland has 7.4% of the number of firms collaborating, the lower percentage of collaborations shows that the average number of collaborations per firm involved in LINK in Scotland is less than that for firms in the UK as a whole. For large enterprises, Scottish firms represent only 1.3% of known-location collaborations, and among foreign owned large enterprises, it is less than 1%.

In contrast to the small percentages of Scottish based business participation in LINK collaborations, the Scottish university sector has been reasonably involved: its 146 collaborations represent 9.8% of all UK HEI collaborations. However, while the average performance per Scottish university is 11 or more projects, the range is from Edinburgh University which has 27 to Abertay, Dundee, Paisley and Glasgow Caledonian which each have one.

The very large number of collaborations where the location is unknown is unsatisfactory from the point of view of this study. In order to improve confidence in the resulting statistics it was necessary to gather ancillary information. To obtain more clarification, further information was sought from two of the largest industrially linked research councils: EPSRC and BBSRC. Their information is as follows:

**EPSRC**

The Engineering and Physical Sciences Research Council (EPSRC), which is the largest of the government’s research councils, had a spend of £91 million on LINK projects to April 2000. Note that in money terms, EPSRC support in LINK is around 35% of the total LINK spend by government departments. EPSRC holds information on the numbers of companies and total number of collaborations in its projects. The following table shows the numbers of firms collaborating in LINK and the number of collaborations since their records began.

The figure of 4.0% for collaborators is substantially lower than the estimate from the DTI of 7.4% for Scottish collaborators which was based on DTI data excluding "not-knowns". For collaborations, the figure of 3.5% is also lower than that based on DTI data (4.5%). There is nothing in this EPSRC data therefore to suggest that the DTI figures underestimate Scottish collaboration. If anything, they suggest that the DTI figures may give an over-estimate.

It is also relevant to note that it is projects in the fields of electronics, (including opto-electronics), communications, IT, engineering, and materials which are the areas supported by EPSRC. These are some of the main industry clusters in Scotland’s economic strategy, yet the representation by Scottish firms in the projects is only 3.5%.

<table>
<thead>
<tr>
<th>EPSRC</th>
<th>UK</th>
<th>Scotland</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINK Companies</td>
<td>501</td>
<td>20</td>
<td>4.0</td>
</tr>
<tr>
<td>LINK Collaborations</td>
<td>751</td>
<td>26</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: Private Correspondence EPSRC

**BBSRC**

From information on BBSRC (Biotechnology and Biological Sciences Research Council) company collaborations in LINK, provided by the DTI in private correspondence, 153 collaborations took place between May 1996 and June 2000. The numbers include all non-research base partners. Here again, the data held had "address unknown" in 60% of the cases, but as the company names and other information was supplied it was possible to find addresses for most of the cases. Of the total, 5 of the collaborations were in Scotland and 138 in the rest of the UK with 10 still unknown; that is collaboration by companies in Scotland represented 3.5% of the total UK known address collaborations. This estimate is the same as that for the EPSRC collaborations.

To summarise, the data from the two main research councils supporting industry LINK projects confirm the low participation rates of firms based in Scotland in the UK LINK programmes. If anything, they suggest that the figures from the DTI are an over estimate.

**Interpretation**

The evidence above shows clearly that participation by firms based in Scotland in the LINK programme is low. It shows that a government initiative that was introduced specifically to encourage pre-competitive industry research has singularly failed to deliver in Scotland. This is particularly worrying as the LINK programme aimed to improve
industrial R&D, and Scotland has a poor rate of business R&D as a percentage of GDP being about one half of that for the UK as a whole.

The natural question to ask is why this is the case? We explore here a number of possibilities as to why there appears to be a relative failure by companies in Scotland to take part in this assisted programme, and consider the following:

- Is the low participation simply a reflection of the relative number of companies in Scotland that have the capacity to use LINK?
- Is it that the less industrial R&D there is in an area, the less the programme is likely to be of use?
- Is there a lack of university based partners in Scotland?
- Is there a lack of networking and lack of assistance in finding partners in Scotland?
- Are the projects specified within the main themes relevant to Scottish industry?

Is the low participation simply a reflection of the relative lack of capacity in Scotland to use LINK?

The latest Regional Competitiveness Indicators from the DTI, August 2000, show the number and percentage of employee jobs in high and medium high technology sectors in 1998. As the table below shows, employee in Scotland represented 7.2% of all GB employees in these sectors. As a proxy indicator of industry's capacity to use LINK in Scotland, these figures would suggest that Scotland does indeed have a lower concentration on high and medium high technology than Britain as a whole, however, the difference in concentration is small. Thus, while lack of capacity may be a contributory factor, it is not likely to be the major factor for Scottish business' poor performance in LINK.

<table>
<thead>
<tr>
<th>Sector</th>
<th>UK Numbers ('000)</th>
<th>Scotland Numbers ('000)</th>
<th>Scotland % of GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>1427.8</td>
<td>112.2</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Source: Department of Trade and Industry, Regional Competitiveness Indicators, September 2001.

Is it that the less industrial R&D there is in an area, the less the LINK programme is likely to be of use?

It seems reasonable to believe that the very low level of business R&D carried out in Scotland is the principal reason why the LINK programme has failed to deliver in Scotland. Academics working on LINK projects and interviewed by the author noted the difficulty of finding industrial partners in Scotland. However, if it is indeed the case that the less industrial R&D there is in an area, the less LINK works, then this has major policy implications which we discuss below.

Is there a lack of university based partners in Scotland?

Our analysis shows that the higher education institutions in Scotland are active players in LINK and have far greater relative involvement in LINK as measured by the percentage of Scottish based university collaborations in total UK university LINK collaborations compared with the percentage of industry collaborations from Scotland. Scottish businesses are recorded as having been involved in 66 LINK collaborations, and universities and other research institutions in Scotland in 206 collaborations. Even allowing for a proportionate share of "address unknown" to be Scottish firms, there is clear evidence that the Scottish academic research base is turning to companies in other parts of the UK for LINK partnerships.

Is there a lack of networking and lack of assistance in finding partners in Scotland?

As the programme is a reserved matter, the Industry Department in the Scottish Executive plays no active role. Firms that do enquire are signposted to the DTI website. A usual route into participation in LINK however is through the universities. Researchers in University departments generally bring the partnerships together and it is here that sponsors can play a crucial role in helping them find partners. There is limited involvement by the Scottish Executive as sponsors in the LINK programme. Among all LINK projects that are currently "open" to potential collaborators, the pattern of Scottish Executive departments' involvement is as follows:

- Biosciences/Medical: there are five major programmes covering topics such as applied genomics, analytical biotechnology, and genetic and environmental interactions in health. There is no Scottish Executive sponsorship.
- Electronics/Communications/IT: there are seven programmes with the Scottish Executive providing sponsorship in one: mobile phones and health.
- Energy/Engineering: there are seven programmes, with no sponsorship by the Scottish Executive. These cover, for example, sustainable technologies, oil and gas extraction, and integration in design and construction.
- Food/Agriculture: Of the nine open programmes, Scottish Departments assist in sponsoring three, with a
further possible interest in five others on a project by project basis.

Are the projects specified within the main themes relevant to Scottish industry?
Scottish Enterprise has been pursuing a cluster policy with four clusters: Oil and Gas, Food, Semi-conductors and Biotechnology. Clustering is regarded as one method whereby companies can form beneficial relationships with other businesses, their suppliers, and the wider community, particularly research and education. These relationships can improve innovation capability, the rate of new company start-up, the growth of existing businesses and the ability to win knowledge-based inward investment. The task force on the knowledge economy noted that, “As a small economy, Scotland cannot develop the necessary critical mass and support the infrastructure necessary for a wide range of unrelated industries. It is not therefore possible for Scotland to be competitive in all clusters. This makes it vital that we have research strengths in Scottish HEIs and research institutes that are linked as closely as possible to those areas of business in which Scotland can compete most effectively.”

However, as noted above, the Scottish Executive departments play a very limited part in contributing to programme selection or project selection within LINK programmes in energy/engineering, biosciences/medical and electronics/communications/IT. Thus while the broad programme areas in LINK are relevant to Scotland’s industrial policy, the required link to enable:

→ Fashioning relevant projects
→ Assisting in forming collaborative ventures with other government departments and research councils under LINK
→ Assisting in forming local LINK partnerships between firms and universities in Scotland has rarely been in existence.

Overall, a picture emerges in Scotland of poor participation by businesses in LINK. While there is a fairly substantial medium and high technology sector, there is relatively little R&D carried out by business. The higher education sector is collaborating in LINK principally with businesses in other parts of the UK. There is poor networking and a lack of assistance to business in finding HEI and other partners, and there is very limited involvement by Scottish Executive departments in the selection of LINK programmes and in project selection within programmes.

Policy Implications
These findings have a number of implications for the design of policy aimed at improving the knowledge economy in Scotland. LINK programmes do not appear to be working efficiently with the Scottish Executive strategy for a knowledge economy. There needs to be both greater Scottish involvement at decision making stages in the UK and greater focus on businesses in Scotland, especially in the clusters defined by Scotland’s economic strategy.

Based on our findings, we suggest the following. First, as a pre requisite in understanding how the LINK programme might be working in Scotland, the Scottish Executive should encourage the DTI and Research Councils to improve their data bases to record location. It is difficult to imagine how we can have a joined up policy for a knowledge economy without such basic information. Second, there needs to be greater involvement by Scottish Executive departments in various aspects of this reserved programme. This should include direct involvement in programme selection and project selection within programmes to maximise the opportunity of synergy between government assisted pre-competitive research and the Scottish Executive’s cluster policy. Third, the Scottish Executive needs to consider how it can improve networking in Scotland, particularly in linking universities and businesses for such pre-competitive research. Fourth, LINK is not going to strengthen the industrial research base in Scotland if many firms in Scotland do not have the research capacity to make use of it. If therefore, the low R&D in Scotland is one of the main factors contributing to the low performance of LINK, then it is time to consider how to improve the level of R&D, and to bring in complementary pre-LINK programmes specifically for businesses in Scotland to address this market failure. However, a large part of such support is still a reserved matter.

At present, rather than helping to remedy the low rate of R&D in Scotland, the LINK programme is in a sense reinforcing it, as it assists those areas that are receptive to R&D. As LINK is attracting Scottish universities and research institutions, this means that they are turning to companies in other parts of the UK to form LINK partnerships. This again shows either a failure of current businesses in Scotland in R&D or a failure of linkage. Either way, any financial assistance given by the Scottish Executive to higher education institutions to develop business partnerships in research is more likely strengthen business elsewhere until major efforts are made to put Scottish business in a position to benefit from the strengthening of the higher education sector.

How well Scotland accesses funding which is reserved is crucial, not only for the Higher Education Institutions in Scotland, but for the competitive position of businesses in Scotland. The overall level of funding for science, engineering and technology in the UK has been shown to be large, and most is reserved. Analysis of this one flagship programme for pre-competitive research shows the poor involvement of Scottish businesses, and we suggest that this is in part due to the lack of involvement of the Scottish Executive in this reserved matter. If this poor involvement were repeated in other SET reserved areas, then Scottish
business and the knowledge economy would be being ill-served. There is some evidence that this may be the case. For example, among all EPSRC collaborative programmes recorded in their data base, Scottish businesses make up only 4.3% of the total of all UK business collaborations.

Acknowledgements
Special thanks to Jim Cuthbert for advice and critical reading of the manuscript.

Endnotes
4. As Endnote 3.
6. Report on the Knowledge Economy Cross-Cutting Initiative, the Scottish Executive, 2001
8. Private correspondence, LINK Directorate, Office of Science and Technology.