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Creating the human resources for enhancing innovation in regional economies

Brendan Goldsmith
Dublin Institute of Technology, brendan.goldsmith@dit.ie

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The Case of Ireland and the Specific Role of the Dublin Institute of Technology.

Address by: **Professor Brendan Goldsmith**
Dublin Institute of Technology
Ireland

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1. Economics and the Celtic Tiger

The economic boom which Ireland has experienced in recent years, particularly in the period from the middle of the 1990s, has been dubbed by the media as the 'Celtic Tiger' and certainly has been the focus of widespread international media (and indeed governmental) attention. Recall that Ireland, or at least the part excluding Northern Ireland, became an independent state in 1922. It was, in many ways, a rather poor country at that time although it is interesting to note its standard of living in 1922 was higher than in many other countries of Western Europe. However, the next 40 years saw its 'ranking' within Europe fall significantly. In particular, economic performance was dismal in the 15 years after World War Two. In the late 50s domestic economic policies began to change but the next 30 years was very much a period of 'catch-up' punctuated with periodic bouts of inappropriate policy making. Table 1 gives some idea of how far behind Ireland was, even in the mid 80's.

Country	1960	1973	1986
Germany	122.1	114.5	116.8
France	105.3	110.5	109.8
Italy	87.3	94.0	102.5
Netherlands	112.1	107.1	102.2
United Kingdom	123.9	104.4	101.9
Portugal	43.2	61.1	54.0
Spain	56.9	74.8	69.7
Sweden	122.7	115.0	112.5
Ireland	60.8	58.9	63.7

Table 1 GDP per head of population, EU15=100

In fact in 1986, of the 15 only Portugal (54.0) and Greece (61.4) lagged behind Ireland. The 1990s however saw economic growth rates, which previously had been achieved only by the 'Tiger Economies' of South-East Asia. If we take the corresponding data for 1999 in Table 1 we get:

Country	1986	1999
Germany	116.8	109.1
France	109.8	103.7
Italy	102.5	101.2
Netherlands	102.2	105.3
United Kingdom	101.9	98.4
Portugal	54.0	74.1
Spain	69.7	80.2
Sweden	112.5	96.5
Ireland	63.7	111.0

Table 2 GDP per head of population, EU 15 =100

Despite some obvious slowing down, GDP continues to expand at impressive rates in Ireland.

Country	2000	2004
Germany	10.4	02.7
France	15.3	06.5
Italy	09.9	03.7
Netherlands	20.0	03.1
United Kingdom	17.2	10.3
Portugal	21.9	02.5
Spain	22.2	12.9
Sweden	19.1	08.8
EU -15	15.0	06.5
IRELAND	58.7	22.9

Table 3 Real GDP growth rate at constant prices (1995) using 1995 and 2000 as baselines.

If we think more about people than economic indicators, then the unemployment figures are interesting:

Country	1985	1990	1994	1996	1998	2001
Ireland	16.8	13.4	14.3	11.7	7.6	3.8
EU*	9.9	7.7	11.1	10.8	9.9	7.4

Table 4 Unemployment, Ireland and EU

(*includes new German Länder from 1994 onwards)

So by the late 1990[s] Ireland had moved from one of the highest rates of unemployment in Europe to a chronic shortage of every form of labour. Employment was at an all-time high in the history of the State and emigration was replaced by the new experience of mass immigration.

The "World" of course wanted to know the secret!. Here let me issue a disclaimer: I am a mathematician, not an economist. So let me give some quotes from the 'experts'

- The canny use of EU funds not their huge scale
- Prudent public spending and a lower birth rate
- Low-cost, English speaking home in EU for foreign corporations

Table 5 (Newsweek Dec 1996)

- Sound macroeconomic management
- Sustained foreign investment

Table 6 (OECD 1997)

Academic commentators have generally agreed that a range of factors is at play and these generally included the following external factors:

- External Economic Environment
- EU Funds
- Foreign Direct Investment
- The Communications Revolution

Table 7 External Factors for Success

The internal reasons for success are generally more extensive and tend to include:

- Fiscal Reform
- Structural Revolution in the Economy
- Demographics
- Social Partnership
- Recognition of Competitiveness
- A Commercialised Public Enterprise
- Industrial Policy
- New Forms of Work Organisation
- Cultural Confidence Building
- An Educated Workforce

Table 8 Internal Factors for Success

It is not my purpose to go through each of these factors here – greater details may be found, for example, in [1]. Let me briefly look at Industrial Policy and Foreign Direct Investment before concentrating on my main theme: Education.

Ireland was the first state in Europe to base its development on Foreign Direct Investment (FDI); since the abandoning of protectionism in 1956, FDI has been the central strand of all Irish economic policy. The policy has been pursued consistently by all governments for some 40 years – see e.g. [2] - and there is an almost complete political consensus on it. This climate of certainty, coupled with significant grants

and attractive rates of corporation tax, has certainly played a significant role in our economic development but it hardly explains the Celtic Tiger phenomenon since such policies were in place long before the unprecedented boom of the 90^{s}. Some commentators have argued – see e.g. [3] - that the "big domestic change was the transformation of the state finances": the new social partnership along with greatly reduced state expenditure and borrowing made Ireland a low tax economy which, when taken in conjunction with the fortuitous arrival of EU cohesion funds and a revival of the US economy, resulted in just the correct climate for large scale manufacturing to flourish. A key complementary strategy in relation to education was, of course, vitally important here and we shall return to this later.

The level of this manufacturing increase is illustrated by:

Year	EU-15	UK	US	Ireland
1996	100.2	99.4	104.7	108.3
1997	104.8	101	112.3	126.2
1998	109.1	101.3	117.8	147.3
1999	110.8	101.4	122.8	156.9

Table 9 Industrial Production: Manufacturing, 1995=100

Despite some inevitable drop and competition from the new States in the expanded Europe, Ireland's performance continues to be impressive especially when considered against other established, but underdeveloped states, from the "Old Europe".

Year	EU-15	UK	Portugal	IRELAND
2004 m12	101.05	98.41	101.80	124.70
2005 m3	100.32	95.93	97.40	115.80
2005 m6	101.65	97.07	104.10	125.00
2005 m9	102.12	96.98	101.20	121.00

Table 10 Industrial Production: Manufacturing (2000 = 100)

Even allowing for some scepticism about the figures – 'transfer pricing' by MNC s seems to have been common – this is an impressive performance. It is also important to remember that the overall small scale of the Irish economy means that the concentration of this, almost totally foreign, manufacturing investment has more effect than in larger countries – see e.g. [4]. Because much of FDI in Ireland comes from the ICT and pharmaceutical areas, there is often an erroneous assumption that high technology employment is the key to Ireland's success. In fact employment in high technology manufacturing and high technology services account for only some 11.6% of total employment. However as a proportion of manufacturing employment, the high technology area is significant, being exceeded within the EU only in Germany and the UK. Again size is important: high technology industries do not require a high standard of education for the entire population but they do require a pool of labour with relevant skills – see [3].

This is perhaps an appropriate time to review the higher education system in Ireland in general and my own institution, Dublin Institute of Technology (DIT) in particular.

2. Higher Education in Ireland

The Irish Higher Education system has been organised since the 70s, on a binary system of universities (offering largely degree and postgraduate programmes) and regional technical colleges (offering in the main two year certificates with a one year "add-on" diploma). However, in Dublin a number of colleges of technology (curiously always known by the name of the street in which they were located) had existed since the late 1880 s and these colleges entered into an arrangement with the University of Dublin whereby the colleges' diplomas were recognised by the University for a degree award. As a result these colleges, which later became a single institution, the Dublin Institute of Technology (DIT), effectively straddled both sides of the binary divide. In the mid 1990s the regional technical colleges were renamed 'Institutes of Technology' (IoT's) but continued to have their awards made by a central body, the Higher Education Training Awards Council. The Dublin Institute of Technology, on the other hand, became an awarding body in its own right with the same powers to make awards (including awards at doctoral level) as the universities.

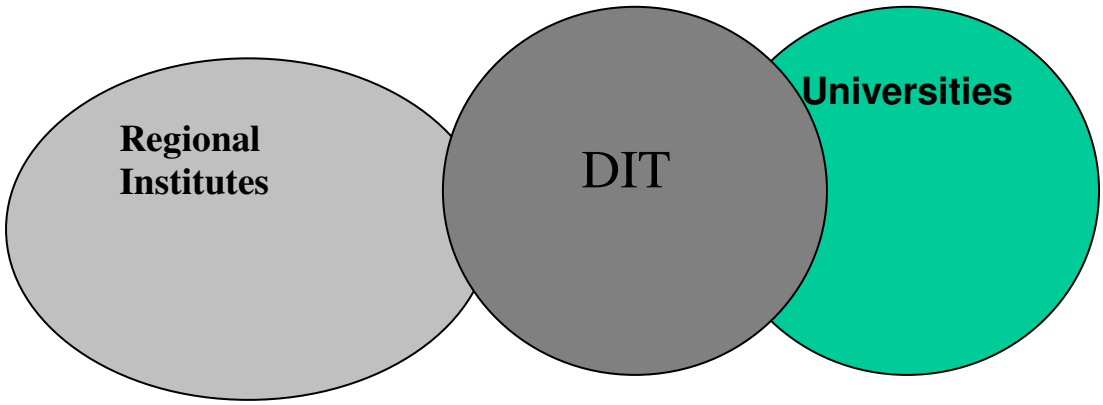

Table 11 Structure of Irish Higher Education

It is interesting to note that most of the non-university sector, including DIT, continues to provide the theoretical dimension of the training of apprentices across a range of disciplines.

The provision of part-time programmes has been largely the preserve of the extra-university sector, particularly DIT, but this has changed significantly in recent years.

	1971/72	1981/82	1991/92	2001/02	2002/03	2003/04
Universities	**19,959**	**23,908**	**42,213**	**72,168**	**74,922**	**77,491**
DIT	**2,447**	**5,384**	**11,745**	**9,873**	**10,162**	**10,164**
IoT's	**590**	**7,119**	**17,903**	**40,017**	**41,345**	**43,422**
TOTAL	**22,996**	**36,411**	**71,861**	**122,058**	**126,429**	**131,077**

Table 12 Full-Time Students in Higher Education in Ireland

	1978/79	1993/94	2001/2
Universities	**2,788**	**7,667**	**13,826**
DIT	**14,282**	**7,262**	**7,623**
Regional Institutes	**10,026**	**6,053**	**12,599**
TOTAL	**27,096**	**20,982**	**34,048**

Table 13 Part-Time Students in Higher Education in Ireland

Let us return to the Celtic Tiger!

3. Higher Education in Ireland and the Celtic Tiger

How significant a role did education really play? Conversely what has been the impact on education of the Celtic Tiger?

Clearly education is rated as a key factor by all commentators, so does this mean that education was a high priority for government spending? The figures are revealing:

Country	Early Childhood	Primary	Secondary	Tertiary
Germany	**19**	**16**	**28**	**43**
France	**16**	**17**	**31**	**34**
Netherlands	**15**	**15**	**23**	**45**
UK	**26**	**16**	**23**	**40**
Spain	**16**	**20**	**27**	**32**
Mexico	**13**	**12**	**22**	**59**
Ireland	**12**	**12**	**19**	**39**
OECD Mean	**17**	**19**	**26**	**45**

Table 14 Expenditure per student relative to GDP per capita (1997)

Note that Ireland's direct expenditure at all educational levels actually decreased from 4.7% of GDP in 1990 to 4.5% in 1997 while the OECD mean increased from 4.8% to 5.1% over the same period – see [5].

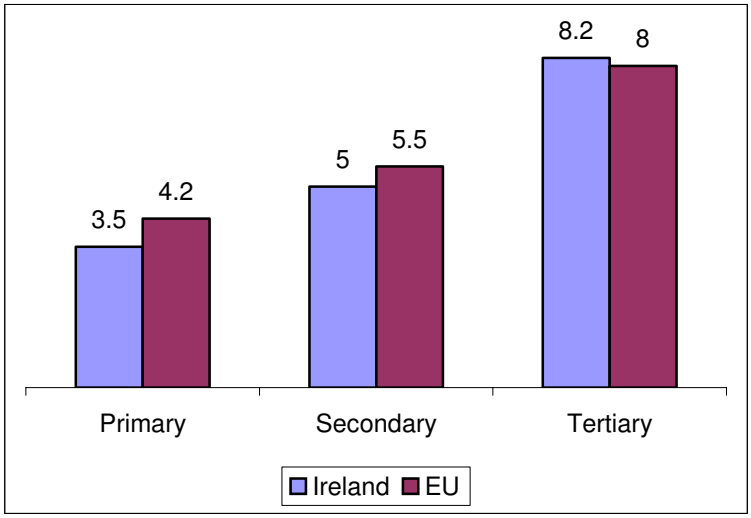

Table 15 Expenditure by level of Education 2002

What in fact has happened is that third-level expansion initially focused largely on low-cost short-cycle undergraduate programmes, followed a little later by a number of Government initiatives in areas of "skills shortage" in both the university and non-university sectors. (For example, the average duration of tertiary studies in Ireland in 1997 was 2.6 years compared to an OECD mean of 4.1 years). Thus relative to the OECD average we see a much greater percentage of Irish students taking certificates (short-cycle courses mainly of two years duration) in the regional institutes of technology and a lesser percentage taking degrees (of three or four years) in the seven universities and DIT. Let me emphasise at this point that although DIT shares many characteristics with the seven Irish universities (e.g. highly competitive entry requirements, specialised research groups, rapidly growing numbers of postgraduate students etc), it is in many ways different: it is unashamedly pro-industry, its research specialisms all tend to the 'applied' end of the spectrum and it seeks to maintain its broad spectrum approach of having a mix of students at all levels from apprenticeship to doctoral level. Hence it must be kept in mind that degree and postgraduate students

in DIT, while on a comparable academic level to that pertaining in the traditional universities, have a significantly more applied bias e.g. there is no traditional arts/humanities faculty in DIT. The Institute also maintains, and indeed has substantially increased, its commitment to be impoverished inner city areas of Dublin: it has led the way in the development of links with primary and secondary schools in deprived areas and heads up an important programme with industry partners in the development of 'digital communities'.

4. Innovation

A common but rather dated assumption is that science somehow *causes* innovation in the business world. The process is, however, much more complex than this and there has been much theoretical discussion of alternative views in recent years – see, for example [6] and the references therein. One outcome of these investigations has been to recognise the importance of **imitation.** Indeed some commentators would go as far as to claim that

"*Imitation is perhaps* the *central fact about innovation and economic development under capitalism."* - [7]

The emphasis here on so-called *creative imitation*: ways of improving and innovating around an original innovative design rather than simply copying. (This brings issues of protection of Intellectual Property sharply into focus but I will not develop this issue further here.) A consequence of this recognition is that the **absorptive capacity** of firms becomes critical – the terminology derives from an important paper of Cohen and Levinthal dating back to 1990 [7]. The notion is not without its critics and indeed its weaknesses have been highlighted in [8]. Nonetheless an area of agreement among many commentators is the importance of **human capital** in the whole innovation process. Recent research, [9] and [10], has revealed a number of interesting points:

- A high proportion of R + D staff and a high proportion of graduates both correlate with a high rate of product innovation
- The provision of training by companies correlates only weakly to innovation
- Companies co-operating with universities are actually **less** likely than equivalent firms to be innovative
- Highly qualified staff promote growth, but **relevantly** qualified staff do so to an even greater extent.

No doubt these data are controversial, particularly the third point!
With this rather brief theoretical background let us move on to consider how universities can, in fact, help in the whole innovation process in a region, particularly in relation to human capital formation. Let me emphasise that Ireland is a *very small* geographical region – some 70,000 square kilometres and only 4 million inhabitants.

5. DIT and the Celtic Tiger

So just what precisely has DIT done to help the development of the Celtic Tiger? Note that the Institute is operating on a very restricted land base so that significant expansion has not been possible; rather a change of direction has been the only possibility for DIT.
A look at enrolment and awards show these points quite clearly:

Year	Full-Time	Part-Time	Apprentice
1984/85	5,892	10,798	5,923
1989/90	7,543	9,644	4,968
2002/03	10,117	6,806	4,968
2004/05	10,480	7,360	3,254

Table 16 Enrolments in DIT (1984 – 2004)

Year	Postgraduate	Degree	Diploma	Certificate	TOTAL
1984/85	-	420	694	585	1,699
1989/90	-	670	869	931	2,470
2002/03	180	1,372	761	740	3,053
2003/04	727	2,682	-	899	4,308

Table 17 Awards by Type in DIT (1984 – 2004)

In the mid-1990[s] the Government, through the Department of Education and Science, initiated a "Skills Shortage Initiative" whereby they requested higher education institutions to provide new programmes in areas that had been identified, in co-operation with industry, as being important to sustaining development. DIT responded enthusiastically to these requests at both degree and sub-degree level. New programmes were introduced as follows:

- Data and Network Communications
- Microelectronics Technology
- Advanced Industrial Maintenance
- Plant Operation and Maintenance
- Systems Control and Electrical Power
- Manutronics

Table 18 Certificate/Diplomas in the Skills Shortage Initiative

- Computer Engineering
- Computer Science (4 options)
- Information Systems
- Information Engineering and Management
- Manutronic Engineering
- Microelectronics

Table 19 Primary Degrees in the Skills Shortage Initiative

The Institute also participated with the seven universities in the Advanced Technical Skills Programme. This programme was an early initiative of the Department of Education and Science with a view to producing masters-level graduates in areas of importance to the economy. It was, in fact, largely replaced by the more focused Skills Shortage Initiative

In addition, DIT commenced a range of new programmes, many of them in a part-time mode suitable for people working in industry, which reflected emerging new needs within the economy. These were:

- Project Management
- Facilities Management
- Strategic Management
- Spatial Management
- Food Safety Management
- Hospitality Management
- Logistics
- E-business

Table 20 New Masters Programmes in DIT

And at undergraduate level:

- Transport Technology
- Environmental Planning and Management
- Transport and Logistics
- Tourism
- Physics Technology
- Analytic/Forensic Chemistry
- Digital Media

Table 21 New Primary Degree Programmes in DIT

There is a number of points here which I believe need to be emphasised. Firstly the range of levels of programmes: national development at that time required a highly skilled workforce **at a number of different levels.** As noted above in Section 4, innovation works best with the **relevantly qualified** staff, so it was not sufficient to simply produce graduates in science, engineering and technology. Secondly as Ireland progressed to a much more *knowledge-based* economy, it was important to have the flexibility to move to new higher-level programmes but *still incorporating the appropriate industrial/commercial orientation.* In essence this is a question of **institutional culture.** A traditional Humboldtian university system is, undoubtedly,

important but so too is a more flexible, industry-oriented one. A key strength of DIT is its ability to operate across all the levels of concern to industry from craft-based work to leading-edge research. A significant factor underpinning this culture is the fact that many DIT faculty members have strong industrial backgrounds and linkages; for example in the School of Computing, some 80% of faculty have had *significant high-level* industrial experience while in other schools there would also be quite a number of staff with such experience, depending, of course, on the particular academic discipline.

Of course it is not enough to be just *responsive*; universities need to engage *proactively* with the innovation and development agendas. This means the commitment of significant resources and the development of a proper infrastructure. In DIT we have a dedicated team managing our interaction with industry: this comprises of

- Director (= Vice-President)
- Head of Industry Development
- Head of Innovation and Industry Services in each of our six faculties
- Head of Corporate Training Unit
- Head of Project Development Centre
- 13 other specialist Development Centres

Table 22 DIT Industry Team

The various activities listed above would have, of course, appropriate support staff; in particular there is a Research Support Unit with a remit to provide, *inter alia,* financial management expertise. The Corporate Training Unit is responsible for marketing DIT's extensive range of training programmes and the development of new training programmes to meet the needs of industry. The last grouping in the list above has a remit to carry out training, consultancy and research for industry. The current groups are:

Unit / Centre
Applied Optoelectronics Centre
Communications Network Research Institute
Centre for Research into Engineering Surface Technology
Centre for Social and Educational Research
Digital Media Centre
Food Product Development Centre
Centre for Industrial & Engineering Optics
Innovation Services of the Built Environment
National Institute of Transport & Logistics
National Maintenance Centre *
National Satellite Services Centre
Radiation & Environmental Science Centre
Tourism Research Centre

Table 23 Development Centres in DIT

The Project Development Centre has a long history in DIT. In the 1980's DIT, with EU support, had initiated two important schemes: A Graduate Training Programme (GTP) and an Enterprise Development Programme (EDP). These schemes were nurtured by the DIT Project Development Centre, a grouping established to help and support entrepreneurial graduates. The Enterprise Development Programme focuses on the development of entrepreneurial skills through real trading experiences. In summary EDP is concerned with

- Entrepreneurship through real trading
- Takes business ideas to the early trading stage
- Some formal training in key business skills
- Provision of individual mentors

Table 24 The Enterprise Development Programmes in DIT

The Graduate Training Programme was effectively a postgraduate research training programme leading to a Masters award but with the added dimension that the research project be industrially relevant.

- Masters level research training
- Industrially relevant project
- Industrial support

Table 25 The Graduate Training Programme in DIT

- **In the period 1994-98, 211 graduates were involved interacting with 117 companies.**

The Project Development Centre at DIT has more recently undertaken a number of new initiatives relating to entrepreneurship/commercialising of research. These include

- Hothouse Programme
  - ►knowledge intensive start-ups
- Fast Growth Programme
  - ►moving from start-up to expansion
- Prospect Programme
  - ► commercialising Irish University research

Table 26 Project Development Centre Initiatives

- **To date more than 400 young companies have been assisted through the initial start-up and early growth stages.**

6. Conclusions

Before trying to draw together some conclusions, let me illustrate the extent of socio-economic change that has occurred in Ireland since 1996. Recent census data reveal the following changes:

Socio-Economic Group	1996	2002	Change %
Employers & Managers	413	608	47
Higher Professional	160	204	27
Lower Professional	290	383	32
Other non-manual	613	671	9
Manual skilled	514	399	-22
Semi-skilled	346	308	-11
Unskilled	277	193	-30
Own Account Workers	203	192	-5
Farmers	309	228	-26
Agricultural Workers	76	35	-54
Other	423	696	65
Total Population	3,624	3,917	8

Table 27 Socio-economic change in Ireland (numbers in 000^{s})

Suggestions of change of this scale made in the early 1990^{s} would have met with derision. It will be interesting to see the role played by our education system in this change; analysis is not yet available but will be in the not too distant future.
What can we say about the extent of the contribution of the very specific policy of "low cost volume production" - in the terminology of [3] – of technical graduates to the Celtic Tiger phenomenon? Without doubt, the calculated political risk of

producing, for a period, an over-supply of technical graduates, has been largely successful. Ireland has been able to move from a mainly agrarian to an industrial (some would even say post-industrial) economy. It is, however, an economy which is highly dependent on mainly American companies in a very small number of high technology areas. The long-term sustainability of this policy is, of course, a major issue for discussion in Ireland today. A consensus seems to be emerging: Ireland must continue to climb the "value chain" and that brings with it new challenges for higher education; research-led initiatives which can subsequently be translated into commercial opportunities take on increasing significance and this will necessitate further quite fundamental changes in our whole tertiary education system.

Finally, I should address, if only briefly, the obvious question: can the Celtic Tiger phenomenon be reproduced elsewhere? I hope that I have demonstrated that there were some very important peculiarities of the Irish situation, which played a disproportionately important role in our country's success. These are not easily replicated elsewhere. However, the role played by higher education in providing the necessary human capital can, undoubtedly, be replicated. A key ingredient is the need for an appropriate educational culture and this may, or may not, be easy to achieve.

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