

Vorsprung durch Technium? Towards a system of innovation in South West Wales

Abbey, James; Davies, Gareth; Mainwaring, Lynn

Postprint / Postprint

Zeitschriftenartikel / journal article

Zur Verfügung gestellt in Kooperation mit / provided in cooperation with:

www.peerproject.eu

Empfohlene Zitierung / Suggested Citation:

Abbey, J., Davies, G., & Mainwaring, L. (2008). Vorsprung durch Technium? Towards a system of innovation in South West Wales. *Regional Studies*, 42(2), 281-293. <https://doi.org/10.1080/00343400601147281>

Nutzungsbedingungen:

Dieser Text wird unter dem "PEER Licence Agreement zur Verfügung" gestellt. Nähere Auskünfte zum PEER-Projekt finden Sie hier: <http://www.peerproject.eu> Gewährt wird ein nicht exklusives, nicht übertragbares, persönliches und beschränktes Recht auf Nutzung dieses Dokuments. Dieses Dokument ist ausschließlich für den persönlichen, nicht-kommerziellen Gebrauch bestimmt. Auf sämtlichen Kopien dieses Dokuments müssen alle Urheberrechtshinweise und sonstigen Hinweise auf gesetzlichen Schutz beibehalten werden. Sie dürfen dieses Dokument nicht in irgendeiner Weise abändern, noch dürfen Sie dieses Dokument für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen.

Mit der Verwendung dieses Dokuments erkennen Sie die Nutzungsbedingungen an.

gesis
Leibniz-Institut
für Sozialwissenschaften

Terms of use:

This document is made available under the "PEER Licence Agreement". For more information regarding the PEER-project see: <http://www.peerproject.eu> This document is solely intended for your personal, non-commercial use. All of the copies of this documents must retain all copyright information and other information regarding legal protection. You are not allowed to alter this document in any way, to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public.

By using this particular document, you accept the above-stated conditions of use.

Mitglied der

Leibniz-Gemeinschaft



Vorsprung durch Technium? Towards a System of Innovation in South West Wales

| | |
|------------------|---|
| Journal: | <i>Regional Studies</i> |
| Manuscript ID: | CRES-2006-0015.R2 |
| Manuscript Type: | Policy Debates |
| JEL codes: | O32 - Management of Technological Innovation and R&D < O3 - Technological Change Research and Development < O - Economic Development, Technological Change, and Growth, O38 - Government Policy < O3 - Technological Change Research and Development < O - Economic Development, Technological Change, and Growth, R58 - Regional Development Policy < R5 - Regional Government Analysis < R - Urban, Rural, and Regional Economics |
| Keywords: | Local innovation systems, South west Wales, Technium |
| | |

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Vorsprung durch Technium: Towards a System of Innovation in South West Wales

JAMES ABBEY*, GARETH DAVIES† and LYNN MAINWARING*

*Department of Law, Swansea University, Swansea SA2 8PP, UK

Emails: j.v.abbey@swansea.ac.uk and l.mainwaring@swansea.ac.uk

†Department of engineering, Swansea university, Swansea SA2 8PP, UK

Email; g.h.davies@swansea.ac.uk

ABSTRACT

Begun in 2001, Technium is a Welsh university-business interface project presently consisting of ten facilities. Seven of these are jointly managed by the Welsh Development Agency and Swansea University. Taken together with other, linked developments at the University, Technium is helping to generate a distinct sub-regional innovation system incorporating many features that researchers have identified as critical to successful localised collective learning and innovation. A provisional evaluation of costs and benefits suggests that recent criticism of the project is unfounded. With its initial dependence on EU Structural Funds, the Technium model incorporates which may be appropriate to other relatively deprived regions of the EU.

Technium Local innovation systems South west Wales

JEL classifications: 032 038 R58

INTRODUCTION

In their recent survey of the literature on innovation policy, TODTLING and TRIPPL (2005) argue that policies that have evolved in the context of high-performing metropolitan regions may not be wholly applicable to regions that are peripheral or facing the consequences of decline in once-dominant traditional industries. The descriptors 'peripheral' and 'old industrial' both apply to Wales and the restructuring of the economy has proved particularly challenging. The collapse of coal and steelmaking employment in the 1980s was addressed by a massive effort on the part of the Welsh Development Agency (WDA) to attract inward investment in manufacturing. While initially successful in meeting the need for jobs, it was a strategy that became increasingly unsustainable in the face of rapid globalisation (MAINWARING, 1995). A shift in emphasis became apparent in 1994 when Wales was selected as one of the regions to pilot the EU's Regional Technology Plan (RTP) and, since the establishment of the devolved National Assembly for Wales (NAW) in 1999, the Welsh Assembly Government (WAG) has adopted – in principle, at least – the aim of developing Wales as a 'knowledge economy'. The Technium project, which emerged in south west Wales as an attempt to strengthen the interface between higher education and business, has become a key component in the new strategy.

In this paper, we argue that Technium provides a valuable case study and potentially replicable innovation model (or component of such a model) for relatively disadvantaged regions. The project has been subject to criticism (COOKE and CLIFTON, 2005) but we believe that in key respects the critics have projected an

1
2
3 unjustifiably negative picture. Technium is presented here as part of a set of
4
5 complementary developments, including the establishment of an Institute of Life
6
7 Sciences and an Institute of Advanced Telecommunications, which have occurred at a
8
9 sub-regional (i.e., sub-Wales) level and which may be characterised as signalling the
10
11 emergence of a local or sub-regional innovation system (IS). The next section provides a
12
13 brief overview of the literature on territorial innovation systems and the policy insights it
14
15 has generated. The following sections put matters in a more localised context with a
16
17 sketch of the recent evolution of policy-making in Wales and a description of the pre-
18
19 Technium research base in south west Wales. We then explain what Technium is and
20
21 describe the architecture of the system of which it is part. That is followed by a
22
23 provisional (and necessarily partial) assessment of the costs and benefits. We consider
24
25 the extent to which these developments constitute a distinct approach to creating a local
26
27 IS, before concluding.
28
29
30
31
32
33
34
35

36 TERRITORIAL INNOVATION SYSTEMS

37
38
39
40
41 The notion that the innovation process in the modern economy is best understood in
42
43 systemic terms seems to have originated with FREEMAN (1987) and was developed
44
45 through the 1990s by LUNDVALL (1992), NELSON (1993), CARLSSON (1995) and
46
47 FREEMAN (1995) himself, among others. It marked a shift away from the idea that
48
49 innovation is an act occurring within a firm or other agent in isolation from the broader
50
51 cultural and institutional context. Innovation was believed to be more effective where
52
53 there is a rich mix of formal institutions (firms, universities, technical colleges, training
54
55
56
57
58
59
60

1
2
3 agencies, government advisory agencies, etc.), operating within a supportive legal and
4
5 policy framework, plus a rich mix of informal institutions, from close personal
6
7 relationships involving trust (MASKELL and MALMBERG, 1999), through industry
8
9 clusters promoting Marshallian external economies (PORTER, 1990; BAPTISTA and
10
11 SWANN, 1998), to localised networks and broad innovation-conducive milieu
12
13 (CAMAGNI, 1991).
14

15
16
17 The IS concept was initially thought out in terms of nation states and, in that
18
19 respect, is territorially constrained despite the obvious trend towards globalization. It has
20
21 survived this trend because globalization and localization are now broadly accepted as
22
23 complementary processes (CANTWELL, 1995; CARLSSON, 2006), the diversity of
24
25 local systems allowing each to find a niche in the global economy and for multinational
26
27 firms to tap into local expertise. The concept is not, however, spatially defined of
28
29 necessity and some have argued for its applicability to technologies (CARLSSON, 1994)
30
31 and sectors (MALERBA, 2002). It is probably best to think of the spatial, technological
32
33 and sectoral dimensions as interacting in complex ways and, in relation to Technium, we
34
35 shall see that, while the spatial aspect is dominant, the others are also relevant.
36
37
38
39

40
41 Because there may be sub-national differences in the mix of institutions and
42
43 economic structures it follows that ISs could be identifiable at smaller territorial levels.
44
45 Indeed, one might imagine a series of systems of increasing locality nested one within the
46
47 other. What are likely to give the more localised versions their identity are the informal
48
49 institutions: trust-based relationships, for example, tend to be promoted by proximity
50
51 (MASKELL and MALMBERG, 1999; MORGAN, 2004); networks function more
52
53 effectively when people meet regularly; labour mobility and idea spillovers occur in
54
55
56
57
58
59
60

1
2
3 clusters (industrial districts) which are, necessarily geographically concentrated. These
4
5 notions were brought together by STORPER (1995) in his characterization of the regional
6
7 economy as a 'nexus of untraded interdependencies'.
8
9

10 If one seeks the distinctive components of an IS in a set of formal and informal
11
12 institutions then, clearly, the degree of institutional development, or 'institutional
13
14 thickness' (AMIN and THRIFT, 1995), has a role to play in the system's success. But
15
16 while institutional development is generally regarded as a positive sign, institutional
17
18 ossification, or lock-in, can have a stultifying effect, something which appears to be more
19
20 problematic in old industrial areas (GRABHER, 1993; HUDSON, 1994; MORGAN and
21
22 NAUWELAERS, 2002). Within the Welsh context, for example, HENDERSON (2000)
23
24 concluded that the RTP may not have filled early hopes because of 'well-entrenched
25
26 interests and responsibilities'.
27
28
29
30

31 All this implies that IS designs that are appropriate for one region may not be for
32
33 another. There may be best-practice regions but not necessarily best-practice systems
34
35 (HUDSON *et al.*, 1997; NEUWELAERS and WINTJES, 2003; TODTLING and
36
37 TRIPPL, 2005). Even so, a number of positive features appear to be common to a wide
38
39 set of regions displaying successful collective learning (KEEBLE and WILKINSON,
40
41 1999, for an editorial summary of case studies in the special issue of *Regional Studies*).
42
43 A checklist of desirable characteristics suggested by these case studies include:
44
45
46

- 47 • the creation of strong local knowledge networks, proximity being important for
48
49 such desirable traits as 'imitation, emulation and reverse engineering'
50
51
- 52 • the exploitation of the multi-disciplinary culture of a university
53
54
55
56
57
58
59
60

- the avoidance of path-dependent overspecialisation in increasingly obsolete areas of technology
- SMEs in different technological areas having their own interactive networks (effectively, therefore, separate technological ISs interacting with the spatial IS)
- large corporations seeking to externalise part of their R&D functions to SMEs that can act as intermediaries with universities
- the importance of developing extra-regional links
- the importance of producing highly qualified workers to support the labour market.

To these, one might add:

- the avoidance of top-down modes of intervention in favour of an interactive and facilitative role on the part of government and its agencies (NEUWELAERS and MORGAN, 1999)
- the avoidance of entrenched cultural attitudes (GRABHER, 1993)

In the context of old industrial areas, TODTLING and TRIPPL (2005) see the key issues as: strengthening higher-education institutions (HEIs) and their links to business; embedding foreign firms in order to acquire complementary knowledge and compensate for the low knowledge-absorption capacity of the region; and overcoming locked-in behaviour.

Wales appears to have been fertile ground for IS analysts and advocates and provided an early example of its application at a regional level (REES and MORGAN, 1991; COOKE, 1992). This is attributable to its distinctive political culture and

1
2
3 autonomy relative to the English regions (long pre-dating formal devolution). Of course,
4
5 the existence of an identifiable system is one thing, its effectiveness quite another.
6
7
8
9

10 ECONOMIC POLICY DEVELOPMENT IN WALES

11
12
13
14
15 Throughout the 1990s, the WDA gradually shifted emphasis away from the 'advance
16
17 factory - subsidy' approach to attracting investment and towards a more collaborative
18
19 business-support regime encompassing indigenous SMEs. Considerable effort was put
20
21 into embedding foreign multinationals into supply chains into which domestic companies
22
23 were insinuated. The quality disciplines and, in many instances, the Japanese-style
24
25 industrial practices, imposed on these firms were seen by the Agency as the way to create
26
27 a domestic innovation culture. The most successful and multi-tiered supply chains
28
29 developed in the automotive parts industry, which has become a well recognised cluster,
30
31 and, to a lesser extent, in the more diffuse electronics sector (COOKE, 2004). According
32
33 to MORGAN (1997), these strong public-private collaborative arrangements were
34
35 instrumental in Wales' invitation to participate in the RTP. That programme, itself,
36
37 represented a switch in the EU's innovation policy away from a technology-driven model
38
39 to one emphasising the social, institutional and commercial aspects of innovation (i.e., a
40
41 recognition of the systemic nature of innovation). Despite the policy adaptations within
42
43 Wales, as late as 1998, the Welsh Affairs Committee of the House of Commons (WAC,
44
45 1998) voiced concern about the slow rate of change in WDA philosophy away from its
46
47 preoccupation with inward investment. This was a clear suggestion that the Agency, or
48
49 some parts of it, remained locked into the old 'build it and fill it' mentality.
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

This, in effect, represented the immediate policy legacy of the new Assembly Government. In terms of the actual state of the economy, what it inherited was per capita GDP at around 80 per cent of the UK average – the consequence of a low employment rate (primarily low activity rather than unemployment) and an unfavourable occupational composition, i.e., too few highly-paid jobs. Moreover, the sector in which the best-paid jobs were to be found, manufacturing, appeared to be in rapid decline, partly as a result of foreign firms severing their links with Wales (COOKE, 2004).

Given that inheritance, the significance of the Government's first economic strategy document, *A Winning Wales* (NAW, 2002), lies in its recognition that the sustainable growth of welfare is dependent on the successful commercialisation of knowledge. Addressing the GDP deficit was no longer seen as a simple matter of job creation but more particularly of: increasing the rate of home-grown, knowledge-intensive start-ups; putting greater effort into attracting high-quality inward investment (i.e., closer to the start of the product cycle); and promoting private-sector professional services, in which Wales appeared to be lagging the rest of the UK. The primary means by which these objectives were to be attained were by encouraging innovation, entrepreneurship and skill acquisition and by improving the communications infrastructure and business support services. In each respect, links between businesses and HEIs were seen as critical and, in relation to the incubation of home-grown ideas, Swansea University's Technium project was considered an exemplar.

Although *A Winning Wales* appears to mark a departure from the old job-creation formula, COOKE and CLIFTON (2005) have been notably pessimistic about actual progress. They argue that, since devolution, Wales has, compared to Scotland, pursued a

1
2
3 less 'visionary' and less robust approach to system building. In part, this is attributed to
4 the weaker nature of the devolutionary settlement in Wales, but they see also a problem
5 in the very culture and institutions that have made Wales distinctive. Among the latter is
6 the WDA which, in their view, is still excessively wedded to its traditional agenda –
7 though more now in the form of advanced offices than advanced factories. WAG's
8 promise (since fulfilled) to take the WDA (a quango) into government, as part of the civil
9 service,¹ is not seen by them as part of the solution but as a reinforcement of WAG's top-
10 down and more 'precautionary' attitude to economic development. As for Technium,
11 COOKE and CLIFTON describe the project as flawed and overambitious, charges which
12 are considered later in this paper.
13
14
15
16
17
18
19
20
21
22
23
24
25
26

27 Perhaps as a result of its institutional development (and the politics of national
28 identity), Wales has been particularly successful in accessing EU Structural Funds. Since
29 1999, 'West Wales and the Valleys' (which incorporates south west Wales) has qualified
30 for Objective 1 funding (directed at regions having less than 75 per cent of the EU
31 average GDP per capita). The same area has also qualified for the successor
32 Convergence Fund, which runs from 2006 until 2012. (For earlier regional funding
33 comparisons, see COOKE, 1992). *A Winning Wales* recognised the opportunities
34 presented by the receipt of EU Structural Funds, especially Objective-1 funding, but did
35 not specifically link these to its strategic objectives. The successor document, *Wales: A*
36 *Vibrant Economy (WAVE)* (NAW, 2005), however, states quite explicitly that 'any post-
37 2006 EU funds should, ... , reflect the Lisbon [summit] reform agenda of promoting jobs
38 and growth – particularly in innovative knowledge-intensive sectors' (p. 18). Not
39 surprisingly, innovation is again ranked first among the key drivers for business growth
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 and not only is Technium cited as a flagship project in this respect (pp.15 and 51) but it
4
5 and related developments such as the Institute of Life Sciences are seen as enabling
6
7
8 Wales to ‘draw away from the “branch factory” economy’ (p.42). This is a clear
9
10 statement that WAG regards the old inward-investment strategy as history.
11

12
13 *WAVE* was drawn up in the light of the Wales Spatial Plan (NAW, 2004) and, as a
14
15 consequence, the spatial aspect of economic strategy is more fully articulated than it is in
16
17 the 2002 document. The Spatial Plan itself is a formalization and acceptance of the de
18
19 facto nature of regional governance, particularly among the former quangos involved in
20
21 education, training and economic strategy. Indeed, GOODWIN, JONES and JONES
22
23 (2005) assert that south west Wales has become one of the (four) key spaces in the
24
25 economic geography of Wales since devolution and that this ‘demonstrates a spatial
26
27 rather than a sector-based approach to the delivery of economic development’. However,
28
29 south west Wales is a far from homogeneous space, being highly urbanised in the east
30
31 (around Swansea Bay) and rural to the west (Carmarthenshire and Pembrokeshire) and
32
33 these differences are respected in the Spatial Plan. In particular, the HEI-based
34
35 innovation approach is not only constrained by the existing distribution of HEIs but is
36
37 initially more appropriate for areas of higher urban density and, therefore, of knowledge-
38
39 absorbing potential (and which in Wales as a whole means Cardiff, Swansea and north
40
41 east Wales). Taken together with eligibility for Objective-1 funding, this leaves Swansea
42
43 as the obvious location to experiment in and nurture an innovation system that can
44
45 subsequently reach out to the more rural areas to the west and to other parts of Wales.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

THE INHERITED RESEARCH BASE

1
2
3
4
5
6
7
8
9 Shortly after devolution, the National Assembly's Economic Development Committee
10 commissioned a report on the state of R&D in the economy (JONES-EVANS, 2002).
11
12 This basically established that the research base in Wales provided inadequate
13 foundations for the knowledge-economy aspirations implicit in the Assembly
14 government's economic plan. Calculations in BEALE and MAINWARING (2006) bear
15 this out. From the 2001 Research Assessment Exercise (RAE) for UK HEIs, it is
16 possible to estimate the numbers of academic staff resident in departments that made a
17 submission to the Exercise. In 27 (of 68) subjects that, broadly, qualify as science and
18 technology (S&T), Wales had 932 staff, as compared with Scotland's 3,146. In per
19 capita terms, Wales's research base, on this measure, was about half of Scotland's (and
20 similar to Northern Ireland's).
21
22
23
24
25
26
27
28
29
30
31
32
33

34
35 The total S&T staff count for Swansea University was 138. This compares with
36 557 at Cardiff (the combined University and College of Medicine). Even ignoring its
37 elite universities, Scotland's other 'old' institutions - Aberdeen, Dundee, Heriot-Watt and
38 Strathclyde - all had more than double Swansea's researcher numbers. Given the weak
39 HE base, it is not surprising that interactions with business have been muted. To take one
40 example (BEALE and MAINWARING, 2006), between 1983 and 2005, Swansea
41 University was granted 0.04 European and US patent grants per S&T researcher (on the
42 basis of the 2001 RAE count), compared to 0.12 for Aberdeen, 0.15 for Dundee, 0.17 for
43 Cardiff and 0.41 for Strathclyde. While these comparisons have to be qualified by
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 recognizing that other avenues for commercialization exist, apart from patent registration
4
5 by the institution itself, they probably do fairly indicate a general performance ranking.
6
7

8 Apart from Swansea University (and the neighbouring Swansea Institute of HE,
9
10 which has very limited research strengths), there is no other public civil research base in
11
12 the area, unless one interprets the ‘south west’ more broadly to include the Institute of
13
14 Grasslands and Environmental Research at Aberystwyth. Nor is there a military research
15
16 establishment or much in the way of defence-related R&D (BISHOP and WISEMAN,
17
18 1999). As is well known, commercial R&D in Wales is low in comparison to other UK
19
20 regions and (given the dominance of the Cardiff area) that almost certainly applies *a*
21
22 *fortiori* to south west Wales. Large firms here tend to be inward investors who, hitherto,
23
24 have shown little interest in devolving fundamental R&D functions to their branch
25
26 plants.² An exception was the steelmaker Corus which had a substantial materials
27
28 research centre at its Port Talbot plant, near Swansea, but this closed in 2001. (The
29
30 facilities remain available for hire to private companies.) Meanwhile indigenous SMEs
31
32 have failed, up till recently, to develop a strong research ethos or research capacity.³
33
34
35
36
37
38

39 Given this historical legacy, the Technium project was designed to do five things:
40
41 improve the knowledge flow from the University into the private sector; help spin out a
42
43 local population of SMEs with a strong research ethos; use the potential for University
44
45 links to attract (spin in) non-local research-driven young firms; promote the retention of
46
47 graduates in the area; and encourage large, established firms to devolve part of their R&D
48
49 functions to Technium and so develop fruitful links to the University and to Technium-
50
51 based SMEs. As is obvious from our description of the inherited research base, an
52
53 ambitious programme of this nature would be unsupportable without a significant
54
55
56
57
58
59
60

1
2
3 that the initial partnership arrangements have been sustained and Technium has remained
4 most faithful to its original philosophy. It would be wrong to think of Technium as solely
5 an incubator programme (though that is an important part), or to evaluate it independently
6 of the other projects which are occurring at the same time and with which it is intimately
7 linked. Insofar as Technium was initiated by an academic bidding for EU Structural
8 funds,⁵ it could be described as a bottom-up initiative, but it is also true to say that the bid
9 could not have succeeded without the involvement of an established and centralised
10 agency (the WDA).
11
12
13
14
15
16
17
18
19
20
21

22 In its physical manifestation, Technium is a set of high-quality buildings
23 providing homes for small business units – which may be small firms or devolved units
24 of larger firms. By the end of 2006, there will be seven of these in south west Wales
25 (eight if a satellite building is counted separately) (see Fig.1). Elsewhere, there are three
26 completed and two at an early stage of planning. The seven in the south west are
27 managed as partnerships between Swansea University and the WDA. Of the three others,
28 one is managed as a partnership between the WDA and the University of Wales
29 Aberystwyth and the others (at Bangor and St Asaph in north Wales) by private agencies
30 on behalf of the WDA. Whilst the entry criteria are meant to be the same for all
31 Techniums, the active and close involvement of Swansea University in the south west
32 group and their incorporation in broader systemic developments, sets these seven apart.
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48 They will be the focus of the remaining discussion.
49
50

51 [Figure 1 about here]
52
53
54
55
56
57
58
59
60

1
2
3
4 The idea of the project was to build on the WDA's existing CETIC initiative
5
6 (Centres of Excellence for Technology and Industrial Collaboration) which arose out of
7
8 the RTP and which aims to link businesses with the leading science and technology
9
10 research groups in Welsh universities. The Swansea-based CETICs, which would
11
12 provide the initial research links for the Techniums, were: power electronics design,
13
14 computation and simulation, communications and software technology, materials
15
16 engineering, and complex fluids processing. Firms wishing to enter the programme had
17
18 (and still have) to satisfy basic criteria. Apart from demonstrating commercial potential
19
20 and managerial capability, applicants are required to be: operating in a high-technology
21
22 or knowledge-based sector; exploiting intellectual property, either their own or via
23
24 licensing; engaged in R&D; and have or wish to develop links to university researchers.
25
26 The latter are facilitated by but not limited to the CETICs. Costs of setting up
27
28 collaborative links with the University can be partially defrayed through grants from the
29
30 Swansea Bay Partnership (of local authorities). Help and advice in respect of intellectual
31
32 property is facilitated by IP Wales, and Technium firms appear to be among the most
33
34 active in exploiting this resource.
35
36
37
38
39
40

41 The first Technium (now known as Technium 1 – abbreviated here as T-1) was
42
43 built on a brownfield site in Swansea's dockland and opened in 2001. (Swansea's docks
44
45 have seen better days and a vast area of land has become available for a 'waterfront'
46
47 redevelopment. As we shall explain below, Technium has been instrumental in bringing
48
49 forward this programme of urban renewal.) Because of pent-up demand, the 14 units
50
51 filled up quickly and the pressing need then was to get firms out rather than in. The
52
53 objective has been an initial incubation stage of two-three years for university spin-outs
54
55
56
57
58
59
60

1
2
3 and other start-ups. Whilst this is essential to maintain a constant flow through the
4
5 system, it was recognised that young firms would still need support through their next
6
7 growth stage. This led to a 'grow-on' Technium (T-2) adjacent to the first.
8
9

10 While T-1 provided firms with academic support and opportunities, and general
11
12 business support and advice from the WDA, T-2 additionally attracted involvement from
13
14 private sector business-support firms Morgan Cole (solicitors), PriceWaterhouseCoopers
15
16 (accountants) and Urquart-Dykes & Lord (patent attorneys), and the first of these set up
17
18 new offices close to the Techniums. T-2 opened in mid-2005 and its occupants have
19
20 collectively funded their own private grow-on space next door. There are thus the
21
22 beginnings of a mixed public-private knowledge-based cluster at this waterfront location.
23
24
25

26 Techniums 1 and 2 are also host to the International Business Incubator which is
27
28 designed to encourage spin-in firms from foreign universities seeking links with Swansea
29
30 University departments. A partnership arrangement with Fudan University in Shanghai
31
32 has brought in two firms, one seeking nanotechnology collaboration and the other co-
33
34 operation in the field of telecommunications and medical devices.
35
36
37

38 The first two Techniums were not intended to have any particular sectoral or
39
40 technological emphasis, but subsequent facilities have been designed with particular
41
42 sectors or technologies in mind and have a wider geographical spread (see Fig. 1 and
43
44 Table 1). First was T-Digital, located on the University campus with a satellite at Sony's
45
46 Pencoed operation. Firms at the latter can make use of Sony's R&D laboratories and
47
48 manufacturing and conference facilities. This enables Sony to spread overheads and use
49
50 up excess space. Apart from Sony, T-Digital has received co-funding from Agilent
51
52 Technologies and it will, in future, provide a destination for spin-outs from the new IAT.
53
54
55
56
57
58
59
60

1
2
3 T-Digital builds on the existing local cluster in the electronics sector. Next comes T-ST
4
5 (sustainable technologies) at Baglan Energy Park, initially in partnership with Neath-Port
6
7 Talbot unitary authority, BP and General Electric, later to be joined by 3M which is
8
9 looking to replicate the Sony model at its Swansea plant. Part of the justification for this
10
11 particular sectoral emphasis is to support the WAG's statutory commitment to pursue
12
13 sustainable development.
14
15

16
17 [Table 1 about here]
18
19

20 Further along the pipeline are T-PE (performance engineering) at Llanelli, which
21
22 aims to reinforce the automotive parts cluster, and Technium Pembrokeshire (T-Pembs)
23
24 at Pembroke Dock. Both of these involve partnerships with the local authorities and with
25
26 IBM and (along with T-Digital) will have direct access to IBM's product life-cycle
27
28 management (PLM) software.⁶ T-Pembs will be focused on energy technologies, taking
29
30 advantage of its location on Milford Haven with its existing oil terminals and refineries,
31
32 and two LNG terminals and associated power plants presently under construction. The
33
34 south Wales coast, with its high tidal range, is also an ideal location for the development
35
36 and testing of wave and tidal power generators. There also appears to be potential here
37
38 for a link-up with Institute of Grassland and Environmental Research (IGER) to
39
40 commercialise new technologies for developing bio-fuels. The remaining sub-regional
41
42 Technium has had a chequered history. T-LS (life sciences) was conceived as a
43
44 'BioTechnium' at the National Botanical Gardens of Wales, a Millennium Fund project
45
46 that subsequently got into financial difficulties. As a result the Technium was put on
47
48 hold. Now that the Gardens have been put on a sound financial footing, the Technium is
49
50 apparently back on the agenda.⁷
51
52
53
54
55
56
57
58
59
60

1
2
3
4 The intention of the sectoral and technological configuration of the later
5
6 Techniums is to combine the advantages of spatial clustering (within a spatially defined
7
8 IS) with the desire among practitioners to form and exploit their own discipline-based
9
10 networks (DE BERNADY, 1999). Collective learning is facilitated by proximity, but
11
12 proximity can be defined in technical and commercial as well as geographical terms. In
13
14 this way embryonic sectoral and technological ISs are woven into the fabric of the
15
16 territorial IS.
17
18

19
20 T-1 remains the hub of the Technium network, housing the IT infrastructure that
21
22 connects to the University and, from there into the UK HEI 'SuperJanet' network.
23
24 However, each individual facility also has on-site business support. All Technium
25
26 tenants will be able to use PLM software (though not all with on-site access). Fig. 2 is a
27
28 schematic representation of the broader system of which Technium is part. The key
29
30 players are the University, the WDA, the local authorities and private companies.
31
32

33
34 [Figure 2 about here]
35

36
37 The Technium philosophy is that new firms should be able to stand on their own
38
39 feet after two-three years of intensive incubation support. During that time they not only
40
41 have favourable access to knowledge and technology networks and business support, but
42
43 they also have the opportunity of sharing information with each other and thus
44
45 establishing informal networks that can continue when they move on. It is too early to
46
47 assess the extent to which such self-supporting behaviour has developed, but the fact that
48
49 T-2 tenants are co-funding their own grow-on space is a positive sign. Even when they
50
51 have left, these firms (and any others that satisfy the criteria) have the opportunity to be
52
53
54
55
56
57
58
59
60

1
2
3 Technium associates: an annual subscription allowing access to the Technium virtual
4
5 network.
6
7
8
9

10 11 12 COSTS AND BENEFITS 13

14
15
16
17 Raising the capital costs of these developments has been facilitated by the operation of
18 EU Structural Funds. To access these funds, project proposers have had to generate £-
19 for-£ match funding. This has come from University overheads and staff time, land
20 (from the WDA, local authorities and the University) and public-sector grants. Over a
21 quarter of the funding has come from the private sector. For the first six Techniums (1, 2,
22 Digital, PE, ST and Pembs), the public/private capital/revenue breakdown is shown in
23 Table 2. The long-term sustainability of the project depends on rental incomes, service
24 charges and associate membership subscriptions. The rentals are levied at commercial
25 rates, commensurate with the quality of the buildings, and will sustain the project (i.e.,
26 pay for maintenance and depreciation) provided that the occupancy rates are adequate.
27
28
29
30
31
32
33
34
35
36
37
38
39

40 [Table 2 about here]
41
42

43 Success in maintaining high occupancy is therefore critical to long-term viability.
44 This has been seized on by COOKE and CLIFTON (2005) who, citing the view of
45 JONES-EVANS (2002) that the research base in Wales cannot support the planned
46 number of incubator spaces (based on average European rates of university spin out),
47 describe the project as ‘overambitious’. Several observations are relevant here. The first
48 is that COOKE and CLIFTON quote figures for the number of Techniums (20), the
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 number of incubator spaces (400) and the project cost (£260 million) which bear little
4
5 resemblance to reality. It is true that they are considering the whole of Wales rather than
6
7 just south west Wales; but even in the all-Wales context each of these figures should be
8
9 halved to approximate the actual state of affairs. (The two additional Techniums planned
10
11 for the Cardiff area, using private funds, will still bring the total only as far as twelve.)
12
13 For the Swansea-based Techniums, the respective figures are: eight; 121; and £52
14
15 million, of which £39 million is public. The second is that, within south west Wales, as
16
17 we have noted, the research base will have almost tripled by the time that the project has
18
19 reached maturity. The third is that Technium aims to encourage spin-ins as well as spin-
20
21 outs. The fourth is that Welsh universities as a whole have a spin-out record that exceeds
22
23 the UK average: in 2001/02 Wales accounted for 10 per cent of UK HEI spin-outs, twice
24
25 its per capita share (HEFCE, 2003). And the final point is that the new Swansea on-
26
27 campus developments, the ILS and IAT, are focused on those areas of S&T which are
28
29 particularly productive of spin-out ventures.⁸
30
31
32
33
34
35

36 One explanation for COOKE and CLIFTON's scepticism is their apparent belief,
37
38 echoed by some media commentators,⁹ that the Techniums represent a return to what they
39
40 call the WDA's 'field of dreams' approach of building facilities (formerly advanced
41
42 factories) in the hope that someone will occupy them. Elsewhere, COOKE (2004) claims
43
44 explicitly that 'true to WDA traditions, they are properties for leasing space [and] thus
45
46 they are not in themselves innovative.' The implication here is that the entry criteria for
47
48 SMEs is some sort of fig-leaf. Given the dangers of locked-in behaviour by entrenched
49
50 interests (in this case the WDA), this is an understandable concern. The transformation
51
52 of Technium facilities into mere commercial office space is at greatest risk where
53
54
55
56
57
58
59
60

1
2
3 effective control is vested in a single agency and the physical assets have potential value
4
5 apart from their role in promoting innovation. In the case of the Swansea Techniums,
6
7 management is shared with the University whose only conceivable interest in the
8
9 buildings is as means of strengthening the two-way relationship between business and
10
11 academic research and graduate skills. The University has a strong interest in
12
13 maintaining the initial philosophy and would undoubtedly suffer were the buildings to
14
15 become mere property assets within a WDA/WAG portfolio.
16
17
18
19

20 COOKE and CLIFTON's final criticism, that Technium has failed to provide
21
22 adequate managerial assistance relating to finance, legal matters and accountancy, is also
23
24 unsubstantiated. All Technium SMEs have direct access to WDA support services,
25
26 support on intellectual property from IP Wales, and access to product life-cycle software,
27
28 and they can apply for financial backing via the WDA's Smart Cymru programme.
29
30 There is also the direct involvement by private-sector service suppliers already noted.
31
32
33

34 What if Technium were to fail? What would be the impact on public funds? It
35
36 can be seen from Table 2 that public-sector capital and revenue expenditure has been
37
38 £38.9 million. Of this, half has come from EU structural funds. A proper evaluation of
39
40 the project would require comparison with other projects which competed for equivalent
41
42 funds but failed to get them. If Technium was not at the expense of any demonstrably
43
44 superior project, it cannot be said (from the perspective of WAG) that these funds were
45
46 poorly invested. Unfortunately, we do not have information on which to make that
47
48 judgement. The remaining public contribution, in the form of university overheads and
49
50 development land, arguably also has an opportunity cost below its nominal value
51
52 (overheads, in principle, having zero marginal cost). Even if these considerations are
53
54
55
56
57
58
59
60

1
2
3 dismissed, a failed project will leave behind capital assets of considerable value. The
4
5 precise value of the residual capital assets will, of course, depend on prevailing
6
7 conditions in the commercial property market.
8
9

10 High-quality commercial property is at a premium in Swansea according to a
11
12 report of the property advisers, Lambert Smith Hampton, *Turning the Corner*, reported in
13
14 the *Western Mail*, 8 June, 2005. According to the newspaper, the Swansea waterfront re-
15
16 development 'has attracted a great deal of private sector interest following public sector
17
18 investment'. The public-sector investment referred to here is T-1 and T-2. It appears that
19
20 these Technium projects have created the conditions for a healthy commercial property
21
22 market, from which they will benefit themselves. Of course, it remains to be seen
23
24 whether something similar will happen to the other off-campus buildings. In the absence
25
26 of any clear knowledge of the residual capital values, it seems sensible to use building
27
28 cost as a proxy. Assuming the public-sector share of the residual capital is equal to its
29
30 share of the capital cost, then that implies subtracting £32.3 million from the total public
31
32 investment to yield an estimate of public sunk cost, i.e., the £6.6 million public revenue
33
34 expenditure.
35
36
37
38
39

40 The public investment has, in turn, helped lever £13.1 million from the private
41
42 sector. Of course the systemic costs, involving the ILS and the IAT are greater. But
43
44 although these are important constituents of the system architecture, they are
45
46 independently conceived on the basis of their own projected internal returns. The system
47
48 is more than the sum of its parts and the system returns, mostly in the form of dynamic
49
50 externalities over a long period, will be greater than the returns to any one component.
51
52 Thus, even assuming that the public contribution to Technium has an opportunity cost
53
54
55
56
57
58
59
60

1
2
3 equal to its nominal value, the modest sunk costs of £6.6 million are buying a critical
4
5
6 piece of a large jigsaw.

7
8 This may be a relatively small sum to risk on a project that could transform the
9
10 local economy, but are there any signs that Technium will actually succeed? Any
11
12 evaluation is necessarily provisional since the programme is still being rolled out. The
13
14 established facilities, at the time of writing T-1, T-2, T-Digital and T-Digital at Sony, are
15
16 77 per cent occupied and are host to around 300 jobs, nearly all graduates; see Table 1.¹⁰
17
18 (A degree of spare capacity is actually desirable to accommodate the turnover of
19
20 occupants.) T-SS was the latest to open and is presently home to two tenants; the
21
22 projection is for full occupancy over three years. In one respect, perhaps not anticipated,
23
24 the project has already had a visible impact - on the Swansea waterfront redevelopment.
25
26 This was scheduled to occur anyway, but there seems little doubt that the Technium
27
28 developments have been instrumental in bringing the scheme forward by several years.
29
30
31
32
33

34 The waterfront example illustrates the fact that the benefits of a system
35
36 component accrue to the whole system and are, therefore, to a substantial extent external
37
38 to the component itself. An evaluation of Technium benefits based solely on jobs
39
40 created, or of value added by businesses located there, or by the value of Technium
41
42 assets, will inevitably miss a large part of the gains to the local economy. These will take
43
44 the form of network externalities that will reach into the economy once firms graduate
45
46 from the project, knowledge spillovers operating within supply chains of which
47
48 Technium firms are part, higher land values, and the multiplier effects associated with
49
50 greater local value added. It was noted earlier that low Welsh GDP is at least partly a
51
52 consequence of an employment structure skewed towards low-paid jobs, and this has
53
54
55
56
57
58
59
60

1
2
3 been reinforced by a tendency for locally-produced graduates to seek opportunities
4 elsewhere. Technium has the potential to host 700 jobs in south west Wales and for these
5 numbers to cumulate throughout the economy over time as firms churn through the
6 system.
7
8
9
10
11
12

13 14 15 16 A SUB-REGIONAL INNOVATION SYSTEM? 17 18 19

20 Just as a regional IS shares many of the features of its parent national IS, so the emerging
21 sub-regional system in south west Wales is still substantially embedded within the Welsh
22 system. The developments described above were, however, stimulated and facilitated by
23 characteristics which, though not necessarily unique individually, collectively help to
24 shape the emerging local system. First, the structural weaknesses of the economy and
25 relative deprivation call for a more overtly interventionist approach (if only in terms of
26 funding), as compared to more dynamic and self-sufficient metropolitan regions
27 (including, in this purely relative sense, south east Wales). Second, is the actual fact of
28 opportunities arising from west Wales' eligibility for the highest level of EU Structural
29 funds over a prolonged period. Third, are the particular industrial strengths of the sub-
30 region in performance engineering, electronics and energy. Fourth are the particular
31 strengths of the University in engineering, computing and, increasingly, life sciences.
32 Fifth is the overall weakness of the pre-existing research base, both within but more
33 especially outside the university. And finally, there is the spatial organization of
34 governance, allowing key agencies such as the WDA/WAG an element of local
35 distinctiveness in approach.
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 In some European regions it is possible to identify indigenous and deeply
5
6 embedded dominant firms as focal points of the innovation milieu: Nokia in Finland
7
8 (SCHIENSTOCK, KAUTONEN and KOSKI, 2004) and Siemens in Bavaria
9
10 (STERNBERG and TAMÁSY, 1999) are examples. The only comparable example in
11
12 south west Wales was the steel industry but that is no longer the case. The weakness of
13
14 the non-HEI research capacity has thus led naturally to a focus on the local university as
15
16 the only institution which could effectively develop adequate research mass. This might
17
18 appear unexceptional in dynamic areas with strong research universities but it is far from
19
20 universal. Renewing the autonomous regions of Spain, for example, has occurred
21
22 despite, rather than because of, the presence of universities. INTXAURBURU and
23
24 OLASKOAGA (1999) note that after 15 years of Basque technology policy, 'the
25
26 university's contribution to the innovation system is much less than was desired'.
27
28 According to BACARIA, BORRAS ALOMAR and FERNANDEZ-RIBAS (2004),
29
30 Spanish universities generally have traditionally been teaching-oriented and, even though
31
32 this has changed radically in recent years, those in Catalonia have successfully resisted
33
34 developing links with industry. As a result, public innovation in these regions is
35
36 generated largely by government-financed technology centres. This has not proved so
37
38 necessary in south Wales largely because of the close historical relationship between
39
40 university engineering departments and the local metalliferous and engineering
41
42 industries. Although these industries have waned, the culture of industry links
43
44 (manifested in collaboration, sponsorship and graduate recruitment) has remained strong.
45
46
47
48
49
50
51
52

53 Despite its links to industry, Swansea's historic status bears no comparison with
54
55 the leading European universities like Oxford and Cambridge. In such places, the mutual
56
57
58
59
60

1
2
3 gains between commerce and the university are readily facilitated by 'thick' local
4 linkages without the need of public funding of systemic developments (LAWTON
5
6 SMITH *et al.*, 2001). What is unusual about the Swansea-based Techniums is that the
7
8 Triple Helix interweaving of government, business and higher education
9
10 (LEYDESDORFF and ETZKOWITZ, 1998) is strongly formalised within a single
11
12 programme via its joint management arrangements.
13
14
15
16
17
18
19

20 SUMMARY AND CONCLUSIONS

21
22
23
24
25 Where does Technium stand in relation to the checklist of desirable characteristics
26
27 for successful collective learning that were noted earlier? It is, quite obviously, an
28
29 attempt to create local knowledge networks focusing on and exploiting a range of
30
31 university disciplines. In terms of the focus of innovative activities, there is a balance to
32
33 be struck between the respective advantages of specialisation and diversity; between the
34
35 benefits of strong clusters and the dangers of industrial lock-in. Some Techniums build
36
37 on existing industrial strengths (automotive parts), others, like life sciences,
38
39 telecommunications and sustainable technologies look to exploit new opportunities. The
40
41 system design incorporates the idea of inter-technology and inter-sectoral networks; and
42
43 it positively encourages large corporations to externalise part of the R&D functions either
44
45 to University spin-outs or directly into the University departments. It also builds in other
46
47 types of external linkage (to overseas universities and SMEs) via the International
48
49 Business Incubator facilities. The last points on the check-list concern the avoidance of
50
51 entrenched attitudes and top-down modes of intervention. If the south west Wales
52
53
54
55
56
57
58
59
60

1
2
3 Technium project is fully to realise its potential it will need to maintain a degree of
4
5 independence from agents that have their own agendas.
6
7

8 Only in respect of one characteristic is there a reversal of perceived need. This
9
10 illustrates the point that what applies to dynamic labour-shortage regions need not be
11
12 valid for peripheral and old industrial regions. For south west Wales, the aim (at this
13
14 stage) is not so much to produce graduates to support the local labour market as to create
15
16 greater opportunities for graduates to work locally. At the highest levels of educational
17
18 attainment, it is the demand for skills that is weak, rather than the supply, with the result
19
20 graduates leave the area to look for opportunities elsewhere. Retention of graduates is
21
22 itself one of the necessary steps to creating a robust innovative milieu.
23
24
25
26

27 Many of the case studies in the literature deal with dynamic regions focused on
28
29 equally successful universities. It is, relatively speaking, easier to emulate best practice
30
31 when one is already close to the frontier and has solid foundations to build on. A much
32
33 greater challenge is to build a successful innovation system in a region with long-
34
35 standing structural weaknesses, focused on a modest-size university with a limited
36
37 number of research strengths. The first prescription is to broaden the research base at the
38
39 same time as the commercial interactions are developed. Poor regions need outside help
40
41 to do this, and it would be difficult to imagine the Technium-ILS-IAT package happening
42
43 (to the extent that it has) without either EU Structural Funds or committed support from
44
45 central government. The second design requirement is to mix SME spin-outs with MNE
46
47 spin-ins and to facilitate interaction between the two. The third is to use funding streams
48
49 to provide complementary 'soft' support such as advice on intellectual property. The
50
51
52
53
54
55
56
57
58
59
60

1
2
3 last, and potentially most important, is to give universities some control over the way the
4
5 programme evolves.
6
7

8 This model is neither necessary nor applicable to all regions but it may repay
9
10 study by those EU regions, particularly in the new members states, which have similar
11
12 structural legacies to south west Wales, have in place existing but under-performing
13
14 universities, and have, or will have, access to EU Structural funds.
15
16
17
18
19
20
21

22 Acknowledgements – We are grateful to Professor Marc Clement of Swansea
23
24 University’s Innovation Office and to the Technium Managers Mike Day and Richard
25
26 Harris for providing information. The paper has benefited from the comments of our
27
28 colleagues Andrew Beale and Iwan Davies and the extensive suggestions of an
29
30 anonymous referee.
31
32
33
34
35
36
37
38
39

40 NOTES

- 41
42
43 1 Despite this change, we avoid confusion by continuing to refer to this department
44
45 as the WDA. Its successor title, the Department for Enterprise, Innovation and
46
47 Networks, does, at least, signal a new intent in relation to the direction of
48
49 economic strategy.
50
51
52 2 PHELPS et al. (2003), however, have shown that multinationals in Wales do
53
54 undertake a considerable amount of local-market development activity.
55
56
57
58
59
60

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- 3 An analysis of the patent stocks of production firms by MOORE and MAINWARING (2006) shows that compared to Ireland, Scotland and South West England, more firms in Wales are single-patent firms. This suggests, for these firms, either the inability or the inadvisability of building on the initial invention through downstream R&D.
- 4 For present purposes, south west Wales may be thought of as the combined unitary authorities of Pembrokeshire, Carmarthenshire, Swansea, Neath-Port Talbot, and Bridgend, and has a population of 775,000.
- 5 It was actually conceived by Marc Clement, then professor of Engineering at Swansea Institute of Higher Education (SIHE). Both he and the project transferred soon after to the nearby university. SIHE remains a partner in Techniums 1 and 2 (see below).
- 6 New EU regulations require companies to meet stringent targets concerning the recycling of materials incorporated in their products. For manufacturers of complex products, the product life-cycle is a major logistical consideration. IBM has seconded one of its staff to teach PLM to Masters students at the University's Engineering School. This is an example of how Technium has helped reinforce more direct university-business interactions.
- 7 This was reported in the *Western Mail* in December 2005. We have not been able to incorporate funding details here. There was also a private-sector proposal for a Media Technium at Gelli Aur in Carmarthenshire. This attracted WDA interest and Objective 1 funds were allocated to it, but the proposal fell through. According to a *Western Mail* report of July 2, 2003, some £434,000 remained

1
2
3 owed to the WDA.
4

5
6 8 COOKE and CLIFTON's claim (2005, pp.443-44) that 'the Californian flagship
7
8 technology firm Agilent in Swansea's Technium folded in 2002' is simply untrue.
9
10 Agilent remains a major University partner and is investing a further £4m. in its
11
12 Laboratory in the IAT.
13

14
15 9 For example, Owain Llywelyn, 'Incubating pros and cons', *Western Mail*, 1 June,
16
17 2005.
18

19
20 10 The Best Science Incubator Award 2005, run by the Centre for Strategy and
21
22 Evaluation Services, assessed 29 schemes (including some established in the
23
24 1980s) from 17 countries. Technium Swansea (i.e., T-1 and T-2) was one of five
25
26 schemes from the UK. Technium was ranked fourth for return on investment,
27
28 fifth for growth and unplaced (i.e., not in the top ten) for sustainability. None of
29
30 the other UK schemes was placed (in the top ten) in any of the categories.
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

REFERENCES

- AMIN A. and THRIFT N. (1995) Globalization, 'institutional thickness' and the local economy, in HEALEY P., CAMERON S., DAVOUDI S., GRAHAM, S. and MADANI-POUR, A. (Eds.) *Managing Cities: The New Urban Context*. John Wiley, Chichester.
- BACARIA J., BORRAS ALOMAR S. and FERNANDEZ-RIBAS A. (2004) The changing institutional structure and performance of the Catalan innovation system, in COOKE P., HEIDENREICH M. and BRACZYK H.-J., (Eds.) *Regional Innovation Systems*. Routledge, London.
- BAPTISTA R. and SWANN P. (1998) Do firms in clusters innovate more? *Research Policy* 27, 525 -40.
- BEALE A. and MAINWARING L. (2006) University patenting in Wales, Scotland and Northern Ireland: a comparative analysis, *mimeo*, School of Law, Swansea University.
- BISHOP P. and WISEMAN N. (1999) The North-South divide in the UK defence sector, *Regional Studies* 33 (9), 829 – 41.
- CAMAGNI R. (1991) Local 'milieu', uncertainty and innovation networks: towards a new dynamic theory of economic space, in CAMAGNI R. (Ed.) *Innovation*

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- Networks: Spatial Perspectives.* Belhaven Press, London.
- CANTWELL J. (1995) The globalization of technology: what remains of the product cycle model? *Cambridge Journal of Economics* 19, 155 – 74.
- CARLSSON B. (1994) Technological systems and economic performance, in DODGSON M. and ROTHWELL R. (Eds.) *The Handbook of Industrial Innovation.* Edward Elgar, Aldershot.
- CARLSSON B. (1995) *Technological Systems and Economic Performance: The Case of Factory Automation,* Kluwer, Dordrecht.
- CARLSSON B. (2006) Internationalisation of innovation systems: a survey of the Literature, *Research Policy* 35 (1), 56 – 67.
- COOKE P. (1992) Regional innovation systems: competitive regulation in the new Europe, *Geoforum* 23 (3), 365 – 82.
- COOKE P. (2004) The regional innovation system in Wales: evolution or eclipse? in COOKE P., HEIDENREICH M. and BRACZYK H.-J., (Eds.) *Regional Innovation Systems.* Routledge, London.
- COOKE P. and CLIFTON, N. (2005) Visionary, precautionary and constrained ‘varieties of devolution’ in the economic governance of the devolved UK territories, *Regional Studies* 39 (4), 437 – 51.
- DE BERNADY M. (1999) Reactive and proactive local territory: co-operation and community in Grenoble, *Regional Studies* 33 (4), 343 – 52.
- FREEMAN C. (1987) *Technology Policy and Economic Performance: Lessons from Japan,* Pinter, London.
- FREEMAN C. (1995) The national system of innovation in historical perspective,

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- Cambridge Journal of Economics* 19 (1), 5 – 24.
- GOODWIN M., JONES M. and JONES R. (2005) Devolution, constitutional change and economic development: explaining and understanding the new institutional geography of the British state, *Regional Studies* 39 (4), 421 – 36.
- GRABHER G. (1993) The weakness of strong ties: the lock-in of regional development in the Ruhr area, in GRABHER G. (Ed.) *The Embedded Firm: On the Socioeconomics of Industrial Networks*. T.J. Press, London.
- HEFCE (2003) *Higher Education-Business Interaction Survey, 2001 – 02*, Higher Education Funding Council for England, London.
- HENDERSON, D. (2000) EU regional innovation strategies: regional experimentation in practice? *European Urban and Regional Studies* 7 (4), 347 – 58.
- HUDSON R. (1994) Institutional change, cultural transformation, and economic regeneration: myths and realities from Europe's old industrial areas, in AMIN A. and THRIFT N. (Eds.) *Globalization, Institutions and Regional Development in Europe*. Oxford University Press, Oxford.
- HUDSON R., DUNFORD M., HAMILTON D. and KOTTER R. (1997) Developing regional strategies for economic success: lessons from Europe's economically successful regions, *European Urban and Regional Studies* 4 (4), 365 – 73.
- INTXAURBURU G. and OLASKOAGA J. (1999) The evolving role of the university in Basque technology policy: a system of innovation analysis, *European Planning Studies* 7 (6), 59 – 74.
- JONES-EVANS D. (2002) *Research and Development in Wales*. Report to the Economic Development Committee, National Assembly for Wales, Cardiff.

- 1
2
3 KEEBLE D. and WILKINSON F. (1999) Collective learning and knowledge
4
5 Development in the evolution of regional clusters of high-technology SMEs in
6
7 Europe, *Regional Studies* 33 (4), 295 – 304.
8
9
- 10 LAWTON SMITH H., KEEBLE D., LAWSON C., MOORE B. and WILKINSON F.
11
12 (2001) University-business interaction in the Oxford and Cambridge regions,
13
14 *Tijdschrift voor Economische en Sociale Geografie* 92 (1), 88 – 99.
15
16
- 17 LEYDESDORFF L. and ETZKOWITZ H. (1998) The Triple Helix as a model for
18
19 innovation studies, *Science and Public Policy* 25 (3), 195 – 203.
20
21
- 22 LUNDVALL B.-Å. (1992) *National Systems of Innovation: Towards a Theory of*
23
24 *Innovation and Interactive Learning*, Pinter, London.
25
26
- 27 MAINWARING L. (1995) Catching up and falling behind: South East Asia and Wales,
28
29 *Contemporary Wales* 8, 9 – 28.
30
31
- 32 MALERBA F. (2002) Sectoral systems of innovation and production, *Research Policy*
33
34 31, 247 - 64.
35
36
- 37 MASKELL P and MALMBERG A. (1999) Localised learning and industrial
38
39 competitiveness, *Cambridge Journal of Economics* 23, 167 – 85.
40
41
- 42 MOORE N. and MAINWARING L. (2006) Intellectual property in the Welsh
43
44 production sector, *Contemporary Wales*, 19, 256 - 74.
45
46
- 47 MORGAN K. (1997) The learning region: institutions, innovation and regional renewal,
48
49 *Regional Studies* 31 (5), 491 – 513.
50
51
- 52 MORGAN K. (2004) The exaggerated death of geography: learning, proximity and
53
54 territorial innovation systems, *Journal of Economic Geography* 4, 3 – 21.
55
56
- 57 MORGAN K. and NAUWELAERS C. (2002) A regional perspective on innovation, in
58
59
60

- 1
2
3 MORGAN K. and NAUWELAERS C. (Eds.) *Regional Innovation Strategies: the*
4 *Challenge for Less-Favoured Regions*. Regional Studies Association, London.
5
6
7
8 NAUWELAERS C. and MORGAN K. (1999) The new wave of innovation-oriented
9 strategies: retrospect and prospects, in MORGAN K. and NAUWELAERS C.
10 (Eds.) *Regional Innovation Strategies: the Challenge for Less-Favoured Regions*.
11 Regional Studies Association, London.
12
13
14
15
16
17 NAUWELAERS C. and WINTJES R. (2003) Towards a new paradigm for innovation
18 policy? in ASHEIM B., ISAKSEN A., NAUWELAERS C. and TODTLING F.
19 (Eds.) *Regional Innovation Policy for Small-Medium Enterprises*. Edward Elgar,
20 Cheltenham.
21
22
23
24
25
26
27 NAW (2002) *A Wining Wales*, National Assembly for Wales, Cardiff.
28
29 NAW (2004) *Wales Spatial Plan*, National Assembly for Wales, Cardiff.
30
31 NAW (2005) *Wales – a Vibrant Economy*, National Assembly for Wales, Cardiff.
32
33
34 NELSON R.R. (1993) *National Systems of Innovation: A Comparative Study*, Oxford
35 University Press, Oxford.
36
37
38
39 PHELPS N.A., MacKINNON D., STONE I. and BRAIDFORD P. (2003) Embedding the
40 multinationals? Institutions and the development of overseas manufacturing
41 affiliates in Wales and North East England, *Regional Studies* 37, 27 – 40.
42
43
44
45
46 PORTER M. (1990) *The Competitive Advantage of Nations*, Free Press, New York.
47
48 REES G. and MORGAN K. (1991) Industrial restructuring, innovation systems and the
49 regional state: south Wales in the 1990s, in DAY G. and REES G. (Eds.) *Regions,*
50 *Nations and European Integration: Remaking the Celtic Periphery*. University of
51 Wales Press, Cardiff.
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- SCHIENSTOCK G., KAUTONEN M. and KOSKI P. (2004) Escaping path dependency:
The case of Tampere, Finland, in COOKE P., HEIDENREICH M. and
BRACZYK H.-J., (Eds.) *Regional Innovation Systems*. Routledge, London.
- STERNBERG R. and TAMÁSY C. (1999) Munich as Germany's no. 1 high technology
region: empirical evidence, theoretical explanations and the role of small
firm/large firm relationships, *Regional Studies* 33 (4), 367 – 77.
- STORPER M. (1995) The resurgence of regional economics, ten years later: the region as
a nexus of untraded interdependencies, *European Urban and Regional Studies* 2,
191 – 221.
- TODTLING F. and TRIPPL M. (2005) One size fits all? Towards a differentiated
regional innovation approach, *Research Policy* 34 (8), 1203-19.
- WAC (1998) *Investment in Industry in Wales*, Welsh Affairs Committee Fourth
Report, Session 1997-98: HC 821. House of Commons, London.

Table 1. Swansea-based Technium Characteristics

| Technium | Opened (Projected) | Sq. m | Spaces | Occupancy (at 01/06) | Jobs realised/ (predicted) |
|------------------------------|-----------------------|--------|--------|-------------------------|-------------------------------|
| T -1 | 04/01 | 2,000 | 14 | 12 | c. 300 |
| T -2 | 05/04 | 3,639 | 13 | 10 | |
| T-Digital | 07/04 | 1,200 | 12 | 12 | |
| T-Dig. @Sony | 07/04 | 800 | 8 | 2 | |
| T-Sust. Techs. | 11/05 | 3,397 | 32 | 2 | (c. 309) |
| T-Perf. Engin. | (04/06) | 2,200 | 15 | | |
| T-Pembs. | (09/06) | 814 | 14 | | |
| T-Life Sciences | (?) | 1,600 | 12 | | |
| TOTAL | | 15,650 | 121 | 37 | (c. 609) |

Source: Innovation Office, Swansea University

Table 2. Funding breakdown for Swansea-based Techniums

| | CAPITAL | | | REVENUE | | | TOTAL |
|---|-------------|-------------|-------------|------------|------------|------------|-------------|
| | Total | Public | Private | Total | Public | Private | |
| T-1, T-2, T-Digital, T- Dig. @Sony | 16.6 | 12.8 | 3.8 | 4.2 | 3.1 | 1.1 | 20.8 |
| Projected investment (to 2007): £m. | | | | | | | |
| | CAPITAL | | | REVENUE | | | TOTAL |
| | Total | Public | Private | Total | Public | Private | |
| T-SS, T-PI, T-Pembs | 25.7 | 19.5 | 6.2 | 5.5 | 3.5 | 2.0 | 31.2 |
| TOTAL All | 42.3 | 32.3 | 10.0 | 9.7 | 6.6 | 3.1 | 52.0 |

Source: Innovation Office, Swansea University

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

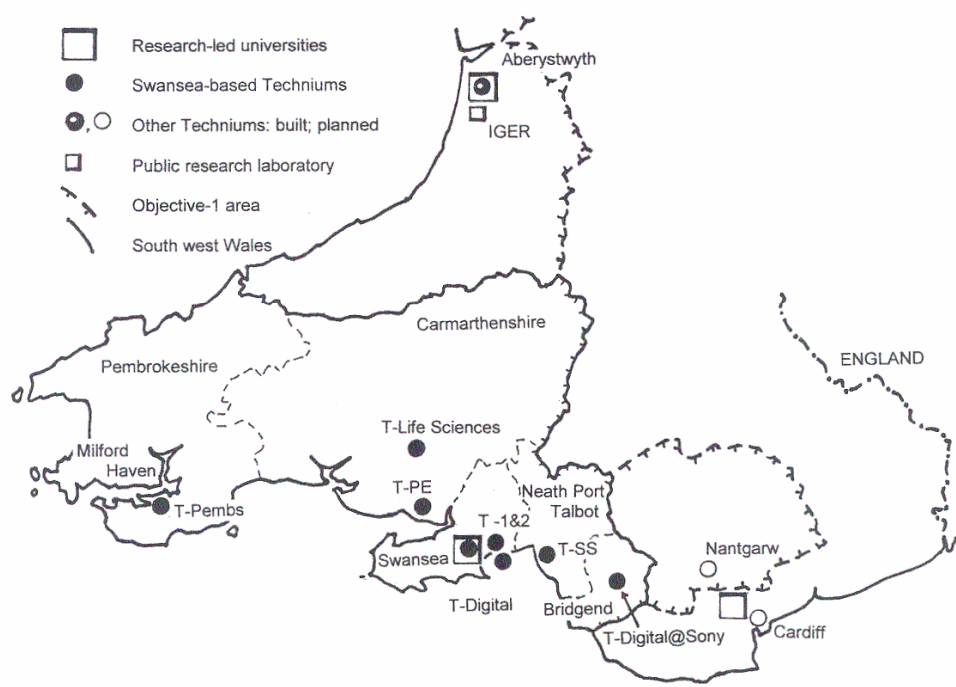


Fig. 1 Techniums and research facilities in south Wales

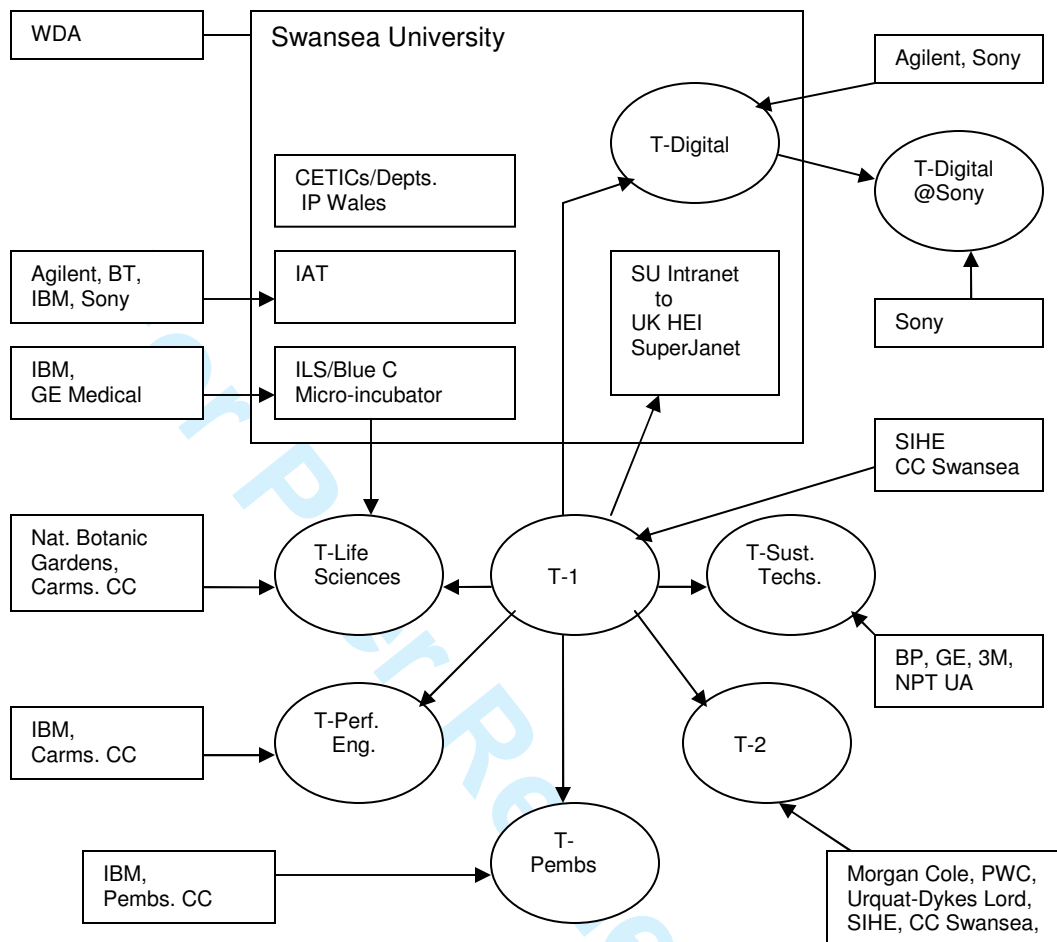


Fig. 2 Technium within the local innovation system

Carms. CC: Carmarthenshire County Council; CC Swansea: City and County of Swansea; Pembs. CC: Pembrokeshire County Council; NPT UA: Neath-PortTalbot Unitary Authority; PWC: PriceWaterhouseCoopers; SIHE: Swansea Institute of Higher Education; Others: see text.