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# Explaining Variations in the Knowledge Economy in Three Small Wealthy Countries

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**ABSTRACT** *At a broad level, it has been shown that different institutional contexts, policy regimes and business systems affect the kinds of activities in which a nation specialises. This paper is concerned with the way in which different national business systems affect the nature of participation of a nation in the knowledge economy. The paper seeks to explain cross-national variations in the knowledge economy in the Australia, Denmark and Sweden with reference to dominant characteristics of the business system. Although Australia, Denmark and Sweden are all small wealthy countries, they each have quite distinctive business systems. Australia has been regarded as a variant of the competitive business system and has generally been described as an entrepreneurial economy with a large small firm population. In contrast Sweden has a coordinated business system that has favoured large industrial firms. The Danish variant of the coordinated model, with its well-developed vocational training system, is distinguishable by its large population of networked small and medium size enterprises. The three countries also differ significantly on two dimensions of participation in the knowledge economy. First, there is cross-national variation in patterns of specialisation in knowledge intensive industries and services. Second, the institutional infrastructure of the knowledge economy (or the existing stock of knowledge and competence in the economy, the potential for generation and diffusion of new knowledge and the capacity for commercialisation of new ideas) differs across the three countries. This paper seeks to explain variations in these two dimensions of the knowledge economy with reference to characteristics of the business system in the three countries.*

## Introduction

Debates on competitiveness have taken a turn in more recent years, focusing increasingly on the concept of innovation and the knowledge economy. The terms the ‘new economy’ and the ‘knowledge economy’ are used broadly to refer to growth in high technology industries, the increasing importance of information and knowledge resources (rather than physical capital) as inputs or factors of production, the growth of knowledge products linked mainly to business services and the increasing importance of information and communications technologies (ICTs) both in terms of the ICT sector’s share of value added, growth and employment and also in terms of its impact on employment and productivity in other industry sectors.<sup>1</sup> The importance of technologies associated with the digitilisation

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of information for economic transformation is a key theme in these approaches.<sup>2</sup> For some, innovation, entrepreneurship and geographical clustering of knowledge firms are also characteristics of the new economy.<sup>3</sup> Underlying most of the discussion of the knowledge economy is a recognition of the growing importance of science and technology and the infrastructure of learning and knowledge creation.<sup>4</sup> As such, the growth of the knowledge economy can be analysed in terms of two key dimensions. First is the changing structure of economic activity and second is the infrastructure of knowledge creation and learning.

Although these widely accepted trends linked to the knowledge economy seem to be impacting on most nations, there appears to be cross-national variation in the way in which countries are participating in the knowledge economy. The business systems/innovation systems literature contributes to an understanding of the way in which different business systems affect innovative capacities in different countries and give rise to contrasting patterns of industry specialisation.<sup>5</sup> The business systems approach therefore provides a basis for explaining variations in the nature of participation in the knowledge economy.

This paper explores the patterns of specialisation in knowledge activities in three small wealthy countries—Australia, Denmark and Sweden—with respect to the two dimensions of the knowledge economy explained above—the changing structure of economic activity and the infrastructure of learning and knowledge creation. The three countries make for an informative comparison given that they are all small wealthy countries, but are participating in the knowledge economy in different ways. As the first section of the paper shows, the countries differ in the kinds of knowledge intensive industries and services in which they specialise. Second, the institutional infrastructure of the knowledge economy (including the existing stock of knowledge and competence in the economy, the potential for generation and diffusion of new knowledge and the capacity for commercialisation of new ideas) varies across the three countries as described in the second section of the paper.

In the final section of the paper, there is an attempt to explain variations in these two dimensions of participation in the knowledge economy with reference to characteristics of the business system in the three countries. The three countries have quite distinctive business systems. Australia has been regarded as a variant of the competitive business system and has generally been described as an entrepreneurial economy with a large small firm population. While Denmark and Sweden might now be regarded as influenced by the EU context, each has a distinctive business system with historical routes. Sweden has a coordinated business system that has favoured large industrial firms. In contrast, the Danish variant of the coordinated model is distinguishable by its large population of networked small and medium size enterprises and well-developed vocational training system. The paper therefore seeks to explain differences in the nature of participation in the knowledge economy in Australia, Denmark and Sweden with respect to these long standing characteristics of their business systems.

### **The Knowledge Economy in Australia, Denmark and Sweden**

The following discussion examines the nature of participation in knowledge intensive sectors in Australia, Denmark and Sweden as defined by three major

trends in the structure of economic activity in OECD countries. First, there has been a shift in the structure of value added and trade amongst OECD countries with the share of low and medium-low technology industries declining and the share of high technology industries increasing. The share of medium-high and high technology industries in international trade increased from 18 to 25% during the 1990s and their share of domestic value added was 9% amongst the OECD countries by the end of the 1990s. The fastest growing sectors in international trade are pharmaceuticals, radio, TV and communications equipment and computers<sup>6</sup>—all of which are defined as high technology industries because of their R&D intensities.<sup>7</sup> Second, there has been a growth in knowledge intensive services activities, such that knowledge-based services now account for around 15% of business value added in the OECD countries.<sup>8</sup> Third, the ICT sector constitutes an increasing component of total economic activity among the OECD countries with its share of value added increasing from around 8 to 9.5% between 1995 and 1999. The ICT sector therefore accounts for almost 10% of business sector value added in the OECD countries and an increasing component of international trade.<sup>9</sup>

The following discussion will examine participation in the knowledge economy in the three countries with reference to the three major trends just described. The first relates to the contribution of medium and high technology manufacturing to value added and trade, the second concerns the component of business activity that falls within the rubric of knowledge intensive services and the third relates to the contribution of ICTs to value added and trade.

#### *Medium and High Technology Industries and Knowledge Intensive Business Services*<sup>10</sup>

Medium and high technology industries, defined with reference to their R&D intensity, are regarded as critical producers of technology intensive products, while service sectors such as finance and insurance services and business services are regarded as major users of knowledge intensive products and are generally regarded as employing a skilled workforce.<sup>11</sup> Table 1 reports the share of value

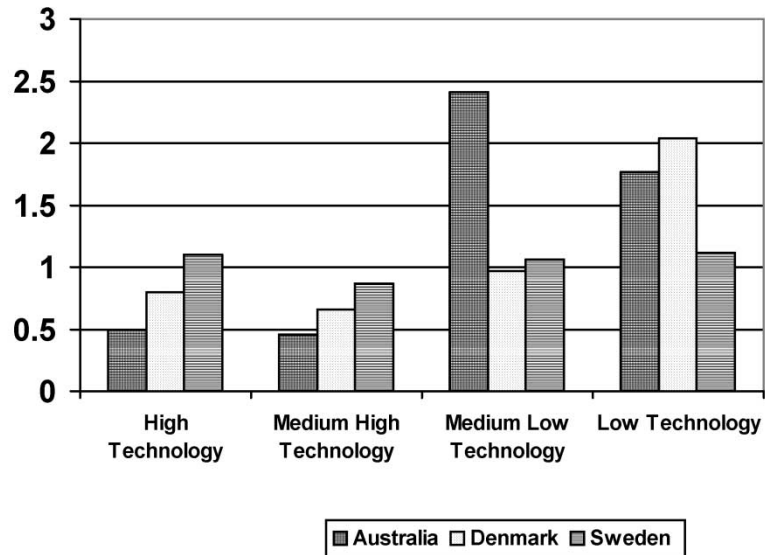
**Table 1.** Knowledge intensive industries and services: share in total business value added, 1999

	AUS	DK	SE	OECD
High and medium high technology	5.7	6.4	<b>10.0</b>	8.8
Post and telecommunications services	<b>3.1</b>	2.4	<b>2.8</b>	2.7
Finance and Insurance services	<b>6.8</b>	5.0	3.5	6.5
Business services	<b>11.3</b>	7.3	8.5	9.0

Source: OECD, *Science, Technology and Industry Scoreboard: Towards a Knowledge Based Economy* (Paris, OECD, 2001b), p. 203.

Notes: Australian figure for business services is derived from national accounts data and is an overestimation. The measure relates to the sector property and business services, which include real estate services, which is excluded from OECD definitions (Australian Bureau of Statistics (ABS), *National Accounts, Cat. No. 5206.0, September 2002* (Canberra, ABS, 2002), p. 67).

Bold figures represent performance above OECD level.



**Figure 1.** Export specialisation, 1999

Source: OECD, *Science, Technology and Industry Scoreboard: Towards a Knowledge Based Economy* (Paris, OECD, 2001), p. 208.

Note: The export specialisation data measure the share of the exports of the particular industrial grouping in the country's total manufacturing exports, divided by the share of total OECD exports of that industrial grouping in total OECD manufacturing exports.

added for each of these sectors in total value added for the three case study countries and the OECD.

In relation to medium and high technology industries, it is Sweden that performs above the OECD, with high and medium technology industries accounting for around 10% of value added. This is almost double the share of the medium and high technology sectors in Australia (at 5.7%) and also higher than the share in Denmark (at 6.4%). Within knowledge intensive sectors, Australia has a greater orientation towards finance and insurance services and business services. On available data, it would seem that Australia performs above the OECD, Danish and Swedish levels both in finance and insurance services and business services.<sup>12</sup> Denmark does not appear to perform above the OECD level on any measure. Both Sweden and Australia perform above the OECD level in postal and telecommunications. The strongest conclusion that can be drawn from this data is that Sweden has an orientation towards high and medium technology manufacturing whereas Australia has an orientation towards knowledge intensive services.<sup>13</sup>

A further basis for comparison of knowledge intensive activities across the three countries involves an examination of patterns of export specialisation. The data reported in Figure 1 confirm that Sweden's trade specialisation in high technology and medium high technology goods is stronger than for the other two countries. Australia has a strong specialisation in medium low technology goods and both Denmark and Australia in low technology goods.

*Explaining Variations in the Knowledge Economy* 347

These data indicate that Sweden is participating to a greater extent in critical knowledge intensive industries than Australia and Denmark and at a level at or above the OECD as a whole. Australia appears to be participating in knowledge intensive services, both business services and finance and insurance services, at a level above the OECD and the other two countries, although the contribution of business services to value added in Sweden is also around the OECD level. It would seem that both Sweden and Australia are participating in the knowledge economy to a greater extent than Denmark. However, aggregate quantitative measures must be interpreted cautiously and there is supplementary evidence that indicates that Denmark is participating in the high-end of traditional low-technology sectors, given its strong orientation towards collective learning and skills development, as explained below.<sup>14</sup>

*The Contribution and Performance of the ICT Sector*<sup>15</sup>

The ICT sector is of growing importance in employment, growth and trade amongst the wealthy countries and is regarded as the driver of the knowledge economy. However, not all countries are participating in ICT activities to the same extent. The following analysis looks at the contribution and performance of ICT manufacturing and services sectors in Australia, Denmark and Sweden with reference to statistics on value added and foreign trade.

*Value added.* The importance of ICT within the economies of Australia, Denmark and Sweden can be measured by identifying the proportion of total private sector value added that is accounted for by the ICT sector. Table 2 shows that ICT accounts for a larger proportion of total private sector activity in Sweden than it does in Australia and Denmark. Measures of value added show that in Sweden, the proportion of value added accounted for by the ICT sector (13.5)

**Table 2.** The contribution of ICT to the economy: ICT value added as percentage of private sector value added

	Denmark	Sweden	Australia
ICT value added % total private sector value added	8.0	13.5	8.2
ICT manufacturing % manufacturing value added	4.6	11.6	3.1
ICT manufacturing % total private sector value added	1.7	4.4	0.6
ICT services % service sector value added	11.7	16.8	12.8
ICT services % total private sector value added	6.3	9.1	7.6
ICT Wholesale % total private sector value added	3.0	1.9	1.5
Telecommunications services % total private sector value added	–	3.2	4.1
Computer consultancy/software % total private sector value added	3.3	4.0	2.0

*Source:* Data for Denmark and Sweden were taken from Statistics Denmark, *The ICT Sector in the Nordic Countries 1995–2000* (Copenhagen, 2001), Table 1.4, p. 65. Data for Australia were taken from Australian Bureau of Statistics (ABS), *Information Technology Australia 2000–2001, Cat. No. 8126.0* (Canberra, ABS, 2001a), pp. 23–24 and Australian Bureau of Statistics (ABS), *National Accounts, Cat. No. 5206.0, September 2002* (Canberra, ABS, 2002), p. 67.

is around 1.5 times that of Australia (8.2) and Denmark (8.0). It would seem that ICT constitutes a greater share of activity in Sweden than is the case for the OECD as a whole.<sup>16</sup> In relation to the manufacturing component of ICT the contrast between Sweden and the other two countries is even stronger than it is for the ICT sector as a whole.<sup>17</sup> Further, the contribution of ICT services to private sector value added<sup>18</sup> in Sweden (9.1) is 1.4 times that of Denmark (6.3)<sup>19</sup> and 1.2 times that of Australia (7.6) and is higher than all OECD countries other than Ireland.<sup>20</sup> In conclusion, it would seem that both ICT manufacturing and services constitute a higher proportion of total private sector value added in Sweden than in Australia and Denmark and other OECD countries.

*Foreign trade.* The performance of the ICT sector can also be measured with reference to foreign trade in ICT products and services. Two important conclusions can be drawn from the trade figures reported in Table 3. First, the size of the export sector in ICT products is much higher in Sweden than in Australia

**Table 3.** The performance of the ICT sector: Foreign trade in ICT manufactured goods and services

	Australia	Denmark	Sweden
<i>ICT Products</i>			
ICT manufacturing exports % goods exports	2.9	9.1	18.9
ICT manufacturing imports % goods imports	12.0	13.4	16.0
Trade balance ICT products % goods exports	Deficit 9.0	Deficit 2.5	Surplus 5.9
<i>ICT Services*</i>			
ICT service exports % service exports	7.2	–	9.2
Trade balance ICT services % service exports	Deficit 2.5	–	Deficit 0.1
<i>Software**</i>			
Software exports % commodity exports	0.1	0.3	0.2
Trade balance software exports % commodity exports	Deficit 0.5	Deficit 0.2	Deficit 0.1

\*Defined as BPM5 262 computer and information services and BPM5 245 communications services (OECD, 2002, Ref. 9, p. 266).

\*\*Defined as HS 852431, 852439, 852440, 852491, 852499 (OECD, 2002, Ref. 9, p. 266).

*Source:* Data for ICT manufacturing for Sweden were taken from Swedish Institute for Transport and Communication Analysis (SITCA), *Facts About Information and Communications Technology in Sweden* (Stockholm, Swedish Institute for Transport and Communications Analysis, 2002), pp. 158–159. Data for Australia from Australian Bureau of Statistics (ABS), *Information Technology Australia 2000–2001, Cat. No. 8126.0* (Canberra, ABS, 2001), pp. 28–29 and Australian Bureau of Statistics (ABS), *International Merchandise Trade, Cat. No. 5422.0, June Quarter 2001* (Canberra, ABS, 2001), p. 32. Data for Denmark from Statistics Denmark, *The ICT Sector in the Nordic Countries 1995–2000* (Copenhagen, 2001), Tables 367 and 370. Data for foreign trade in ICT services and software for Australia and Sweden were taken from OECD (OECD, 2002, Ref. 9, pp. 39 and 277). Figures for total services exports were obtained from OECD, *OECD in Figures* (Paris, OECD, 2002), pp. 62–63 and total commodity exports from pp. 60–61. Note that definitions for trade in ICT services are different from those used for value added and employment in ICT services in which software is included within ICT services (computer consultancy) according to national definitions. The OECD has a separate category of software products, which forms the basis of the trade figures.

and Denmark and ICT services exports are also higher in Sweden than Australia. ICT product exports from Sweden constituted 18.9% of total goods exports, which is more than double the Danish level and 6.5 times the Australian level. ICT service exports from Sweden constituted 9.2% of the value of total service exports, which is around 1.3 times the figure for Australia. Sweden's software product export sector also constitutes a larger component of total commodity exports than is the case in Australia, although Denmark outperforms Sweden in terms of the component of commodity exports accounted for by software products.

Second, Sweden outperforms both Australia and Denmark in relation to the balance of trade in ICT products and Australia in relation to services. Of the three countries, it is only Sweden that has a surplus in trade in ICT goods valued at 5.9% of total exports. Sweden's superior performance also holds in relation to services given the smaller size of its deficit when compared with Australia (although comparison is not possible with Denmark because of a lack of data). It would seem that Sweden's trade performance in software products is also superior to the other countries.

#### *Overview of Nature of Participation in Knowledge Economy*

The preceding analysis can be used to reflect on the three measures of participation in the knowledge economy specified above (see Table 7). First, the above analysis has shown that Sweden outperforms Australia and Denmark in medium-high and high technology sectors both in their contribution to value added and in terms of the orientation of exports. Second, Australia appears to have a specialisation in knowledge intensive services, both finance and insurance services and business services, as measured by their contribution to value added, although the contribution of business services to value added in Sweden is close to the OECD level. Third, quantitative data indicate a specialisation in low-technology sectors in Denmark, although supplementary evidence indicates that Denmark has an orientation towards the high-skill end of traditional industry sectors (explained in more detail below). Finally, Sweden outperforms Australia and Denmark with respect to both the size and export performance of the ICT sector.

#### **The Infrastructure of the Knowledge Economy in Australia, Denmark and Sweden**

In order to understand differences in the nature of participation in the knowledge economy in the three countries, it is necessary to go beyond a consideration of the structure of economic activity to include an analysis of the infrastructure of knowledge activities. The following discussion develops the concept of the science, technology and industry infrastructure (STII) as a basis for comparing the knowledge infrastructure in Australia, Denmark and Sweden. The STII is comprised of elements of the national political, economic and social system that constitute the institutional environment of the knowledge economy. The idea of the STII draws on several key bodies of research on national systems of

350 *R. Parker*

innovation,<sup>21</sup> technological systems,<sup>22</sup> national innovative capacity<sup>23</sup> and competence blocs.<sup>24</sup> These literatures highlight the institutional factors that provide the basis for new knowledge generation and diffusion as well as environmental conditions that impact on the capacity to commercialise new knowledge. Three dimensions of the institutional infrastructure of the knowledge economy are examined—the existing stock of knowledge and competence in the economy, the potential for generation and diffusion of new knowledge and the capacity for commercialisation of new ideas.

#### *The Stock of Knowledge and Competence in the Economy*

*Supportive industries.* An important element of the STII is the existing stock of knowledge associated with current patterns of economic activity. Existing industries generate competencies in certain areas and thus create a bias in the economic system towards the development of associated activities. Because of technological and commercial interdependencies, new activities are more likely to be successful if introduced in the location of related activities, suggesting that past patterns of industrial specialisation are important for future industry development.<sup>25</sup> There are several reasons for the path dependency of patterns of industry specialisation, including the momentum that is created in universities, research institutions and the training system towards particular technological trajectories and the importance of the supply base of production equipment and components, technological know-how, tacit-knowledge (associated with learning by doing and using), specialist management and administrative competencies and skilled employees.<sup>26</sup> We might therefore expect the presence of supporting industries to be important for the stock of knowledge and competence that constitutes the infrastructure of the knowledge economy.

The Australian economy is domestically orientated for a small country with the trade to GDP ratio<sup>27</sup> for goods and services amounting to 22.2% in 2001.<sup>28</sup> A further feature of Australia's export orientation is the strong presence of resource based industries generally and food products in particular.<sup>29</sup> Resource based industries constitute almost half of all manufacturing exports and food products constitute well over half of all resource based exports. Resource intensive industries are those in which access to natural resources is the primary factor influencing competitiveness. In Australia, as with other industrial economies, there are key sectors that dominate manufacturing. Australia ranks among the top 15 countries, in terms of contribution to world value added, in three manufacturing sectors. These are non-ferrous metals, in which Australia accounts for 4.6% of world value added, food products (1.8%) and metal products (1.2%). Two of these industry sectors (non-ferrous metals and food products) are resource-based industries. The other (metal products) is a labour intensive industry in which labour costs are the most significant factor affecting competitiveness. Australia has therefore captured the largest market share of world value added in industries in which there is a heavy dependence on primary commodities or low wage costs. Australia has captured a significant portion of the international market in food products (ISIC 311/2), which includes processing and preserving

of meat, fish, fruit and vegetables in addition to dairy products, grain mill products, starches, animal feeds, bakery products and sugar.

Denmark is more open to international markets than Australia with its trade to GDP ratio in goods and services amounting to 44.0%, well above the OECD level of 21.9%.<sup>30</sup> Denmark, like Australia, has a clear specialisation in the agro-food cluster. Looking at patterns of exports specialisation in Denmark, Archibugi and Møller conclude that around two-thirds of internationally competitive commodities produced in Denmark come from the agro-industrial cluster including animals, dairy products, fish, cereals and animal feed.<sup>31</sup> Denmark also has an export specialisation in housing-construction including wood products, furniture, heating/refrigeration equipment and household appliances.

However, Australia and Denmark differ with respect to the extent of knowledge activities that occur within the traditional industry sectors that characterise their economic base. Denmark is renowned for developing competencies in the knowledge intensive components of traditional industry sectors such as food and furniture, whereas Australia's pattern of specialisation has been in the low-skilled and low technology end of traditional industries. While the Danish economy is regarded as being oriented towards continuous innovation and skill development, Australia's training system and capacity for innovation in traditional sectors has been relatively weak.<sup>32</sup>

Like Denmark, Sweden is an open economy with its trade to GDP ratio in goods and services amounting to 43.7%.<sup>33</sup> As in Australia and Denmark, there are key sectors that dominate Sweden's industry structure.<sup>34</sup> Sweden ranks among the top 15 countries, in terms of contribution to world value added, in five manufacturing sectors. These are paper, in which Sweden accounts for 2.8% of world value added, metal products (1.4%), electrical machinery including communications equipment, household appliances, electrical generators and engines (1.2%), non-electrical machinery (1.1%) and chemicals (other than drugs and industrial chemicals) (1.1%). Three of these five sectors (electrical machinery, non-electrical machinery and metal products) fall within ISIC 38 and indicate the dominance of the engineering sector in Sweden. Like other key sectors of the Swedish economy, the engineering sector is dominated by a small number of large firms. The top employers of Swedish workers in the engineering sector are Asea Brown Boveri (ABB), a leading electrical engineering group, Electrolux, well known for its manufacture of household appliances, the Ericsson group, which produces telecommunications systems and Volvo, Saab and Scania, which cover automobiles, electronics and aerospace. Like other industries in Sweden, engineering is highly oriented towards the international economy such that over two-thirds of the output in the engineering sector is exported.

Sweden's higher level of openness in relation to international goods trade and its competence in mechanical engineering suggest that Sweden has an industrial structure and industry competence that is supportive of the development of high and medium-high technology sectors as well as ICT manufacturing.

*Education and training.* Table 4 shows that Australia has a large proportion of the population whose highest level of education is below upper secondary education (at around twice the level in the other two countries). This indicates

**Table 4.** Educational attainment of the population. Distribution of the population of 25–64 year olds by highest level of education attained, 2001

	Primary and secondary education		Post-secondary tertiary education	
	Below upper secondary education	Upper secondary education	Tertiary type B education <sup>b</sup>	Tertiary type A education <sup>a</sup>
Australia	41	30	10	<b>19</b>
Denmark <sup>c</sup>	<b>20</b>	<b>52</b>	<b>21</b>	8
Sweden	<b>19</b>	<b>49</b>	<b>15</b>	<b>17</b>
OECD	34	41	11	15

Bold figures represent performance above OECD level.

<sup>a</sup>Tertiary type A education (ISCED 5A) 'are largely theory based and are designed to provide sufficient qualifications for entry to advanced research programmes and professions with high skill requirements, such as medicine, dentistry or architecture'.

<sup>b</sup>Tertiary type B education (ISCED 5B) 'are typically shorter than those of tertiary type A and focus on practical, technical or occupational skills for direct entry into the labour market'.

<sup>c</sup>Tertiary type B education for Denmark includes 2% of the population in post-secondary non-tertiary level that lies somewhere between upper secondary or tertiary.

Source: OECD, *Education at a Glance* (Paris, OECD, 2002), pp. 53, 375–376.

an overall lower level of educational attainment in the Australian workforce when compared with the other two countries.

The percentage of the population whose highest qualification is a tertiary qualification is largest in Sweden at around 32%, although Denmark and Australia are not far behind each at 29%. An important difference in tertiary education in the three countries concerns the type of tertiary education, with Denmark having a stronger orientation towards Type B tertiary education than either Australia or Sweden. Of the three countries, Australia has the lowest level of the population whose highest qualification is Type B tertiary education. Type B education focuses on practical, technical or occupational skills and might be expected to be important to technology-based and engineering sectors. The Danish system therefore has an orientation towards practical skills and broad vocational training,<sup>35</sup> rather than the acquisition of more formal knowledge.

Table 5 reports the field of study of tertiary graduates in the different types of tertiary studies. Australia and Denmark appear to have a stronger orientation towards education in humanities, arts, social sciences, business and law than does Sweden. Sweden in contrast has a strong orientation towards engineering manufacturing and construction in both Type A and B education and computing in Type B education. Almost 50% of Type B education in Denmark is oriented towards health and welfare.

These data indicate a stronger supply of educated employees in the Danish and Swedish labour force and a strength in the Danish system's orientation towards practical and technical skills. It further reveals a strength in the Swedish education system in engineering, manufacturing and construction and in the development of technical and practical skills in computing.

**Table 5.** Tertiary graduates, by field of study and level of education, 2000

Type	Australia A	Denmark A	Sweden A	OECD A	Denmark B	Sweden B	OECD B
Education	11.3	1.0	<b>18.8</b>	13.2	<b>19.2</b>	4.9	13.0
Humanities and arts	<b>13.9</b>	<b>23.6</b>	5.7	12.6	2.2	6.3	7.6
Social sciences, business, law	<b>36.0</b>	<b>44.7</b>	21.6	33.5	7.9	14.6	25.8
Services	<b>2.8</b>	0.3	1.0	2.5	5.4	<b>14.3</b>	9.0
Engineering, manufacturing and construction	7.9	8.9	<b>20.5</b>	13.2	12.4	<b>23.3</b>	14.7
Agriculture	1.2	<b>3.2</b>	1.0	2.3	1.1	<b>7.1</b>	2.4
Health and welfare	<b>15.0</b>	5.5	<b>22.8</b>	11.5	<b>49.2</b>	8.9	18.8
Life sciences	<b>5.6</b>	<b>4.2</b>	2.3	3.1	–	0.1	–
Physical sciences	1.1	<b>4.3</b>	2.4	3.0	–	0.1	–
Mathematics and statistics	0.5	1.0	0.6	1.1	–	0.2	–
Computing	<b>4.6</b>	1.8	3.1	3.1	2.7	<b>20.5</b>	6.8

Bold figures represent performance above OECD level.

Source: OECD, *Education at a Glance* (Paris, OECD, 2002b), p. 61.

#### *The Potential for Learning and the Generation of Knowledge*

The capacity for learning and knowledge creation constitutes a further dimension of the infrastructure of the knowledge economy. Traditionally, research and development has been regarded as important for the generation of knowledge-based activities. However, innovation studies have shown that innovation is a process of interactive learning between a firm and its environment, involving feedback mechanisms or loops, representing the complex interactions between a variety of institutions in the system as part of a continuous process involving incremental change, error and modification.<sup>36</sup> Knowledge activities do not follow a linear trajectory, moving in a straight path from basic research to applied research to commercial application.<sup>37</sup> As such, while R&D provides some indication of the potential for the generation of new ideas, interactions between firms and other institutions is a key element of the learning process associated with knowledge intensive activities. Of particular importance to knowledge intensive sectors are the interactions between universities and industry.<sup>38</sup> Further, relations between customers, suppliers and labour mobility in a regional context are relevant to the transfer of tacit knowledge.<sup>39</sup> The extent of research and development as well as other forms of innovation expenditure therefore comprises an element of the infrastructure of the knowledge economy.

*Research and development.* One measure of the capacity to generate new knowledge is R&D expenditure. It would seem that the contribution of government to knowledge creation through R&D is declining as governments are responsible for a declining share of total R&D funding, down from 37% to less

**Table 6.** Research and development

Business RandD expenditures as a percentage of GDP	1999	
	1981	1999
Australia	0.24	0.64
Denmark	0.53	1.32
Sweden	<b>1.42</b>	<b>2.84</b>
OECD	1.29	1.53

Bold figures represent performance above OECD level.

Source: OECD, *OECD Science, Technology and Industry Outlook 2002* (Paris, OECD, 2002a), p. 300.

than 30% in the OECD countries in the 1990s.<sup>40</sup> As such, business expenditure on R&D is of increasing importance to the generation of knowledge.<sup>41</sup>

Table 6 reports the level of business expenditure on R&D as a percentage of GDP at the beginning of the 1980s and end of the 1990s. At both time points, the level of business expenditure on R&D in Denmark was around twice the level in Australia. In Sweden business expenditure on R&D was around 2–3 times that in Denmark or 4–6 times the level in Australia.<sup>42</sup>

*Innovation expenditure.* There are problems with an exclusive focus on R&D in seeking to determine the capacity to generate new knowledge because it ‘overemphasises the discovery of new scientific or technical principles’ and thus understates the importance of learning and interactions with firms and their environment.<sup>43</sup> The community innovation survey (CIS) provides an alternative view of innovation expenditure, which takes into account ‘all expenditure related to the scientific, technological, commercial, financial and organisational steps that are meant to lead to the implementation of technologically new or improved products and processes’.<sup>44</sup> In Australia, innovation expenditure in the manufacturing sector amounted to 1.9% of sales in 1997. In Denmark innovation expenditure in manufacturing constituted 4.8% of sales and in Sweden 7.0% of sales was expended on innovation in 1996. Data for services is unavailable for Australia. Interestingly, these figures reflect the same country patterns as the R&D data and compare with an overall European Union level of 3.7%.<sup>45</sup> As such, Swedish companies also show a greater willingness to engage in non R&D innovation related expenditure.

*University and Industry Interactions.* Over the last two decades, the share of industry R&D funding going to university research has increased from 0.8% in 1980 to 1.7% in 2000<sup>46</sup> indicating greater collaboration between universities and industry in the development of new knowledge. This suggests an increasing willingness on the part of the private sector to direct funds to universities for research purposes and is suggestive of the growing importance of university–industry interactions in the knowledge economy.

One approach to measuring interactions is to focus on the percentage of R&D performed by universities and funded by industry. The share of industry funding of university R&D increased from 3 to 6% between 1981 and 2001.<sup>47</sup> This is

suggestive of the increasing emphasis on the commercial relevance of university research.<sup>48</sup>

In Australia, 5.2% of university R&D is funded by industry. The figures for Denmark and Sweden are lower at 2.1% and 3.9% respectively. This higher level of industry funded university research in Australia may indicate a strength in the commercial relevance of university research. However, it should be noted that all three countries fall below the OECD level of 6.1%.

#### *Capacity for Commercialisation of New Ideas*

In order to bring new ideas to the market it is necessary to have entrepreneurs, particularly in relation to new industries involving new firm start-ups, where the risks and potential rewards are both high. Venture capitalists are also required in order to finance entrepreneurial activities. Eliasson has made reference to 'competent' venture capitalists who have sufficient expertise to understand new business proposals. As he points out, the supply of competent venture capitalists is likely to be weak in technology fields that fall outside the range of traditional industries.<sup>49</sup> When the range of traditional industries is quite narrow, one might expect the overall supply of competent venture capitalists also to be weak, further highlighting the importance of the existing stock of knowledge and competence in the economy. It is generally regarded that important signs of flourishing entrepreneurial and venture capital activity are the dynamics of nascent, start-up and exit activity, and the more static measure of business ownership and self-employment.<sup>50</sup>

*Entrepreneurship.* One indicator of entrepreneurial activity is the level of start-up activity. The percentage of surveyed adults engaged in starting a business in the previous 12 months is around 8% in Australia, 3% in Denmark and 2% in Sweden.<sup>51</sup> This would indicate a strength in small firm start-ups in Australia.

Business ownership and self employment are sometimes used as proxies for entrepreneurship. They capture people 'who provide employment for themselves as business owners rather than seeking a paid job'.<sup>52</sup> Consistent with the measure of start-up activity, business ownership is highest in Australia at 15.5%. In Denmark and Sweden the figure is around half the Australian level at 6.4 and 8.2% respectively. This would seem to further indicate an entrepreneurial strength in Australia.<sup>53</sup>

*Venture capital.* Baygan and Freudenberg provide an important source of data on venture capital investment in the OECD countries. In the period 1995–1999 Australian venture capital investment was 0.093% of GDP, which is higher than Denmark (0.031) but not as high as Sweden (0.216). The overall figure for the 19 OECD countries included in the study was 0.204. The figures are some indication that Sweden is relatively strong in terms of its overall level of venture capital investment. Further, the data indicate that Australia and Sweden appear to be somewhat stronger than Denmark in early stage investment while Denmark is somewhat stronger in high-technology investment. The performance of all three countries on both measures relative to the OECD and US is quite weak.<sup>54</sup>

These figures do not provide a clear sense of strengths and weaknesses in the availability of venture capital funds. Sweden appears to perform around the OECD standard in terms of the size of its venture capital market and around the EU standard in terms of the orientation towards start-ups and high-technology sectors. It therefore seems to outperform Australia and Denmark in terms of the size of the venture capital market, although Denmark seems to be successful in attracting venture capital investment from outside the country and has a strong orientation towards high technology sectors.

### **Explaining Patterns of Participation in the Knowledge Economy**

Table 7 contains a summary of the preceding analysis and provides a basis for comparing the nature of participation in the knowledge economy across the three countries on two dimensions—the structure of knowledge industries and services and the infrastructure of the knowledge economy. Table 7 identifies strengths and weaknesses in each of the countries by comparing them with each other and the OECD.

Australia was shown to have a specialisation in business services/finance and insurance services and a strength in the commercialisation of research in terms of the strong evidence of entrepreneurship and commercial relevance of university research. In contrast, Sweden has a strong orientation towards high and medium/high technology industries and has a strength in the stock of knowledge and competence in the economy and strong investment in learning and knowledge generation. Denmark was shown to have medium performance in most areas of the knowledge economy but is renowned for its specialisation in knowledge intensive activities within traditional industry sectors. In addition, Denmark has a good skills base and a strong system of vocational training.

The following discussion seeks to acquire insights into these differences from the literature on varieties of capitalism or comparative business systems. At a broad level, the literature distinguishes between coordinated and competitive business systems. These two types of business systems are thought to give rise to quite different innovative capabilities amongst firms and therefore cross-national patterns of sector specialisation. This literature provides a basis for understanding cross-national variations in patterns of participation in the knowledge economy in Australia, Denmark and Sweden.

#### *Business Systems and Patterns of Industry Specialisation*

The literature on varieties of capitalism and patterns of industry specialisation suggests that the coordinated and competitive business systems give rise to different competencies and result in contrasting patterns of industry specialisation. The coordinated business system is characterised by close long-term linkages between industry and banks involving relational banking; long-term stable relationships with customers and suppliers; forms of inter-firm cooperation involving information sharing and the pooling of resources for research and development, design and marketing; an industrial relations system characterised by collective bargaining and labour market programs and institutions that

emphasise skills development in the workforce and security of tenure; business associations which are encompassing and well integrated with state policy making institutions and cultural orientations towards cooperation, trust and equality.<sup>55</sup>

This system is regarded as being oriented towards incremental innovations and rapid diffusion of knowledge—characteristics typical of innovation in medium-technology industries such as machinery. Innovation in these industries involves the development and application of new technologies to existing production activities, as opposed to the development of new products and processes. Medium technology industries depend on collaborative internal and external firms relations involving information sharing, something typical of a coordinated business system.<sup>56</sup>

In contrast, the competitive business system is characterised by weakly organised business groups and unions; decentralised determination of wages (at the level of enterprises); a highly competitive labour market characterised by high-labour turnover; a financial system heavily dependent on capital markets providing ready access to high-risk capital; hierarchical forms of business organisation not usually involving decentralised inter-organisational relationships or participation in clusters, and a strong emphasis on competition and anti-trust.<sup>57</sup>

This system is regarded as conducive to risk taking and rapid change leading to success in industry sectors dominated by new firms or characterised by rapid and radical innovations including software systems or knowledge intensive services such as management consultancy. This is because innovation in new high technology and knowledge intensive sectors depends on risk taking behaviour and a capacity for rapid change.<sup>58</sup>

### **Business Systems and the Knowledge Economy in Australia, Denmark and Sweden**

Drawing on the business system approach, the following discussion categorises the business systems of Australia, Denmark and Sweden and draws links between the nature of the business system and patterns of participation in the knowledge economy as described in previous sections of the paper. The clearest contrast can be drawn between the business systems of Australia and Sweden with the former fitting fairly closely with the model of competitive capitalism and the latter representing a fairly typical example of the coordinated model.

Like most other Anglo-Saxon economies, Australia fits the model of competitive capitalism. The Australian system, like the competitive model, is characterised by weakly organised business groups and unions, mechanisms for the decentralised determination of wages (at the level of enterprises), a competitive labour market with high-labour turnover, a financial system heavily dependent on capital markets, a strong emphasis on competition and anti-trust, and an unwillingness of the state to interfere with the investment and production decisions of private firms.<sup>59</sup>

In contrast Sweden is a coordinated economy. As such, Swedish business is regarded as embedded in long-term stable relationships with customers and suppliers and particular forms of inter-firm cooperation in relation to information sharing and the pooling of resources for research and development, design and

**Table 7.** The knowledge economy in Australia, Denmark and Sweden

Country	Main characteristics of performance in critical knowledge intensive sectors	Characteristics of science, technology and industry infrastructure		
		Stock of knowledge and competence	Potential for learning and generation of knowledge	Capacity for commercialisation of new ideas
Australia	<p>Weak performance in high and medium-high technology sectors both domestically and internationally.</p> <p>Strong in knowledge intensive services, particularly finance and insurance and business services.</p> <p>Weak performance in ICT products and services. Sub-sectoral strength in telecommunications services.</p>	<p>Lack of supporting industries: closed economy with specialisation in resource based industries and food products.</p> <p>Weakness in skills base of workforce: lower levels of educational attainment, weakness in practical skills and training. Orientation towards humanities, business, law social science rather than engineering and ICT.</p>	<p>Low industry investment in knowledge—both R&amp;D and non-R&amp;D.</p> <p>Stronger commercial relevance of university research than other two countries but still below OECD level.</p>	<p>Strong entrepreneurship—strong performance in business start-ups and business ownership.</p> <p>Size of venture capital market below EU and OECD and orientation towards early stage/expansion and high technology quite weak.</p>
Denmark	<p>Performance in knowledge intensive products and services is below the OECD level. But evidence of specialisation in the high technology end of traditional sectors.</p> <p>Performance in ICT products and services below the OECD level but higher than Australia. Sub-sectoral strength in foreign trade in software products.</p>	<p>Lack of supporting industries in mechanical engineering: open to international markets but economy orientated towards agro-industry.</p> <p>Good general skills base of workforce: high levels of educational attainment, strength in practical skills and training, but orientation towards business, law social science and humanities.</p>	<p>Moderate level of investment in knowledge—R&amp;D slightly below OECD level and non-R&amp;D slightly above EU level.</p> <p>Weak commercial relevance of university research.</p>	<p>Weak entrepreneurship—business ownership and start-ups low.</p> <p>Small domestic venture capital market with weak orientation towards early stage/expansion and moderate orientation towards high technology.</p>

Table 7. *Continued*

Country	Main characteristics of performance in critical knowledge intensive sectors	Characteristics of science, technology and industry infrastructure		
		Stock of knowledge and competence	Potential for learning and generation of knowledge	Capacity for commercialisation of new ideas
Sweden	<p>Strong performance in high and medium-high technology sectors both domestically and internationally</p> <p>Moderate performance in business services and weak in finance and insurance services.</p> <p>Strong in ICT manufacturing and services (particularly computer consultancy/software).</p>	<p>Supporting industries: open to international markets with orientation towards engineering sectors.</p> <p>Good skills base: high levels of educational attainment, strength in engineering sectors and computing.</p>	<p>High level of investment in knowledge, both R&amp;D and non-R&amp;D.</p> <p>Weak commercial relevance of university research.</p>	<p>Weak entrepreneurship—business ownership and start-ups low.</p> <p>Medium sized venture capital market at OECD level. Orientation towards high technology and early stage expansion below OECD but around EU level.</p>

marketing. In addition, the industrial relations system is characterised by collective bargaining and labour market programmes and institutions that emphasise skills development and security of tenure. Business associations are encompassing and well integrated with state policy making institutions. Culture is oriented towards cooperation, trust and equality. Many of the features of the Swedish policy and institutional context, including the dominance of large MNCs, the regulated labour market, high taxation, large public sector and income equality fit with the coordinated model and are generally regarded as favouring large rather than small firms.<sup>60</sup>

The contrast between the Australian and Swedish models is quickly revealed in an analysis of OECD statistics on the size of government, welfare, taxation and the labour market. In 2000, government expenditure as a percentage of GDP was 55 in Sweden and 32 in Australia indicating that Australia has a much smaller government sector than Sweden.<sup>61</sup> In addition, social security spending in Australia was 8% of GDP and therefore less than half the level of Sweden at 18.9% of GDP. This reflects the well-developed public welfare system in Sweden and the orientation towards private insurance in the Australian model.<sup>62</sup> Higher levels of government expenditure are consistent with higher levels of taxation, which constituted around 52% of GDP in Sweden and only 30% in Australia.<sup>63</sup> Australia has a higher degree of income flexibility than Sweden, which fits with patterns of income inequality that show that the wealthiest 20% in Australia earn around 41% of total income while the same group accounts for around 35% of income in Sweden.<sup>64</sup> The much higher levels of labour organisation in Sweden are revealed in statistics on union membership in the mid 1990s, which indicate coverage of around 90% of the workforce in Sweden and around 40% in Australia.<sup>65</sup> Finally, data on the average tenure of employees shows that the level in Sweden is 10.5 years compared with 6.4 years in Australia. This is indicative of longer and more stable relations between employers and employees in the Swedish coordinated model.<sup>66</sup> These data highlight the competitive orientation of the Australian economy and the higher levels of coordination in Sweden in terms of government involvement in the economy, labour market coordination and welfare state development.

Australia's competitive system appears to affect its participation in the knowledge economy and helps to explain its specialisation in business services/finance and insurance services. These are rapidly changing and highly competitive sectors with a commercial rather than industrial orientation. Further, Australia's competitive business system explains its strength in entrepreneurship as it has an individualistic business culture that encourages high-risk activity with the possibility of high rewards. In Australia, there is an emphasis on individual initiative and individual responsibility, which is consistent with the values of entrepreneurship. Further, Australia's strength in finance and insurance services is consistent with its stock-market oriented financial system and the emphasis on private insurance that characterises its welfare system.

The coordinated nature of the Swedish business system also provides an explanation for Sweden's relative strength in medium-high technology industries. The coordinated system is regarded as favouring medium technology industries because it facilitates the sharing of information between economic actors and

allows for the pooling of resources for research, marketing and information gathering. The system also ties economic actors to existing relationships, either outside the firm (with other institutions such as research and education institutions) or within the firm (between managers and employees—as indicated by high levels of tenure). As such, incremental innovations, or gradual improvements in existing products and production processes are favoured, rather than more radical innovations involving new technological trajectories which would require firms to change the composition of their workforce or to disrupt long term relationships outside the firm.

Sweden's success in medium-technology knowledge intensive industries is therefore explained by the coordinated nature of its business system. Its more recent success in high technology sectors can be explained by the fact that large industrial firms account for a high level of investment in new knowledge in Sweden and have provided an industrial training ground for engineers who acquire the capacity to establish small technology intensive companies in new industry sectors. This provides an explanation for Sweden's more recent success in sectors such as computer software. Further, the state has compensated for the limited capacity of the coordinated nature of the Swedish business system to encourage high technology and rapidly changing sectors, for example by providing access to public sources of venture capital funding through institutions such as Industrifonden and the Technology Bridge Foundations which link universities and commercial enterprises. This helps to explain Sweden's performance in high technology sectors.

The distinction drawn between coordinated and competitive systems and their influence over the development of particular national competencies and patterns of specialisation is therefore helpful in understanding differences in the knowledge economy in Australia and Sweden. The business systems framework can also be used to explain the Danish case, but Denmark represents a distinctive variant of the coordinated system.

Denmark can be described as a variant of the coordinated model with two distinguishing characteristics in the negotiated nature of its economic system and its strong system of vocational training. The Danish negotiated economy has provided a context within which policies affecting business innovation have been developed and coordinated in local communities by a multitude of agents including industrial firms, banks, and public institutions at various levels of government.<sup>67</sup> Further, the state funded system of vocational training has ensured a good supply of skilled workers. This has created a pattern of learning and innovation that is distinctive and dependent on a flow of personnel and expertise between enterprises as well as high levels of information sharing and knowledge transfer through interactions associated with social networks and trade associations.<sup>68</sup> This has meant that Denmark has specialised in the high skilled end of more traditional industry sectors, which represents a distinctive pattern of performance in the knowledge economy.<sup>69</sup>

Finally, the high level of participation in key areas of the knowledge economy in Denmark and Sweden may also have resulted from the strong emphasis on the knowledge economy and innovation at the level of the EU. At the European level, the EU has focused its attention on the need to redress technological

divergence between regions. There is concern about variation in the level of research and development expenditure and innovative activity between regions in the EU, which constitutes one of the most significant forms of economic divergence within the Union.<sup>70</sup> Structural funds have been used to invest in new technologies and access to information-society resources including telecommunications networks. A focus on the information-society constitutes one aspect of the shift in the EU away from sectoral policies, focused principally on agriculture, towards policies oriented to regional development, particularly technological development within regions.<sup>71</sup> The EU orientation has stimulated research and public discussion of the importance of innovation and learning throughout the EU.

### **Conclusion**

There have been common trends amongst the OECD economies in terms of the growth of knowledge intensive industries and services, the increasing importance of ICT in business value added and trade and the growing importance of the science and technology infrastructure in stimulating innovation and therefore competitiveness. These common trends, however, mask differences between countries in terms of patterns of participation in the knowledge economy.

This paper has shown that Australia, Denmark and Sweden are participating in the knowledge economy in different ways. Australia is specialising in business services and finance and insurance services and has a strength in entrepreneurship or the commercialisation of new ideas, an important element of the institutional foundations of the knowledge economy. In contrast, Denmark is specialising in the high-technology end of more traditional industry sectors and has a strength in the skill base, also a critical institution in the knowledge economy. Sweden is performing well in medium-high and high technology industry sectors and has a strength in terms of the stock of knowledge and competence in the economy and the capacity to develop new ideas.

The paper has shown that these variations in the nature of participation in the knowledge economy are linked to characteristics of the business system in the three countries. In Australia, the entrepreneurial climate of the competitive business system and the market based rewards for high risk activities as well as the tradition of private insurance are consistent with a strength in the capacity to commercialise new ideas and high performance in sectors such as business services and finance and insurance services. The foundations of the coordinated economy in Denmark—the public system of vocational training and the negotiated nature of the economy—are consistent with a strength in the skills base and a capacity to specialise in the high skilled and high technology end of traditional industry sectors. In Sweden, the coordinated system is linked to past performance in medium technology sectors, which is fuelling current success in high technology sectors that depend on new knowledge and a stock of industrial competence amongst the high skilled workforce.

These three small wealthy countries are therefore participating in knowledge activities in ways that vary according to long established political, social and economic traditions that have defined the distinctive nature of their business

systems. Rather than leading to a convergence across nations, the development of the knowledge economy would appear to be associated with distinctive patterns across nations, which can be linked to long established characteristics of the national business system.

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9. OECD, *OECD Information Technology Outlook: ICTs and the Information Economy* (Paris, OECD, 2002), pp. 30–31.
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18. OECD 2002, *op. cit.*, Ref. 9, p. 124. The ICT service sector incorporates the wholesale of ICT products, telecommunications services (such as network operations) and computer consultancy services (including software consultancy and supply, data processing, information storage and retrieval services and computer maintenance services). Computer consultancy services (ISIC Rev 3. Div. 72) can be broadly understood as the software sector.
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*Explaining Variations in the Knowledge Economy* 365

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366 R. Parker

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