RESOURCE-BASED INDUSTRIALISATION STRATEGIES: LESSONS FROM THE DEVELOPED WORLD EXPERIENCE

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Introduction

This paper provides a review of some of the key factors underpinning the transition of economies such as the United States, Sweden and Finland (and to some extent Australia and Canada), from factor-based growth to high-tech, knowledge-based industrialisation. While previously regarded by development economists as a 'curse' for development, these varying country experiences highlight that natural resources can in fact provide the basis for growth in developing and semi-industrialising countries provided a number of policy 'lessons' are borne in mind. Three critical lessons, in particular, can be distilled from the international experience of resource-based industrialisation: a sound macro-economic approach development during the factor-based stage is imperative; a commitment of all participants to long-term R&D development and sustained investment in innovation and entrepreneurship is necessary; and, the promotion and enactment of cluster development strategies is essential.

The paper commences with a brief consideration of the debates pertaining to resource-based development in the current economic context and the merit in reassessing the notion of resource endowments as a 'curse' for development. This is followed by an analysis of each of the three policy 'lessons' drawn from the experiences of resource-based industrialised countries such as the United States, Finland, Sweden, Canada and Australia. The paper ends with a brief discussion and conclusion. This paper is aimed at contributing to the global learning process regarding alternative development strategies for mineral-rich industrialising countries and appropriate management practices linked to natural resource endowments.

Re-evaluating the Role of Natural Resources in Development

A number of fundamental changes are taking place at the global level which are prompting governments throughout the world to re-evaluate and re-assess long-standing approaches to development and economic growth. The advent of the information and communications technology (ICT) revolution, in particular, has resulted in a fundamental shift in the determinants of national comparative advantage. Increasingly, created assets such as technology and innovation capacities, the availability of skilled human capital, and marketing networks are replacing traditional price-driven sources of national comparative advantage (such as raw materials, capital and cheap labour) (Pajarinen *et al*., 1998). New knowledge creation and innovation are among the primary forces of industrial renewal and socio-economic change. Countries dependent on traditional endowments for continued growth and development are facing increased competition in three areas. First, the ICT revolution has assisted in reducing many of the geographical barriers and transport costs associated with the export of raw materials. Raw materials are increasingly being traded internationally which has meant that manufacturers throughout the world are faced with similar prices and delivery conditions for raw material inputs. Competition has also been intensified as a consequence of historically low material commodity prices. ICT has also contributed to consolidation in resource-based industries by creating new economies of scope. Changing social and environmental perceptions, especially in the mining and minerals sector, have broadened the expectations and extended the range of knowledge that is relevant and necessary for economic success, adding a new dimension to securing competitive advantage in the industry (Pajarinen *et al*., 1998).

Second, the diffusion of information and production knowledge has increased. Wider access to information and easier means of communication have enhanced the efficiency of markets and enabled capital and skills to flow to where they can be employed most productively. It has been pointed out that as the market for new technology has increased, a concomitant increase in the need for the continual adaptation and innovation in order to remain competitive has also occurred. A skilled and adaptive workforce and effective management capacity are increasingly regarded as being prerequisites for sustained and long-term economic growth. The shift by multinational companies to basing their locational decisions on the availability of such competitive advantages has meant that countries lacking traditional comparative advantages are equally placed to compete for foreign direct investment (FDI). The need to identify new sources of competitiveness has therefore become a necessity (Pajarinen *et al*., 1998; Humphreys, 2000). Third, over the past two decades the majority of countries throughout the world have introduced measures promoting macroeconomic stability while simultaneously opening markets to competition through liberalisation and privatisation. As large industrialising countries such as Indonesia, India, Brazil and China become more integrated into the world economic system, cheap, unskilled and semi-skilled labour can no longer be considered a sustainable source of comparative advantage (Pajarinen *et al*., 1998; ECA, 2000).

Governments are gradually taking cognisance of the fact that to compete and operate efficiently and successfully in the new economic environment requires a concerted and committed approach at all levels to improve the overall level of industrial competitiveness and promote economic diversification and product differentiation. At the same time, available resources need to be used to the maximum potential and in an environmentally- and economically-sustainable manner. Since the late-1990s, there has been renewed interest throughout the world, particularly in developing and semi-industrialised countries, regarding the potential for using natural endowments as a basis for achieving national competitiveness, securing basic socio-economic and development indicators, and broadening existing competence in resource-based industrial sectors (Buitelaar, 2000; 2001; Khemani, no date; Walker and Jourdan, 2003). With regard to mineral resource endowments, key focus areas include beneficiation with an emphasis on mineral cluster development; increasing the local value-added content of goods and other economic linkages; localising resource technologies and the creation of a new knowledge base; amending current ownership patterns (facilitating the formation of indigenous capital and broad-based socio-economic empowerment and participation to try contain/prevent the leakage of critical resources abroad); and human resource and skills development (ECA, 2000; Walker and Jourdan, 2003).

The merits and demerits of resource-based industrialisation strategies have been subject to considerable debate following the deleterious economic experiences of various mineral- and oil-rich developing countries which arose after the commodity booms in the late 1970s and early 1980s. While non-resource-rich economies successfully achieved diversification and product differentiation, resource-rich countries experienced the opposite. Based on this experience, dependence on natural resources came to be regarded by many development economists as a 'curse' rather than a blessing for industrial development. It was argued that mining is an ultimately unsustainable economic activity due to its 'wasting' nature (i.e. mineral resources are a non-renewable resource) as well as their susceptibility to price volatility and cyclicity and long-term real decline. Many governments were therefore encouraged to identify alternative sources of exports and implement appropriate strategies to foster economic growth (Ballance, 1987; Auty, 1991; 1995; Östensson and Uwizeye-Mapendano, 2000; Ross, 2001; Wright, 2001; Power, 2002; World Bank, 2002). Nevertheless, as Power (2002) asserts, poor economic management of resources and the over-zealous pursuit of unrealistic goals by policy makers and key decision makers should not be used as a basis by which to assess the economic potential inherent within a natural resource endowment. If the proceeds generated from the resource base are reinvested and used to diversify the economy into other sectors, then it can provide a sustainable base from which to initiate and stimulate long-term growth.

In the case of mineral resources, there are a number of favourable features which distinguish it from other business activities and which offer the potential for catalysing industrialisation (Humphreys, 2000; Power, 2002). First, mining is at the start of the value chain and therefore has the capacity to kick start economic development. Secondly, unlike manufacturing, mining does not require a sophisticated supply chain to be in place before operations can take place nor does it require the existence of developed local markets. Thirdly, modern mining operations are often on a scale where the injection of capital needed to undertake them can make a material impact on the economy of host developing countries. Once operational, mining activities can generate surpluses or rents that can be used to finance additional investments. The establishment of a new mining operation can stimulate the development of basic transportation infrastructure. The wages paid in mining are generally much higher than those offered in other primary activities such as agriculture. In addition to creating opportunities for the emergence of a cluster of local suppliers of goods and services, foreign investment results in the transfer of technology and skills which can be transferred to other sectors of the economy (Power, 2002).

Resource-rich developing and semi-industrialised countries have recently begun to re-evaluate their approach to the management of their resource endowments. Many policy developers and economic strategists have looked to the industrialisation experiences of the Nordic countries and North America in the hope of deriving 'lessons' and policy approaches to help guide current and future industrial planning (Altamirano, 1999; Buitelaar, 2000; ECA, 2000; Buitelaar, 2001; Khemani, no date; Power, 2002; Walker and Jourdan, 2003). While the United States, Finland, Sweden, and to a certain extent Canada and Australia, have all managed (to varying degrees), over the course of the last century, to move beyond the simple extraction and processing of primary raw materials into high-tech, knowledge-intensive industries, natural resources still remain an important element in their economies. For example, the United States economy developed on the back of iron ore deposits in Minnesota and agricultural production. While it is emerged as a world leader in certain manufactured goods, it is still first and foremost a net exporter of foodstuffs (de Ferranti *et al*., 2002a; Power, 2002). Similarly, exports of staples underpinned Canada's economic growth and development and the country still exports forest products. Canada is, today, also one of the most high-tech mining-related goods and services producers in the world (Lemieux, 2001; Cranstone, 2002). In Australia, while the production of agricultural products (staples) and wool provided the initial impetus for growth, exports of expertise and know-how linked to the minerals sector (environmentally-friendly techniques, mine closure methods, mineral detection technologies) now exceeds that of wine production (de Ferranti *et al*., 2002a; McKay *et al*., 2002). In addition, in 2000 resource-based manufacturing industries accounted for approximately 42% of employment and 50% of manufacturing value added to the Australian economy (Stockall and Associates, 2000). In Finland, while electronics and telecommunications have increased in importance over the past decade, close to two thirds of the country's export revenues are still generated in two traditional sectors – forestry and basic metals (Hernesniemi *et al*., 1996). Moreover, despite a remarkable change in the structure of production over the past two decades, Finland is still more dependent on the forest sector than in any other industrial economy. Vuori and Ylä-Anttila (1992) assert that 40% of total export earnings are generated within the sector and that the value of forest industry exports per capita is around US$ 2000; twice as much as that in Sweden and three times that of Canada.

This evidence suggests that natural resources need not be a temporary stage in the economic development of a country, but rather can play an integral and sustainable role in the industrial evolution of an economy. These various experiences also highlight that a reassessment of the potential role natural resources can play in the industrialisation process may be necessary. According to Wright (2001, 1), "the practical policy issue is whether countries with resource potential should encourage investment, exploration, and research for the purpose of developing that potential to its maximum". Maloney (2002, 2) states that, "central to every example [developed resource-based countries] are the foregone opportunities to exploit the global stock of knowledge to increase productivity growth and create, or perpetuate, dynamic industries". He goes on to argue that, while the economic environment is different today from that which existed in the 19th century, emerging resource-based industrialising countries share similar possibilities and constraints for growth (Maloney, 2002, 19). Thus, it is only through an in-depth study of the economic histories of successful resource-based countries, and the firms which underpinned their development process, that a real understanding of the dynamics responsible for engendering growth based on natural resources can be understood. Identifying the critical lessons and key criteria for growth is an essential first step before a sustainable, dynamic and appropriate approach to resource-based industrialisation can be conceptualised and formalised in policy (Fogarty, 1985; Wright, 2001; Maloney, 2002; Power, 2002).

A Sound Macro-economic Approach to Factor-based Development

The 19th century was the turning point in the economic histories of Sweden, Finland and the United States. Industrialisation commenced a few years later in Canada and Australia and at a more moderate pace. Nevertheless, over the course of 20th century, the foundation was laid in each of these countries for economic growth and development based on available natural resource endowments. Initial success hinged on the establishment of an efficient macro- and micro-economic environment and the effective mastery of various social, economic and political challenges.

Growth of the export sector

Basic factors of production such as raw materials, favourable climate, and an abundant, but not necessarily skilled, labour force were the critical competitive advantages upon which the first internationally successful industries grew in Sweden, Finland, the United States, Canada, and Australia. Market dominance was secured through low prices and costs of production and the export of primary goods. However, in the early years of industrialisation there was very little national production of investment goods for export (Porter, 1990; Landes, 1998; Wright, 2001; Blömstrom and Kokko, 2002; Blömstrom *et al*., 2002; de Ferranti *et al*., 2002; Power, 2002).

<u>The Role of External Demand</u>

For a variety of reasons, which included maritime supremacy, availability of resource endowments such as coal and iron deposits in close proximity to one another, and new inventions, the industrial revolution first took place in Britain. British producers and exporters favoured free trade and open competition in unrestricted markets, with the result that the country dominated exports of cheap mass-manufactured goods for the first half of the 19th century. It was only from 1860 onwards that Britain's prominent position began to be challenged following the commencement of industrialisation in Italy and later Germany. By the early 1870s, Germany had become one of the most powerful industrial states in Europe. The United States started to make rapid strides towards industrialisation following the Civil War of 1861-1865. The war provided the initial impetus for the production of coal, iron and steel in the country. The industrialisation process was aided by a mass immigration of approximately 14 million people, mainly Europeans, to the country between 1860 and 1900. The vast natural resource endowments of the country together with the absence of threats from neighbouring states and the rapid increase in population spurred the industrialisation process. By 1890, the United States had the largest factory system in the world. Internationalisation of activities occurred relatively early on, largely due to the smallness of the domestic economy. External competition for cheap manufactured exports increased considerably in the late 19th century as countries throughout Europe started to industrialise and the United States and Britain were thus forced to explore new markets elsewhere (Smith and Nöthling, 1993, 148-149).

The rapidly urbanising and industrialising countries in Western Europe and the United States largely drove demand for specialised temperate foodstuffs and raw material products supplied by countries such as Sweden, Finland and Canada. Manufactured products, labour and capital were imported in exchange for goods such as cereals and sawn wood (for use as pit props and railway sleepers, etc). These countries retained the position of producer and importer for a number of decades until local demand exceeded the imported supply of critical inputs, necessitating the development of a local manufacturing sector. Factor disadvantages, such as distance from local and international markets, lack of appropriate skills, and inaccessible resources also prompted the early drive towards differentiation, diversification, and internationalisation of enterprises. Industrial diversification initially involved two stages. First, in the early stages of primary processing activities included meat packing, diary processing, milling of wheat, saw milling and iron ore processing. However, as local demand for imported capital goods and services increased a variety of input support and service industries emerged such as farm machinery, fertilisers, transport equipment and chemicals. Furthermore, not only was surplus outputs and export revenues reinvested directly into the resource-based export sector, but they were used indirectly to fund the establishment of critical infrastructure necessary for the transportation, storage, processing, commercialisation and financing of the goods produced in the hinterlands of the industrialising countries. These formed the backward and forward linkage activities; the immediate effects arising from the export sector (Fogarty, 1985; Kasvio, 2001; Korten, 1996; Blömstrom and Kokko, 2002; de Ferranti *et al*., 2002a).

Diversification and Internalisation Initiatives

As industrial centres and cities started to form, the process of diversification was complemented by the emergence of a number of small-scale urban consumer industries based on individual and family capital, which supported the new industrialising core. Through these final demand linkages the multiplier effects of the export sector growth were felt throughout the country as wealth increased and improvements in basic living standards resulted (Armstrong, 1985). Armstrong's (1985, 85) comment on the Canadian and Australian experience of diversification effectively sums up and parallels the situation experienced in Sweden, Finland and the United States in the early years of industrialisation –

> "It is clear that the development of [these] societies was characterised by a significant degree of internally diversified, sectoral expansion; much of this was directly associated with the spillover effect of staples sector growth into related activities in commerce, finance, administration, transport and manufactures, supplying inputs or processing outputs. It was also part of a wider multiplier effect throughout the whole society, where the interaction of the social classes within a relatively autonomous and modern nation-state provided the conditions for partial industrialisation of the economy".

It is important to note, however, that the emerging manufacturing sector remained tied to the growth and expansion of the initial export industry and therefore was susceptible to cyclical fluctuations in prices and shocks in the international market.

Larger manufacturing and processing operations expanded through early internationalisation initiatives, the attraction of foreign investment, and the acquisition of technologies and patents developed abroad. Canada was one of the earliest recipients of foreign (United States) production capital at the turn of the century (Power, 2002). In both Sweden and Finland the government actively encouraged foreign competition and domestic firms were therefore forced to expand productive capacity relatively early on in order to remain competitive and operational. Acquisitions and mergers and the establishment of subsidiaries characterised the early growth and development strategies of private firms in the latter two countries. Each of these factors served to expand the domestic market and local economies of scale raising productivity and employment levels (Vuori and Ylä-Anttila, 1992; Hernesniemi *et al*., 1996; Vuori, 1997; Kasvio, 2001; Blömstrom and Kokko, 2002; Blömstrom *et al*., 2002).

<u>Development of an Entrepreneurial Core</u>

The early capacity to initiate and carry through a process of partial, domestic industrial development within an indigenous manufacturing sector utilising modern technology and efficiently managing and organising business led to the emergence of a class of industrial capitalists. Technologies were generally sourced from abroad and were inexpensive and widely available. In the early years of industrialisation, research and development (R&D) was only of minor importance to firms and interaction with end-users was kept to a minimum. However, as diversification started to occur, an increasing share of critical growth factors (e.g. communications infrastructure, renowned universities and research institutes, etc.) began to be developed internally. In time, these generic and sector-specific factors of production became new sources of national competitive advantage (Vuori and Ylä-Anttila, 1992; Blömstrom *et al*., 2002; Power, 2002).

Private and Public Sector Collaboration

Growth and diversification was a cumulative and collaborative effort. Private companies led the pursuit of export markets and diversification. However, the active participation of the government in the early years of industrialisation played an important role in the initial success of the resource-based sector. Due to the high level of competition between firms in the 'take-off' years, R&D resources were reserved for efforts that would lead to immediate/short-term commercial success. Internal training initiatives were few. The public sector therefore took responsibility for ensuring the continuation of basic research, establishing training facilities to ensure the dissemination of research know-how, and bearing the business risks associated with the adoption and application of a new technology. Moreover, due to the widespread availability and ease of application of new technologies, the prudent identification and targeting of resources called for the active participation and involvement of the government in the development process (de Ferranti *et al*., 2002a; 2002b). The important early role of the government is illustrated by the following country experiences. First, although Finland fell under the ruling authority of Russia when industrialisation commenced in the 19th century, the government nevertheless proceeded to establish an independent set of economic institutions and organisations, including a national currency (*Markka*), legislation system, language, and system of administration. Significant additional interventions were made by the government before the turn of the century with regard to the formation of a central government, banking system, transportation networks (railways and waterways), communications infrastructure (telegraph), and general infrastructure (energy and electricity). In contrast to other countries, the Finnish government did not always directly favour domestic producers. In the formative years of industrialisation the government stressed competition as a means by which to nurture the domestic market, particularly in new growth-driven industries, and permitted foreign competitors to enter Finnish markets. Domestic companies were therefore forced to become competitive in order to survive and expand. At the same time, the government encouraged the growth of all industrial sectors. For instance, a law was instituted that forbade forest owners from purchasing farming land, which helped to preserve basic agricultural activities. The government also protected economic perceptions by instituting conservative fiscal policies and by avoiding large domestic deficits or foreign debt (Hernesniemi *et al*., 1996; Ali-Yrkkö *et al*., 2000; Blömstrom and Kokko, 2002). Hernesniemi *et al.* (1996) point out that most of the early resource-based industries in Finland were developed as state-owned companies and for a long time accounted for as much as 80% of total employment in the country. The government also supported the modernisation of state-owned companies. It has been asserted that that remarkable growth of Nokia can be partially attributed to this active approach to policy on the part of the state (Ali-Yrkkö *et al*., 2000).

Second, in Sweden, the industrialisation process was significantly advanced, if not triggered, by a number of reforms made by the government to restructure agricultural/farm land and forestry holdings. These restructurings, together with improved implements, boosted productivity, employment and output levels. In addition to these interventions, policy changes in education and corporate activity as well as investment in infrastructure spurred economic development. The financial sector, moreover, was developed on the initiative of the private sector (Lindbeck, 1978; de Vylder, 1996; Korten, 1996; Blömstrom and Kokko, 2002).

Third, in Canada and the United States diversification was aided by the early emergence of a well-developed and stable legal system and a pervasive culture of trust, entrepreneurship, and respect for private property and markets between the private and public sectors (Armstrong, 1985; de Ferranti *et al*., 2002b). Wright (2001) identifies, in particular, the relatively liberal attitude of the government toward mining rights as a critical factor underpinning the sector's success in copper, iron ore, antimony, magnesite, nickel, mercury, silver and zinc between 1870 and 1910. Key elements in the US mining laws in the late 19th were: open access for exploration, exclusive rights to mine a specific site upon proof of discovery, and the requirement that the claim be worked at some frequency or be subject to forfeit.

Fourth, in Australia the construction, maintenance and operation of railway lines in each of the colonies was undertaken by the federal government, often financed by foreign loans and expertise, which opened up the interior and facilitated rapid growth (Armstrong, 1985).

Fifth, in both Canada and Australia mechanisms were developed to provide the general population with access to land and natural resources. De Ferranti *et al.*

(2002a; 2002b) highlight the important role of the homestead-style settlement of the plains of Canada and the United States in the emergence of local industries. These reforms encouraged a more equalitable distribution of income and reduced the possibilities for social and political conflict (Armstrong, 1985; Power, 2002).

Last, Power (2002) points out that incentive schemes on the part of the various governments further encouraged the development of economic opportunities and new technologies. Most importantly, in all five of the countries, institutional arrangements served to ensure that the potentially large economic rents associated with mineral development did not lead primarily to conflict, corruption, and waste, but were in fact effectively reinvested in the economy (Armstrong, 1985; Pajarinen *et al*., 1998; Kasvio, 2001; de Ferranti *et al.*, 2002; Power, 2002).

<u>Government's Approach to Foreign Trade</u>

The government's initial approach to foreign trade is also a distinctive feature underpinning the initial resource-based industrialisation success of these countries. Regulations controlling imports of certain agricultural and manufactured good and trade policies limiting the degree of foreign ownership were initiated in an attempt to protect and boost the growth of domestic industries. However, import substitution initiatives were never of the extreme inward-looking type characterised by recurring balance of payments crises, political instability, limited entrepreneurship, and restricted innovation. Instead, what emerged was a dynamic domestic manufacturing sector with a capacity for renewal. Commenting on the motivating factors behind increased protection in the early Australian and Argentinean economies, Armstrong (1985) states that –

> "Both economies attempted more merciful and less costly industrial revolutions, by relying heavily on government regulations and controls, and contrived economic rents. They were both guided by sentiments of nationalism and nativism, stressing the nation's defence against competition from cheaper labour and/or more powerful foreign economies".

In Finland, authorities nurtured co-operation and strategic coalitions among companies in order to defend local firms against foreign industry giants and their cartels. The early growth of Nokia was partly due to these policy initiatives. Competition and co-operation were not perceived as mutually exclusive, rather both were based on the need for and maintenance of economic sovereignty – competition would ensure innovation and upgrading while co-operation would reinforce national independence and cultural identity in the wake of global competition. In Sweden, inward-looking policies were only implemented after the export-oriented resource-base was in place, which helped to ensure sustained vibrancy and competitiveness (Blömstrom and Kokko, 2002). In Canada, the protective tariffs of the National Policy adopted in 1879 were intended less to promote an indigenous class of Canadian manufacturers than to encourage industries on Canadian soil. It was a policy that persuaded the larger and more dynamic US manufacturers to establish branch plants in Canada, many of which were financed in later years by powerful domestic banks (Armstrong, 1985). Power (2002) also points out that relatively open approaches to foreign investment and immigration policies to those of European heritage played a significant role in facilitating the influx of capital and labour resources to boost the emerging economies such as the United States and Canada.

R&D Involvement and Long and Sustained Investment in Education, Innovation and Entrepreneurship

As the growth of the resource-based export sector expanded, well-targeted and well-managed investment policies gradually replaced consumption-based and distributive policies. While the particular reasons accounting for the shift from factor- to investment-based growth varied between these countries, in all cases the public sector played an important role in selectively channelling capital to particular industries, providing temporary protection to others, and establishing collective risk sharing arrangements. Investment-driven competitive advantage, however, was only successful in certain industrial segments; those characterised by scale economies, standardised products, low service content, and easily transferable technologies. The base of sophisticated industrial firms, therefore, was relatively narrow. A willingness and ability of private sector firms to expand activities by investing aggressively in modern and efficient production technology and facilities matched the proactivity on the part of the government. A strong national consensus to pursue national wealth and long-run growth gave new impetus to the development of national competitive advantage and a rise in wages and other factor costs. An early commitment by both the private and public sector to ensuring high levels of basic literacy and numeracy within the population, followed by sustained investments in skills development, research and development (R&D) and constant emphasis on innovation, also underpinned the success of the resource-based developed countries. The following section elaborates on the experiences of investment-based growth in Sweden, Finland, the United States, Canada and Australia.

Investment in Education

In Sweden, initiatives to improve the literacy of the population began in the late-1840s, two decades before industrial 'take off' officially occurred (Blömstrom and Kokko, 2002). These were supplemented with reforms and programmes aimed at reducing the rigidities imposed by, for example, the guild system and increasing the diversity and range of skills in secondary, tertiary and vocational activities. A growth in the number of technical institutions and industry organisations as well as technical workshops in various private firms throughout the country provided the base for the emergence of a class of highly-skilled and competent engineers and craftsmen by the turn of the century. New engineering schools and workshops played a pivotal role in providing the talent to drive the industrialisation process forward. Swedish engineering expertise and know-how were in already in high demand overseas by the late 19th century. Indeed, it was the result of early Swedish entrepreneurship and innovation that led to a number of critical technological breakthroughs and innovations in the first decades of industrialisation, most notably steam turbines, the adjustable spanner, the safety match, air compressors, automatic lighthouses, instruments for precision measurements, and ball bearings (Lindbeck, 1978; Korten, 1996; Blömstrom *et al*., 2002).

Commenting on the Australian experience of early investment in education and skills development, Duncan and Fogarty (1984, 129) point out that "geological knowledge and mining expertise became part of the Australian heritage enriched by schools of mines of world class and the industry has been at the forefront in the development and application of mining and treatment technology".

According to de Ferranti *et al*. (2002), more than 80% of the population over 10 years in Canada and the United States was literate by 1870. Discussing the divergent experiences of Canada, Australia and Sweden, on the one hand, and Latin America (which failed to use the resource endowments to trigger growth) on the other, de Ferranti *et al*. (2002a; 2002b) state that by 1920 Australia had 5 times the number of engineers as Chile or Colombia. In 1917, there were 7 500 mining engineers in the United States (Wright, 2001). By 1926, Australia had 27 times more technical school graduates per capita than Argentina, and Sweden had 10 times the density of engineers as Colombia and Chile (Armstrong, 1985).

Another distinguishing feature of the early emphasis on literacy in the Scandinavia and North America was the type of education offered. Subjects such as mathematics, physics, chemistry, topography, and hydraulics as opposed to law, philosophy and theology (which were the preferred subjects in Latin America in the 19th century) provided the necessary foundation for the emergence of skilled artisans, technicians and engineers. Other cultural aspects such as religious and ethnic homogeneity also contributed to the growth process (Maloney, 2002).

Investment in Innovation

Education and the growth of innovation and entrepreneurship was also underpinned by the government's recognition of the importance of actively encouraging engagement with the world economy and learning from experiences elsewhere. In Sweden, knowledge of current developments and techniques was acquired through the transfer of skills and know-how facilitated by various foreign-study programmes and interaction with visiting researchers and industrialists to the country (Blömstrom and Kokko, 2002). In Canada and Australia, immigrants played an integral role in the early innovation and entrepreneurship activities within the countries. Indeed, Wright (2001) points out that most mining activities in Australia were begun by Cornishmen ("Cousin Jacks") who had a high degree of applied skills (Cornwall has a long history as a tin mining district). In addition, in 1886 the Australian government recruited a number of highly paid engineers and metallurgists from the United States in an attempt to boost the growth of the local mining industry (Maloney, 2002).

Interaction with the foreign firms and scientists and researchers was matched by both a willingness and ability of local entrepreneurs to source basic technology from around the world through licensing, adapt it to suit local requirements, implement it, and develop alternatives to broaden the range of applications in the firm. Continuous investment resulted in the upgrading of basic factors of production to more advanced ones, although the resultant product technologies remained behind the most advanced generation. Fogarty (1985, 22) maintains that, "Countries became leaders in the export of a particular resource (staple product) by improvising and adapting technologies, but above all standing in the fore as contributors of technological advances".

According to Wright (2001), the mining industry in the United States rose to prominence in the 1870s and 1880s due to a series of technological advances in drilling and blasting using nitroglycerine dynamite (developed and patented by Alfred Nobel, a Swedish engineer, in 1866) and rock drilling machines powered by compressed air. Steam engines were adapted to hoist ore from the deepest mines in the country, as well as in stamping and other surface operations. Furthermore, the development of electrolytic processes in the 1890s was essential for the subsequent development of copper and aluminium (de Ferranti *et al*., 2002a).

De Ferranti *et al*. (2002, 49) assert that, "It is the dynamic process of productivity growth arising from innovation and adoption of new technologies that propels development". While the receipt of foreign technologies and processes contributed to growth and development, adaptation and implementation relied on an open and creative workforce. Each of these five countries developed a certain degree of workforce flexibility which enabled them to retain superiority in spite of challenges from other producers. By producing a superior product they were not only in a greater position to respond to rapidly changing demands, but created new demands. Illustrating this, the first Nokia paper and pulp mills were directly the result of a young metal and mechanical engineer who witnessed the paper manufacturing process while visiting Germany. Believing that the Finland possessed the manufacturing potential, technical capabilities and natural resources to replicate the process, Fredrik Idestam introduced the manufacture of paper and pulp in the country. The first paper board machine was sourced from the United States and established in Finland for domestic use in 1905. After a long period of incremental innovations and close domestic user-producer interactions the first paper machine was manufactured for export in 1948, following the war (Vuori and Ylä-Anttila, 1992; Ali-Yrkkö *et al*., 2001). In addition to paper machines and forest harvesters, another area in which Finland has excelled has been in the chemical market. While the majority of forest industry chemicals were imported up until the 1970s, a number of Finnish companies now dominate the international supply market (Hernesniemi *et al.*, 1996).

Inherent personal characteristics, such as perceptiveness and creativity, amongst the new entrepreneurs and engineers also contributed to the growth process. In his account of the growth and initial success of the wool industry in Australia, Fogarty (1985, 27) asserts that while an essential ingredient was the ability of a select group of dedicated breeders to respond to market demands, the dynamism and ability to remain ahead of competition rested on “the personal qualities and perceptions of the individuals involved”. Similarly, Blömstrom and Kokko (2002) argue that it was due to the “ability of Swedish industry to create, adapt and disseminate new technologies” that led to the country’s remarkable developments in manufacturing. Sweden’s early success in the minerals industry was largely due to the acquisition of the patent rights for the Bessemer method of steel production, Krupp technology in cemented carbides, and diesel technology for automotive applications (Porter, 1990). Commenting on the Finnish approach to innovation, Herring (2001, 12) states that if something is to be learnt from their experience it is to “Innovate not just because it is fun to think up exciting new ideas … but because you know there is something you could do with the technology if you can come up with it”.

Investment in Entrepreneurship

Rather than being driven by a single industry or select group of individuals, early industrialisation in Finland, Sweden, Canada, the United States and Australia was a cumulative process resulting from a series of incremental advances made by individuals in a range of different economic sectors (de Ferranti *et al.*, 2002a). The creation and adoption of new technologies was aided by partnerships and close collaboration between industry, government and academic/learning institutions. Blömstrom and Kokko (2002) argue that networks and co-operative relations became one of the most important ingredients for industrial clustering in Sweden particularly as companies started to differentiate their product lines and exports such as pulp, paper and engineering products became increasingly important. Prior to World War I these networks often substituted for specialised research and development departments which were largely absent in many firms. Furthermore, such knowledge networks are regarded as pivotal to further growth and productivity in the country and “perhaps the main strategic and competitive asset of the Swedish forest industry” (Blömstrom and Kokko, 2002, 34). Moreover, while accumulated internally-developed competence in telecommunications enabled Ericsson to develop and overcome technological problems, in recent years, as technology has become increasingly sophisticated and the technological lags shorter, collaboration has become a necessity (Blömstrom and Kokko, 2002). It is also noted in the literature that economics professors from various universities played a highly influential role, and still do, in guiding strategic decision-making in the Swedish government (NUTEK, 2000).

Close collaboration between the users and producers in the testing and refining of new technologies was an important feature in the Finnish growth process. According to Ericsson and Särkkä (2001), many of the metallurgical processes developed in the 1950s and 1960s were linked universities, research institutes, and technical divisions in prominent firms such as Outokumpu and Alvista Polarit. Likewise, Hernesniemi *et al.* (1996) point out that during the postwar years, forest companies and metal workshops worked in close co-operation in the development of new technology. This interaction has been most apparent between paper mills and machinery suppliers. As a result of these partnerships, Finland has successfully moved from being an importer of forest industry machinery to a technological leader and exporter. This partnership provided a source of innovation to both sectors. Blömstrom and Kokko (2002) argue that close collaboration with both government and academic institutions underpinned Nokia's development. Limited experience in the area of telecommunications forced Nokia to purchase various local and international firms in order to acquire relevant skills and expertise. In-house training initiatives and public investments in education complemented this. In the 1980s, Nokia commenced with an aggressive human resource development programme in partnership with the state and academic institutions. The public education system was modernised, international student-exchange programmes were supported, employees were encouraged to work abroad in foreign affiliates to gain new skills and experience, continuous life-long learning was encouraged, and the Nokia University was established to raise the formal competence of all Nokia employees by one level (bachelors to masters, masters to doctorate) (Ylä-Anttila, 2000; Ali-Yrkkö, 2001; Ali-Yrkkö *et al.*, 2001). More significant is the fact that Finland is currently one of the world leaders in both technological co-operation between companies and in research co-operation between companies and universities. Local companies, moreover, are actively encouraged to pursue the formation of joint ventures and research partnerships with foreign companies (Saarnivaara, 2003).

Regarding the experience in the United States, Wright (1999, 308) asserts that success in mining was "fundamentally a collective phenomenon" between world-class mining universities and both government and private research centres. The national governments of Canada, the United States and Australia assisted the advance in mineral development through the provision of national geological surveys providing public information on mineral potential. Co-operative agreements between mining companies and leading universities resulted in the emergence of mining engineering, mineral processing, and geology programmes that enhanced exploration, development and processing. According to Power (2002, 25) "From the very beginning of the US industrial period, and at later periods in Australia and Canada, mining was a 'knowledge' industry that was at the forefront of developing science and engineering". Knowledge spillovers resulted from R&D activities, technical or managerial know-how, learning-by-doing, and trained workers who 'job hopped' across firms. Such know-how and knowledge prepared firms to identify and exploit unforeseeable technological opportunities and enabled discontinuous lateral migration leaps to be made (Blömstrom and Kokko, 2002; de Ferranti *et al*., 2002b). At the same time, participation in world trade fairs, exhibitions, and collaboration with researcher and research institutes abroad encouraged the development of knowledge spillovers, broadened international exposure and advanced local know-how. Indeed, it was as a result of participation in the Moscow Exhibition (1872) and the World Fair in Philadelphia (1876) that Sandvik's international status and reputation was initially forged (Teigland *et al*., 1998). Similarly, at the Paris World Fair in 1867, Fredrik Idestam (the founder of Nokia), won a bronze medal for his groundwood pulp, which stimulated a large amount of international (primarily in continental Europe and Russia) and local interest for Nokia forest-based products (Kasvio, 2001).

In the Swedish case, another important aspect of collaboration was the inclusion of labour unions, voluntary associations and grassroots organisations in the development process. According to Korten (1998) these organisations served as 'schools of democracy', providing strong pressure groups for social change and emphasising the importance of competition and innovation. Indeed, "the Confederation [of Trade Unions] was resolutely free trade, strongly criticised government protectionist measures, and argued that tariffs would decrease productivity growth since it would protect stagnating and less competitive industries" (Maloney, 2002, 20). Increasing total factor productivity was the primary goal of the trade unions in the post-war period, which went a great way to advancing growth and development in the country.

Investment in R&D

Underlying Finland's economic success has been the approach adopted by the government, academic institutions and industry towards innovation. In the late 1970s, a combined initiative was undertaken within the country to improve R&D. Know-how and technology were considered imperative for the country's future prosperity. This move encompassed a dramatic increase in the level of R&D spend in both traditional sectors and new technology-competitive industries within private and public firms, improving R&D infrastructure, and ensuring the innovation process was well-managed and efficient (Ministry of Finance, 2002; Saarnivaara, 2003). In the early 1980s, Finland allocated about 1% of GDP to R&D investment. At the turn of the decade, this had increased to 2% and by 2000 had reached 3% (Asplund, 2000). Finnish companies, universities, and research institutes invested EUR 5 billion in R&D (3.6% of GDP) in 2001. Approximately 70% of this R&D is undertaken by the private sector. This high level of R&D investment has been reflected in the increasing shift in Finnish industry towards more high-tech activities. Finnish high-tech exports accounted for 21% of country's total goods exports in 2001 (Saarivaara, 2003). As a consequence of this approach to R&D spend, Finland achieved a number one ranking in the world by the World Economic Forum with regard to competitiveness in 2001. While most innovative technology developed in Finland is generated within large companies, most research funding is reserved for small- and medium-sized enterprises. R&D networks, moreover, are informal and based on trust, collaboration and co-operation.

In Sweden, approximately 3.58% of GDP is spent on R&D, one of the highest figures in the world. Underpinning the Swedish government's current approach to industrial development is the recognition that prerequisites for long-term sustained economic growth and development include: strong regions and dynamic industries; continuous knowledge generation and support for R&D; well-functioning education system; good entrepreneurship; well-organised labour; and opportunities for co-operation and collaboration supported (NUTEK, 2000).

The economic success of the United States can be attributed in part to sizeable and sustained investments in education, research and development, and infrastructure by all levels of government over a considerable length of time. Since the late-1940s, constant improvement and investment in initial factors of production have served to stimulate the expansion and diversification of initial areas of competitive advantage and have thus broadened the economy. While the United States government spent US $61,790,000 on R&D in 1960, by 2000 this figure had increased to US $247,519, 000 (Leach, 2002). Through other factors such as strong domestic and international demand conditions, the geographic clustering of firms, the integration of many industries (such as electronics), minimal levels of direct intervention and public ownership of industries, and the government's free and open trading system and anti-trust policy, the United States has succeeded in becoming world leader in a number of end products, parts, machinery and service industries. Key industrial sectors include, amongst others, automobiles, aircraft, energy, power generation, electronics, mining and construction. More importantly, it has been the ability to use innovations and know-how as the stepping stone to further growth that has elevated the United States to the position as one of the most competitive nations in the world (Porter, 1990; Stockall and Associates, 2000; Wright, 2001; de Ferranti *et al*., 2002a; 2002b).

A breakdown of the technological capability of some of the leading countries in the world in 1997 is portrayed in Table 2 and Figure 1 shows the differences in R&D expenditure as a percentage of GDP for seven countries in 2000.

Table 2: Indicators of Technology Capability (1997) (Blömstrom *et al*., 2002, 7)

Rank According to Technology Index	**Country**	**Scientists and Engineers in R&D (per 100,000 people)**	**Research and Development Expenditures as a % of GDP**	**Research and Development Expenditures in Business as % of Total**
1	Finland	2,799	2.8	57.7
2	United States	3,676	2.6	59.4
3	Sweden	3,826	3.8	62.9
4	Japan	4,909	2.8	81.7
5	Korea	2,193	2.8	84.0
6	Netherlands	2,219	2.1	44.7
7	United Kingdom	2,448	2.0	51.9
8	Canada	2,719	1.7	50.7
9	Australia	3,357	1.8	45.7
10	Singapore	2,318	1.1	62.5
11	Germany	2,831	2.4	61.4
12	Norway	3,664	1.6	49.9
13	Ireland	2,319	1.6	63.4
14	Belgium	2,272	1.6	64.8
15	New Zealand	1,663	1.0	33.9

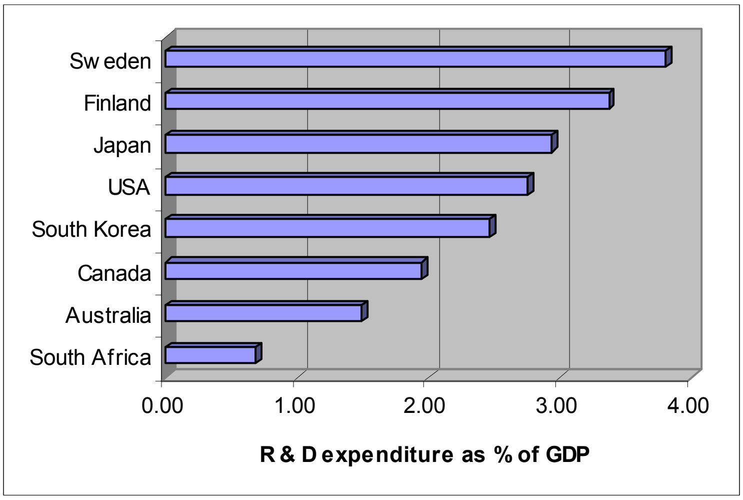

Figure 1: GDP share of R&D expenditure for selected countries (adapted from DST, 2002; Werner, 2003, 7)

Recognition of the importance of R&D and the identification of new sources of innovation is a continuous and critical process. Maloney (2002, 16) maintains that, "It is not that you have created a manufacturing sector, but whether you have created a source of innovation, or a brake on the dynamism of the traditional sectors who are forced to subsidise it". In the case of Sweden, Finland, the United States, Canada and Australia, while resources played a significant role in initiating development and are still critical sources of national revenue, growth is now linked to created and advanced factors of production – highly qualified personnel and world-class research. The future economic success of these countries will depend on the manner in which existing project and process know-how is applied and utilised in new economic sectors. In Australia, promising opportunities are envisaged in the ‘lateral migration’ of the country’s know-how and technology in various resource- and non-resource-base sectors such as cleaning up air, water and soil, recycling waste and eliminating pollution. Ericsson and Särkkä (2001) maintain that Finnish technologies and skills linked to the identification, treatment, and processing of ores are utilised in various extractive and resource-based industries. Numerous possibilities exist for the application of such skills in equipment manufacturing, engineering, earth science industries, environment, water supply, and town planning.

Cluster Development

The period of sustained investment-based growth culminated in the emergence of an internationally-competitive industrial base made up of distinct clusters of various economic activities. The formation of clusters, particularly in Finland, Sweden and the United States, has been attributed to the presence and interaction of four distinct elements: unique factor conditions, demand conditions in the local and international market, a network of related and supporting industries, and firm strategy, structure and rivalry (Porter, 1990; Hernesniemi *et al*., 1996; Brandt, 2001; de Ferranti *et al*., 2002a; 2002b). While cluster development had its roots in the 19th century (at the outset of industrialisation), the shift to an emphasis on the further application and exploitation of technological know-how and competence built up in particular industrial sectors in the 20th century generated a ‘virtuous cycle of innovation’ within each of these countries. Clusters consequently became the key ‘engine of growth’ around which economic superiority and dominance was achieved and is being maintained. The development of clusters was a critical factor underpinning the transition of these countries from resource-based growth to high-tech, knowledge-intensive industrialisation and is an integral feature in current industrial planning and strategy formulation in all three of these countries (Rosenfeld, 2001; Sommers, 2001; Ministry of Finance, 2002; Rosenfeld, 2002). The various elements and features of cluster development in Sweden, Finland, the United

States, and to a certain extent Australia and Canada, will be discussed and reviewed in the following section.

Factor conditions

To a large extent, the industries comprising the economic clusters/development blocks in these resource-based industrialised countries obtained their competitive strength from traditionally strong sectors, which reflected the country's specific history and environment. For example, Sweden and Finland developed on the back of forestry, followed by metals and mining. In Australia and Canada, it was on agriculture and stock farming, followed by mining.

The impetus for the rapid increase in the number of technological developments and innovations, which spurred the development of clustering, in the first few decades of industrialisation came from a variety of different sources. First, factor advantages were often matched with factor disadvantages. The harsh climate, rugged topography, hard bedrock and mineral deposits with a low-ore content in Finland and Sweden triggered a variety of technologically-advanced spin-off industries including power generation, logistics, transportation, and drilling equipment in order to overcome these factor disadvantages. In addition, a shortage of skilled personnel and the high cost of labour spurred early moves towards automation, process control, streamlined management procedures, and the pursuit of markets abroad (Porter, 1990; Blömstrom and Kokko, 2002). In the United States, mineral deposits were of a relatively low-grade and often located in remote areas. Transportation costs were also high. Consequently methods were developed relatively early on to increase the profitability of the ores, mobilise large quantities of capital, and reduce the high transportation costs. These included the integration of mining, concentrating, refining and other manufacturing operations at the site of the ore bodies. In this way, mining provided the impetus for the development of new, complex forms of business organisation incorporating all stages of the value chain (Power, 2002).

Second, chance factors also played a role in facilitating the development of clustering. Sweden managed to remain neutral during both World Wars and therefore was able to capitalise on the increased international demand for building and construction goods needed in the European restoration process (Korten, 1996). In Finland, the growth of the export industry was significantly advanced by access to

Russia and the Baltic markets in the early years of industrialisation. As a Grand Duchy of Russia, Finnish exports to Russia were free of import tariffs and customs duties. In the post-World War II period, the need to provide a huge amount of industrial goods to Russia as war reparations forced many Finnish industrialists to intensify production, expand capacity and diversify into a range of metal- and engineering-based activities. It was this move, which ultimately shifted the economy away from primary into secondary activities (Saarinen, 2000).

Demand conditions

The industrialised country experience of resource-based development was underpinned by the successful growth of both local and international markets for the products produced within the clusters. In the initial stages of Swedish industrialisation, export-led growth was driven by the demand for forest products in Great Britain and other parts of Western Europe, which were needed to further their industrialisation processes (e.g. sawn wood for pit props and railway sleepers). Later, international demand for metal-based products such as air compressors, ball bearings, engines, drilling equipment encouraged firms such as Sandvik and SKF to internationalise operations and establish subsidiaries and sales offices around the world (De Vylder, 1996; Korten, 1996). The Swedish steel industry was also driven in the formative years by the internal industrialisation process (*Swedish Industry*, 2001). In Finland, a small domestic market and lack of competition prompted firms to internationalise operations and expand through mergers and acquisitions relatively early on. Moreover, demand for Finnish products both locally and abroad was significantly advanced by an early emphasis on quality and the efficient meeting of customer demands. Indeed, Frame (2000) points out that it was largely due to the early marketing endeavours and application of the Goodyear vulcanisation process that boosted the growth and regional competitiveness of the Finnish Rubber Works (which was one of the three companies that combined to form Nokia Corporation in the early 1960s) in the early 20th century. The company adopted the slogan “Wear only Finnish galoshes in Finland”, which resulted in an increase in the domestic demand for a range of rubber-based products including, pacifiers, footwear, raincoats, and numerous industrial applications such as rubber parts for maintenance, heating plants, waterworks, power plants, hoses, and seals. The need to adapt technologies to international standards and tailored to meet customer needs has also been important driving factors in Sweden, the United States, Canada, and Australia (de Ferranti *et al*., 2002a; 2002b). The rapid increase in the number of new firms and entrepreneurs at the outset of industrialisation increased the level of domestic rivalry. Increased competition and demand, both from abroad and within the domestic market, spurred the development of new innovations, technologies and capital equipment.

Specialised related and supporting industries

As mentioned previously, using existing resource comparative advantages as a base these countries have succeeded in industrialising through an on-going process of improvement, adaptation and innovation. These three actions enabled firms to move up the value chain, increasing the value-added to the original resource with each subsequent stage entered. Initial success and dominance have been sustained over the years, keeping pace with technological and market changes through the self-reinforcing nature of initial areas of comparative advantage and specialisation (Porter, 1990).

The foundation for this dynamism emerged right at the outset of industrialisation as the environment in which industrial 'take-off' commenced was right – social, political and economic factors were all conducive to growth and the fostering of entrepreneurship. A number of firms engaged in similar activities linked to the resource base emerged as a consequence. Close proximity resulted in a range of spin-offs: a deep pool of highly skilled and competent scientists, engineers and craftsmen; a source of sophisticated and specialised services and inputs industries which could not be accessed remotely; and a continuous process of knowledge acquisition and dissemination amongst firms. These knowledge spillovers, specialised inputs, and specialised skills combined to raise the level of competition and dynamism within the cluster. As competition increased, knowledge acquisition increased, the prosperity and attractiveness of the area to labour and investment increased, and more specialised input companies emerged resulting in a continuous cycle of innovation (Porter, 1990).

The process of cluster development

The process of cluster development involved various stages depending on the type of industry or economic segment. Firstly, in the initial years, diversification initiatives usually entailed broadening the product line in a variety of different areas, boosted by domestic and international demand for such products and advanced by the purchase/acquisition of both domestic and international companies engaged in such activities. Wright (2001) asserts that after cotton, nearly all the leading export categories in the United States between 1879 and 1909 were manufactured goods with linkages to the resource economy: petroleum products, primary copper, meat packing and poultry, steel works and rolling mills, coal mining, vegetable oils, grain mill products, sawmill products, and so on. From the 1930s onward, cars became the leading export product. The growth of the automobile industry stimulated a variety of resource-based related and supporting industries such as petroleum products, cotton, primary copper, steel works and rolling mills, coal mining, tobacco, sawmill products, and farm equipment. In turn, these industries triggered further spin-off enterprises including canned foods and mining machinery.

In Finland, in response to a series of booms in the sawn wood industry in the late-19th century and first decades of the 20th century, numerous forestry-based firms extended their product range to include wood pulp, paper, matches, cellulose, and plywood. These industries led, in turn, to the creation of further downstream enterprises that produced textiles, cement, and metal products (Vuori and Ylä-Anttila, 1992; Saarinen, 2000; Kasvio, 2001; Blömstrom and Kokko, 2002). The growth of the Finnish forestry industry is regarded as the epitome of a successful and sequential clustering process. Although dependence on traditional, primary-based activities have gradually given way to high-tech activities such as telecommunications in Finland, the forestry cluster is still an integral element in the economy and is the third most important economic cluster after electronics and mining. In 2000, pulp and paper and wood products together accounted for 28% of total exports from Finland, metals comprised 24%, electronics and electrical equipment 32%, and other industrial goods 16%. According to Vuori and Ylä-Anttila (1992, 1), “the forest sector forms by far the most important development block in the Finnish economy and many of the new high-tech, knowledge-intensive industries owe their origins to the forest sector or to forest-related spin-off companies”. Härmälä (1999, 14) states that, “Finland depends on its forests and the sustainable utilisation of renewable resources is a prerequisite for our standard of living”. In Finland, the concept of the forest ‘cluster’ relates to forest-based industries (forests, wood processing, printing matter) and relevant sections of associated industries and sectors such as the energy, chemicals, machinery, construction, printing and publishing, marketing, and logistics sectors (Ministry of Trade and Industry, 1993; Hernesniemi *et al*., 1996). Hernesnieme *et al*. (1996) assert that many internationally competitive and successful Finnish engineering product and service industries (specifically related to mining, information technology and electronics), have backward linkages to the accumulation and adaptation of know-how developed within forestry or the forestry industry. The most important of these spin-offs relate to process control electronics, forestry tractors, boilers for pulp factories, design and planning of the entire production line in paper mills, machinery, training and education systems, and advances in automation (Vuori and Yla-Antilla, 1992; Ministry of Trade and Industry, 1993; Hernesnieme *et al.*, 1996). In addition to this, while all the required capital equipment and machinery needed in the production of pulp, paper, paperboard and sawn wood is manufactured within Finland, as much as 75% of the technologies used in the industry have been developed in other sectors, particularly in those related to machinery and equipment production, chemicals, and biotechnology (Hernesnieme *et al*., 1996).

In the case of Sweden, Porter (1990) argues that the country is essentially made up of clusters of related and supporting industries, many of which have their roots in forestry- or metals-based activities. Overlapping linkages of demand and supply from various sectors reinforced and propelled cluster growth. For example, forestry offered downstream demand for both paper and pulping technologies, as well as transport products developed by Saab and Volvo in Sweden, which boosted the growth and diversification of two separate clusters (de Ferranti *et al*., 2002a).

Secondly, over time the emphasis in some industries expanded to include the whole product line of a variety of different industrial sectors within one firm. For example, in Australia, by the early 20th century enterprises such as Broken Hill Proprietary (BHP) and Collins House were well-established industrial conglomerates, with vertical control extending from mining to blast furnaces to wire-rope factories to shipping lines – all of which had links to foreign capital through joint ventures (Armstrong, 1985). In Sweden, Atlas Copco, started out as a railway car manufacturer, but gradually diversified into advanced related products such as steam engines, locomotives and machine tools. It was largely due to the company's own need for pneumatic tools and machines that fuelled the company's interest in importing and adapting items such as compressors and yoke riverters. Moreover, the need for spare parts and replacement fittings spurred innovation and technology development and resulted in further diversification. Although Atlas Copco's diversification extended to include carpentry and sheet metal, it has generally remained focused on the production of mining-related tools and engineered products, most notably diesel engines, compressed air tools, pneumatic tools, compression-ignition engines, carbide steel drill bits, and rock drills (all high-tech in nature). Over the 100-year history of the company, each new product reflects an incremental process of development (www.altascopco.com). In Finland, Valmet (now part of Metso Corporation) initially began as a small shipbuilding operation and gradually diversified into producing rolling stock, elevators, aircraft, tractors, and paper machines for the local and international market. By the 1990s, however, these operations had all been divested, and paper machines and related technologies (which only became a significant product area of the company following World War II) became the main focus area of the company (Harnesniemi *et al*., 1996; www.metso.fi). According to Ali-Yrkkö (2001), one of the reasons why Nokia has been so successful has been due to the fact that it constantly focused on mastering the full value chain, from operations and new product development to marketing, sales, and service. Prior to 1967 (when the Finnish Cable works, Finnish Rubber Works and the Nokia Forestry business were officially merged to form one company, the Nokia Corporation), Nokia was renowned for its rubber boots, Hakkapeliita winter tires and toilet paper. However, the strategic move within the Finnish Cable Works to develop an electronics department in the post-Second WorldWar period shifted the focus of the company. The company gradually diversified into the manufacture of televisions, computers, and telecommunications. It was only in 1992 that Nokia divested of all its associated business areas and focused instead on telecommunications. Kasvio (2001) points out that between 1990-1996 five large colour television factories were closed down; the cable business continued independently as NK Cables; the production of computers was taken over by ICL/Fujitsu; tire manufacture was taken over by Sumitomo; and JA/Mont took over the paper manufacturing operations. After all these changes, only one building and one employee remains in the town of Nokia where the company's history was founded in the 1860s (Kasvio, 2001).

A third distinct phase in the corporate growth of resource-based companies and the expansion of domestic industrial clusters entailed the shift to specialisation, internationalisation, and increased recognition of the role and inclusion of local small- and medium-sized support enterprises in the development process. Firms competed on the global market with differentiated goods. The switch to specialisation and concentration in niche product areas in order to remain competitive and retain market dominance emerged largely as a consequence of a changing international market environment in the 1970s and 1980s. The most important factors in this regard were: the oil crises in the 1970s, which led to a decline in industrial districts and collapse of many traditional industries throughout the world; the liberalisation of many markets; the growth of the newly industrialised countries (NICs); and, the increased internationalisation of capital markets and labour. Changing business methodologies and structures also played a role. In particular, the increasing role of services in manufacturing activities and the need for close collaboration and contact with customers. Many multinational firms divested non-core activities and merged and acquired firms throughout the world in response to these changing dynamics. Reliance on outsourcing and small- and medium-sized supplier firms consequently increased, broadening the clustering process. Foreign direct investment was deemed critical for sustained competitiveness and decisions were motivated by the need to broaden and enhance firm-specific assets and attributes and increase market share rather then keeping production costs to a minimum (Porter, 1990; Landes, 1998; Pajarinen *et al*., 1998).

Specialisation relied on advanced factors of production – creativity, inventiveness, adaptability and intellectual know-how – for success. The development of clusters facilitated the formation of such factors and gradually dependence on raw materials and semi-skilled labour for national competitive strength started to wane. Decreasing reliance on traditional sources of comparative advantage for economic growth and gradual shift to higher value-added products resulted in a much more stable economic environment characterised by higher rates of return and increased market stability (Pajarinen *et al*., 1998; Blömstrom *et al*., 2002; de Ferranti *et al*., 2002a; Power, 2002). According to NUTEK (2000), –

> "In addition to having higher productivity, knowledge-intensive sectors have a greater potential for renewal than other sectors. Their production is based on human knowledge and the use of technology. Products from knowledge-intensive manufacturing allow for better conditions for growth because such products are usually newer, less sensitive to prices and have a demand that is growing faster than that for more mature products".

Likewise, Ali-Yrkko *et al*. (2001) assert that a knowledge-driven sector, especially if it is based on a generic-type of technology, is likely to induce growth over other (traded) sectors through technological spillovers and other positive externalities. Power (2002) points out that the fact that resource development was linked to a variety of manufacturing activities and stimulated the expansion of the sector, competition for resources and other “Dutch Disease” type effects were avoided, which resulted in a much more vibrant and sustainable economic environment.

The economic importance of cluster activities

The economic impact and pervasive nature of clustering within the resource-based industrialised countries can be illustrated quantitatively. The mining and mineral processing sector is an integral component of the Australian economy. According to Hooke (2003, 4), “The Australian industry [mining and minerals] is a leader among other industries in Australia, and a global leader within the sector”. The contribution of the sector to the Australian economy is highlighted by Cusack (2003):

- Over the past two decades the sector has directly contributed around AUS$500 billion to the national economy.
- Mining and mineral processing accounts for around 8.5% of national gross domestic product.
- Direct and indirect macro-economic impacts include payments amounting to AUS $4.5 billion – AUS $1.2 billion in mineral royalties, AUS $1.3 billion in Government port and rail charges, AUS $1.9 billion in income tax expenses, and AUS $400 million in indirect taxes.
- The industry generates added value of around AUS $10 billion annually, of which around AUS $8.5 billion is exported.
- The industry accounts for around AUS $43 billion of Australia’s current total annual export revenues, representing approximately 37% of total merchandise exports and 28% of Australia’s total exports of goods and services.
- Exports of mining technology, equipment and services are worth AUS $2 billion – 60% of the mining software used in operations around the world is exported from Australia.
- The sector provides direct and indirect employment for 317 000 people – approximately 5.9% of total employment in 2002.
- In 2002, the sector generated around 16% of private new capital expenditure in the country.
- The mining and mineral processing cluster has made a significant contribution to infrastructure development in the country – since 1967, 25 towns have come into existence, 12 ports and additional port bulk handling infrastructure at many

existing ports have been established, 25 airfields have been built, and over 2 000 kilometres of railway line laid.

- The sector has critical supply and demand linkages with other sectors in the Australian economy including manufacturing, construction, banking and financial, process engineering, property and transport.

Similarly, the impact of the mining cluster on the Canadian economy can be summarised as follows (Brewer, 1999; Lemieux, 2001; Cranstone, 2002):

- Minerals and metals generated CAN $36.15 billion in national revenues in 2002, approximately 3.7% of total GDP in Canada.
- Exports from the sector amounted to CAN $49.5 billion, approximately 13,54% of total exports.
- The mining and mineral processing industries directly employed 361 000 Canadians in 2002: 47 000 were employed in mining, 52 000 in smelting and refining, and 262 000 in the manufacture of mineral and metal product.
- Average weekly earnings in the mining, quarries and oil wells industry in 2002 were over CAN $1 000, one of the highest levels of any industry in the Canadian economy.
- In 2002, total mining expenditure amounted to CAN $2.40 billion.
- Exploration spend in Canada in 2002 was CAN $534.1 million.
- There are more than 2 200 firms in Canada that may be called “mining suppliers” of which half depend on sales to mining companies for 50% or more of their total revenues; 24% are from the professional, scientific, and technical services sector such as banking and legal services, and 27% are manufacturers and 45% are located in either Toronto, Vancouver or Sudbury.
- Exports account for between 30 and 50% of Canadian mining suppliers’ revenues.
- Almost a quarter of the mining supply firms are engineers, geologists, geophysicists, chemists, process engineers, environmentalists or members of related disciplines.
- Canadian suppliers sell in all the major markets. Canada also supplies the majority of equity capital for mining around the world, and has 75% of the world’s mining companies (1 447) listed on its stock exchange.
- Every dollar of additional mining output requires 56 cents of supplies from other sectors of the economy. Each billion dollars of additional mining output creates 4 360 job-years in Canadian supply sectors.

Capitalising on the various economic linkages associated with the resource-based sector to develop vibrant clusters capable of driving sustained economic development has also been matched by a commitment on the part of all cluster participants to achieve economic competitiveness and superiority. Indeed, it has been argued that Finland is more a 'club' than a series of separate industries; everyone knows everyone else, collaboration and knowledge-sharing is pervasive, and academia, industry and government are all involved in the decision-making process (Ylinenpää, 2001). A distinctive feature of all these countries' developmental experiences, moreover, is that maximising all direct and indirect linkages associated with a resource base is seen as the only way to secure and maintain current and future competitiveness. In Finland, there is a deep "commitment to seeing know-how and technology as the basis for the country's future prosperity" (Saarnivaara , 2003, 16). In the case of Canada, Brewer (1999, 2) states that –

> "The vision that Canada has for 'mining' envisages optimum use of the resource endowment as one source of employment and sustainable growth in the total economy. The development of mining, and mining clusters, was based on "knowledge capital", that is, the knowledge of mineral resources and how best to exploit these resources. The drive to remain competitive in the face of international competition has kept these sectors on the frontier of technological change. Clusters service domestic mining equipment in Canada, but the global nature of Canada's mining industry has taken the mining equipment and service supply companies global as well".

In order to realise this, the public and private sector are working together to develop a coherent and committed long-term cluster strategy for the mining supply and service sector (NRCAN, 1996; Rhéaume and Warda, 2001; Robinson, 2003).

Discussion

According to Pajarinen *et al*. (1998, 16), the global competitiveness of a nation can be defined as –

> "The ability of a nation-state to continuously attract high-value-added activities of private enterprises worldwide in such a way that all factors of production are fully employed, earn high returns and long-term external balance of the country is maintained. This is reached on a sustainable basis by offering appropriate framework conditions and sufficient pools of advanced factors of production".

Industrial development is a prerequisite for economic growth and sustained development. It is through the incremental upgrading of the industrial base that per capita income levels can increase and societal transformation and equality is achieved. Moreover, it is via this channel that innovation, technical development, and the skills of the labour force are diffused. The process of industrialisation is a complex phenomenon and the manner in which it is achieved and secured subject to considerable debate. It is widely acknowledged, however, that countries have to proceed through various stages of growth before reaching the highest possible economic state – that of industrialisation and global economic superiority (Porter, 1990; Pajarinen *et al*., 1998; Landes, 1998). It is the interventions and interactions between different participants in the economy, whether government, industry, labour unions and universities, can determine whether a country makes the next step in the developmental process or not. These interventions range from the direct support of R&D, education, infrastructure development and networking, to initiatives such as promoting gender equality in the workplace and sponsoring social upliftment programmes.

In the case of Finland, Sweden, the United States, Australia and Canada, a combination of different impulses and factors provided the initial impetus for industrialisation to occur. In some cases, chance factors such as the timeous advent of a War, a mass immigration of people to the country, the discovery of a new technology or mineral body, or the gaining of national independence played a determining role. In others, it was the result of a various advantages and disadvantages associated with available resource endowments (capital, labour or raw materials), that presented either opportunities or imperatives for a fundamental shift in the prevailing approach to macroeconomic management and governance. In the case of all the countries reviewed in this paper, less tangible factors such as a commitment to growth, entrepreneurial spirit, nationalistic pride, and attention to quality and customer satisfaction at both the personal, firm and national level at the outset of industrialisation helped to galvanise development and growth. If there is one common thread running through the experiences of the industrialised country experiences of resource-based growth it has been the realisation and recognition that it is not the number of assets or the level of wealth possessed by a country that is important, but rather the disciplined manner in which they are managed, the attitude of the workforce towards them, and the size of the domestic intellectual/know-how base which can take the asset in its basic form and continuously add value to it.

The economic success of Sweden, Finland, United States, Canada and Australia, illustrate, to varying degrees, the possibilities for growth embodied within a natural resource base and give hope to developing and semi-industrialised countries wishing to pursue a similar path. While the prevailing economic contexts and histories differ between countries, and therefore strongly influence the trajectory pursued, a resource-based approach to industrialisation is a favourable alternative growth strategy provided a number of key pointers are taken into consideration. First, the determinants for economic growth have changed. Traditional forms of comparative advantage (raw materials, cheap capital and abundant labour) have been replaced by competitive advantages, specifically knowledge. According to NUTEK (2000), "...the process of restructuring from an industrial economy into a knowledge-intensive economy has made human knowledge and the way the labour market functions important competitive factors between countries". Increasingly, multinational firms actively competing with each other are dominating the global economic environment, rather than individual nations. MNCs have the flexibility and independence to choose where to locate and in which sectors to specialise. In light of this, the most competitive nations are those which provide the most attractive and favourable business and socio-economic environment.

While firms engage in direct competition with each other and generate the products and processes required to propel and sustain growth, the role of government is far more indirect, guiding and influencing the structures and contexts within which firms operate and work through. Porter (1990, 29) asserts that, "government policy at the state and local level has an important role to play in shaping national advantage" and that "government, at all levels, can improve or detract from the national advantage". According to Porter (1990), the competitiveness of firms is determined by four elements: factor conditions; demand conditions; links to supporting and related industries; and firm rivalry. Competitiveness is only sustainable when all of these elements exert a favourable impact on the economy. It is for this reason that a successful industry/sector cannot be based on the simple extraction and export of raw materials alone. According to Wright (2001), natural resources require a certain degree of investment before they become economically viable. Governments need to amplify and broaden the deeply rooted forces of competitive advantage through indirect intervention and invest in the resource base in order to achieve this. An indirect policy mix should include policies that aim to boost demand conditions, promote structural change, safeguard financing and competition, advance human resource development, invest in machinery and equipment, and overall competence in science and technology. Resources should also be allocated and targeted to protecting intellectual property, regulating product quality, and ensuring environmental sustainability. However, it has been pointed out variously that while a sound macroeconomic policy is necessary, it is not a sufficient condition for growth (Porter, 1990; NUTEK, 2000; Stockall and Associates, 2000; Rhéaume and Warda, 2001; Ministry of Finance, 2002). Firms need to prompted, challenged and encouraged to develop competitive strategies to complement government interventions. According to NUTEK (2000), "…[it is the] will and ability to make a concerted effort at work, in every individual and at every level of the workplace, that create[s] economic growth". Furthermore, "…long-run success requires public policies and company strategies that preserve the raw material sources and create skills and competence that are needed to remain competitive in the face of increasing labour costs and changing technologies" (Blömstrom and Kokko, 2002).

Secondly, it is apparent from an examination of the industrialised country experience that economic growth is fastest in those countries where technology has advanced the quickest and where investments in machinery, equipment and human resources have been the greatest. Underpinning this success has been three critical factors: local/regional co-operation, the emergence of clusters of companies and organisations engaged in specific branches of industry, and continuous R&D and innovation. Recent studies pertaining to local economic growth emphasise the importance of science and technology and collaboration and co-operation between industry and specialised knowledge centres such as universities and higher education institutions (HEIs). Due to the increasing need for specialisation, firms seldom innovate in isolation and require the inputs and expertise from both private and public sources. Government (national, regional and local) co-operation is important as public and semi-public organisations are often both a market for goods, a source for funding, and intermediary in enacting and influencing policy choices (Porter, 1990; NUTEK, 2000; Ylinenpää, 2001). According to Ylinenpää (2001), the three-way interaction between universities, industry, and government is a fundamental criterion for the development of successful knowledge-based societies – global competition stimulates innovation, but knowledge production and the actual innovation process is dependent on co-operation and interaction.

With regard to the second factor, Porter (1990) maintains that ‘clusters’ can be defined as a conglomerate of independent companies and support industries located in a particular area, and representing a specific type of competence. While co-operation and collaboration between firms in a cluster may arise voluntarily, in general, most firms openly compete with each other. This competition is beneficial to the growth of the cluster as it encourages continuous development and innovation. Clusters arise when local and often tacit knowledge is transformed into marketable products and services, and can be vertical or horizontal in orientation. Cluster-based strategies are therefore being increasingly adopted by governments throughout the world in order to effectively manage and redirect the industrialisation and growth process and capture the benefits associated with linkage development (Khemani, 1996; Ylä-Anttila, 2000; Buitelaar, 2001; Frame, 2001).

To be successful, instead of promoting targeting policies, governments are advised to let market forces determine which clusters are likely to be successful over the long-term and which will not (Porter, 1990). Specific actions can, however, be taken to indirectly strengthen networking, knowledge development, and partnership development provided competition in the market is not stifled (Brandt, 2001). Competition, moreover, must be encouraged based on particular local characteristics. In Sweden, the emphasis of current cluster policies is on strengthening knowledge networks and the links between companies and their external environment (NUTEK, 2000; Brandt, 2001). In Finland, since the early 1990s, cluster policies have been applied at the national and regional level, in industry, science and technology, education and regional policies as well as in export-promoting activities. The government has also allocated funding for various sectoral cluster programmes in order to promote innovation by strengthening the links between various innovation programmes. Government support has also increased in R&D and investment in human capital in IT (Brandt, 2001; Ministry of Finance, 2002).

The importance of R&D and innovation in the industrialisation process of Finland, Sweden, the United States, in particular, cannot be over-emphasised. Early industrialisation was based on the cumulative impact of incremental advances made by individuals throughout the economy, rather than by progress in a single industry or the actions of a narrow elite. The high rate of invention in these countries has also been due to an early emphasis in equality in human capital development and work opportunities. In these countries, as well as in Canada and Australia, development was achieved through the sequential processing of a raw/primary product to a processed good or service. Industrialisation was a slow process involving an ongoing process of know-how accumulation, continuous interaction with foreign and domestic competitors, and leading-edge technological developments. These factors were complemented by a long and sustained period of investment by the government in various sectors of the economy. Pajarinen *et al*. (1998), point out that the impacts of an increase in R&D investment generally take 5-10 years to realise, while the lag for basic research and educational investment is much longer, 20 years. By neglecting investment, the attainment of economic competitiveness is delayed. However, they caution that investing in R&D alone will be an insufficient means to secure growth. The entire innovation system has to be developed including financial institutions, links between firms as well as the research and educational system. In a successful innovation system there are venture capitalists, the education systems are comprehensive in scope and the shares of natural science and technical education are high. Moreover, a sound basic secondary education is no longer enough to maintain a high standard of education, but rather what is needed is extensive tertiary support, and adult education, especially on-the-job training. Furthermore, the public and private sectors need to collaborate in identifying future needs and restructuring the education system to meet these needs.

Conclusion

This paper has sought to provide a review of the developed country experience of resource-based industrialisation and to identify the policy and strategy 'lessons' which developing and semi-industrialised countries wishing to emulate their success can take cognisance of and implement. The experiences of the United States, Sweden, and Finland, and more recently Australia and Canada, epitomise and illustrate what can be achieved if the situation, approach and attitude towards resource endowments is right. It is clear that resource-based industrialisation will not work and will prove unsustainable if it is undertaken in a context of underdeveloped social, political and economic institutions, where there is insignificant human knowledge, physical and institutional capital, a lack of technical progress, and inefficient economic and business organisation. If there is an over-reliance on the export earnings and other fiscal linkages arising from the resource sector, development is also likely to be negative. To be successful, therefore, resource-based industrialisation strategies need to be: flexible; well-structured and focused; emphasise clustering, networking, entrepreneurship and collaboration; be inclusive of all persons and economic sectors; and embody and reflect a deep sense of commitment and the economic vision of all participants in the economy to the furthering of growth and development.

References

Ali-Yrkkö, J., 2001: *Nokia's Network - Gaining Competitiveness from Co-operation*. ETLA Ser. B 174, Taloustieto Oy, Helsinki.

Ali-Yrkkö, J., Paija, L., Reilly, C. and Ylä-Anttila, P., 2001: *NOKIA - A Big Company in a Small Country.* ETLA Ser. B 162, ETLA, Vantaa.

Altamirano, N., 1999: Sustainable Development and Exhaustible Resources: The Dutch Disease is not a Disease at All, *IR/PS Research Report,* No. 99-08, Graduate School of International Relations and Pacific Studies, University of California, San Diego.

Armstrong, W., 1985: The Social Origins of Industrial Growth: Canada, Argentina and Australia, 1870-1930, in D.C.M Platt and G. di Tella (eds.), *Argentina, Australia and Canada: Studies in Comparative Development, 1870-1965*, St Anthony's College, Oxford, 76-94.

Asplund, R., 2000: Introductory Summary, in R. Asplund (ed), *Public R&D Funding, Technological Competitiveness, Productivity, and Job Creation*, ETLA, Taloustieto Oy, Helsinki, 1-14.

Auty, R.M., 1991: Third World Responses to Global Processes: The Mineral Economies, *Professional Geographer,* 43 (1), 68-76.

1995: *Patterns of Development, Policy and Economic Growth*, Edward Arnold, London.

Blomström, M. and Kokko, A., 2002: *From Natural Resources to High-tech Production: The Evolution of Industrial Competitiveness in Sweden and Finland*, Stockholm School of Economics, Stockholm.

Blömstrom, M., Kokko, A. and Sjöholm, F., 2002: *Growth and Innovation Policies for a Knowledge Economy: Experiences from Finland, Sweden and Singapore*, Working paper 156, Stockholm School of Economics, Stockholm.

Brandt, M., 2001: Nordic Clusters and Cluster Policies, in Å. Mariussen (ed.) *Cluster Policies – Cluster Development?*, Nordregio Report 2001:2, Stockholm.

Brewer, K.J., 1999: Economic Clusters: A Vision for Mining and Mining Suppliers, Presentation prepared for the EXPONOR '99 Mining Conference, La Mineria del Siglo XX1 – Mining in the XX1 Century, Antofagasto, Chile, 23 November.

Buitelaar, R.M., 2000: Policies to Build Competitive Advantage around Natural Resources, Paper prepared for the conference on Export Development in the Millennium: Challenges and Opportunities for Latin America and the Caribbean, Washington D.C, 18-19 September.

2001: *Mining Clusters and Local Economic Development in Latin America*, ECLAC.

Cranstone, D.A., 2002: *A History of Mining and Mineral Exploration in Canada*, Natural Resources Canada, NRCAN, Ottawa, Ontario.

Cusack, B., 2003: Australia's Mineral Resources, Presentation to the 2003 Resources Industry Dinner, Hyatt Regency, Adelaide, 30 May.

De Ferranti, D., Perry, G.E., Lederman, D. and Maloney, W.F., 2002a: Comparative Advantage, Diversification, and Intra-Industry Trade: Determinants and Consequences, in D. de Ferranti, G.E. Perry, D. Lederman, and W.F. Maloney (eds.): *From Natural Resources to the Knowledge Economy Trade and Job Quality*, The World Bank, Washington DC, 13-48.

De Ferranti, D., Perry, G.E., Lederman, D. and Maloney, W.F., 2002b: It's Not Just What You Produce, But How: Lessons From Comparative History, in D. de Ferranti, G.E. Perry, D. Lederman, and W.F. Maloney (eds.): *From Natural Resources to the Knowledge Economy Trade and Job Quality*, The World Bank, Washington DC, 49-74.

De Vylder, S., 1996: *Sweden 1870-1995. The Rise and Fall of the 'Swedish Model'*, a report commissioned by UNDP, Human Development Report Office, mimeo, Stockholm, October 1995, published by UNDP Human Development Report Office, Occasional Papers no. 26, New York.

DST (Department of Science and Technology)., 2002: *South Africa's National Research and Development Strategy, 2002*, The Department of Science an Technology, Pretoria.

Duncan, T. and Fogarty, J., 1984: *Australia and Argentine: On Parallel Paths*, Melbourne University Press, Victoria.

ECA (Economic Commission for Africa)., 2001: *Enhancing Africa's Competitiveness: Policy Issues in Natural Resources and Science and Technology*, ECA, Notes from the Secretariat, June.

Ericsson, M. and Särkkä, P., 2001: *Socio-economic Impact of Finnish Extractive Industries*, unpublished paper (Raw Materials Group, Stockholm and Helsinki University of technology, Espoo) presented at a Workshop at ETLA, Helsinki, 28 October 2002.

Fogarty, J., 1985: Staples, Super-Staples and the Limits of Staple Theory: the Experiences of Argentina, Australia and Canada Compared, in D.C.M Platt and G. di Tella (eds.), *Argentina, Australia and Canada: Studies in Comparative Development, 1870-1965*, St Anthony's College, Oxford, 19-36.

Frame, D., 2000: *Finland and New Zealand: A Cross-country Comparison of Economic Performance*, Treasury Working Paper 00/1, New Zealand Treasury.

Härmälä, E., 1999: Sustainable Utilisation of Renewable Resources, *Forest Cluster Project 1997-1999*, Painotalo Auranen Oy, Finland, 14-15.

Herring, P., 2001: Driven by technology, *High Technology Finland 2001*, TEKES, Helsinki, 11-14.

Hooke, M.H., 2003: Policies for Growth, Presentation for "Minerals Week"- Annual Seminar, Minerals Council of Australia, Canberra, 3 June.

Humphreys, D., 2000: Mining as a Sustainable Economic Activity, Paper prepared for an informal seminar on the Mining and Metals Industry, OECD, Paris, 9 February.

Kasvio, A., 2001: Historical Roots of the Finnish Information Society, Lecture Series, 07012001, http://www.info.uta.fi/winsoc/engl/lect/HISTORY.html.

Khemani, R., no date: *Fostering Diversification and Competitiveness Strategies and Options for the Kingdom of Saudi Arabia*, Background paper for the Symposium on the Future Vision of the Saudi Economy, World Bank document, Saudi Arabia.

Korten, D.C., 1996: *When Corporations Rule the World*, Kumarian Press, West Hartford, Connecticut.

Landes, D. S., 1998: *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor?*, W.W. Norton, London.

Leach, A.T., 2002: Science & Engineering Indicators: Trends in U.S. R&D Expenditures, *FYI: The AIP Bulletin of Science Policy News*, 99, 30 August.

Lemieux, A., 2001: Canada's Global Mining Presence, *Canadian Minerals Yearbook 2001*, Natural Resources Canada, NRCAN, Ottawa, Ontario.

Lindbeck, A., 1975: *Swedish Economic Policy*, Macmillan Press Ltd, London.

Maloney, W.F., 2002: Missed Opportunities: Innovation and Resource-based Growth in Latin America, World Bank Policy Research Working Paper 2935, World Bank.

McKay, B., Lambert, I. and Miyazaki, S., 2002: The Australian Mining Industry: From Settlement to 2000, *Australian Mining Industry*, 1998-99, ABS Catalogue No. 8414.0.

Ministry of Finance., 2002: *Finland's Competitiveness and the Way Forward*, Ministry of Finance, Helsinki.

NRCAN (Natural Resources Canada)., 1996: *Minerals and Metals Policy of the Government of Canada: Partnerships for Sustainable Development*, Minister of Public Works and Government Services, Natural Resources Canada, Ontario.

NUTEK (Swedish National Board for Industrial and Technical Development)., 2000: *Swedish Industry and Industrial Policy 2000*, NUTEK, Stockholm.

Östensson, O. and Uwizeye-Mapendano, A., 2000: Growth and Diversification in Mineral Economies, Draft paper prepared for the regional workshop for mineral economies in Africa, Cape Town, 7-9 November.

Pajarinen, M., Rouvinen, P. and Ylä-Anttila, P., 1998: Small Country Strategies in Global Competition: Benchmarking the Finnish Case, *ETLA Discussion Document*, B144 Series, Taloustieto Oy, Helsinki.

Porter, M., 1990: *The Competitive Advantage of Nations*, MacMillan, London.

Power, T.M., 2002: *Digging to Development? A Historical Look at Mining and Economic Development*, A report prepared for Oxfam America, Oxfam, Boston.

Rhéaume, G and Warda, J., 2001: *Investing in Innovation in the Resource Sector*, Innovation and Knowledge Management, Conference Board of Canada, Ottawa, April.

Robinson, R., 2003: Creating a World-class Mining Supply and Services Cluster for Ontario, Submission to the 2003 Pre-budget Consultations for the Province of Ontario, Institute for Northern Ontario Research and Development, Laurentian University, February.

Rosenfeld, S.A., 2001: Backing into Clusters: Retrofitting Public Policies, Paper prepared for OECD "Integration Pressures: Lessons from Around the World", John F Kennedy School Symposium, Harvard University, 29-30 March.

2002: *Just Clusters: Economic Development Strategies that Reach More People and Places: A Synthesis of Experiences*, Regional Technology Strategies Inc., North Carolina.

Ross, M., 2001: *Extractive Industries and the Poor*, an Oxfam America Report, Department of Political Science, University of California, Los Angeles.

Saarinen, J., 2000: *Innovation Activity in Finnish Industries – A New Pattern*, Lund Papers in Economic History, No. 69, Department of Economic History, Lund University, Lund, Sweden.

Saarnivaara, V-P., 2003: Building future prosperity, *High Technology Finland 2003*, The Technology Academies of Finland, Helsinki, 16-17.

Smith, K. and Nöthling, F.J., 1993: *North of the Limpopo: Africa Since 1800*, University of South Africa, Pretoria.

Sommers, P., 2001: Cluster Strategies for Washington, Report for the Office of Trade and Economic Development, Daniel J Evans School of Public Affairs, University of Washington, Washington.

Stockall and Associates., 2000: Industrial Technology Competitiveness in Australia, Paper prepared for the New Energy and Industrial Technology Development Organisation, Sydney, Stockall and Associates (Pty) Ltd., Canberra.

Swedish Industry., 2001: The Mining and Steel Industries in Sweden, *Swedish Industry*, Fact Sheet 128A, November, 1-5.

Teigland, R., Birkinshaw, J. and White, R.E., 1998: *Sandvik AB*, Ivey Management Services, Richard Ivey School of Business, University of West Ontario, Ontario.

Vouri, S. and Yla-Anttila, P., 1992: *Industrial Transformation in Finland – From Factor Driven to Technology-based Growth*, ETLA Discussion Document, No. 413, ETLA, Helsinki.

Vuori, S., 1997: *Technology Sources and Competitiveness – An Analysis of Finnish Industries*, ETLA, Taloustieto Oy, Helsinki.

Walker, M. and Jourdan, P., 2003: Resource-based Sustainable Development: An Alternative Approach to Industrialisation in South Africa, *Minerals & Energy*, Vol. 18 (3), 25-43.

World Bank., 2002: *Treasure or Trouble? Mining in Developing Countries*, World Bank and International Finance corporation, Washington DC.

WEF (World Economic Forum)., 2003: *Global Competitiveness Report, 2002-2003*, www.weforum.org/pdf/Gcr/GCR_2003_2004/Executive_Summary.pdf.

Wright, G., 2001: Resource-based Growth Then and Now, Paper prepared for the World Bank project "Patterns of Integration in the Global Economy", June.

Ylä-Anttila, P., 2000: Nokia and Oulu – National and Regional Growth Drivers in Finland, Paper presented at the seminar Verdiskaping, kompetanse og innovasjon, mot en ny politikk for nyskaping og naeringsutvikling, Oslo, 8 May.

Ylinenpää, H., 2001: Co-operation, Trust and Triple Helixes in a Northern Dimension, Paper presented at the Think-tank seminar on the Northern Dimension and the Future of the Barents Euro-Arctic Co-operation in Björkliden Mountain Centre, Swedish Lapland, 14-17 June.

Internet References

http://www.metso.fi/

http://www.atlascopco.com