

Innovation and growth in resource-based economies

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Introduction

One of the striking features of the economics of development and growth, both in the mainstream and its self-styled heterodox alternatives, is a resolute failure to take account of some key empirical and historical characteristics of the world we live in. The major problem seems to be an inability to look clearly at the structures of production and learning which actually characterize growing economies. This failure takes two forms. On the one hand there is an approach, popular in Treasuries and Finance Ministries, that conducts economic analysis at a highly aggregated level. This in effect erases industries and sectors by treating the economy as a one-sector operation that produces one output (an output that is labeled ‘GDP’). On the other hand, there is a sectoral and industrial approach that focuses on a small number of industries and technologies that are held to ‘drive’ economic growth.

In the latter perspective, much of twentieth-century economic history consists of a focus on a series of allegedly critical industries such as steam power, mechanised factory technologies, electricity, vehicles, ICT etc., without ever examining how large such sectors actually were and are, and without exploring the wider characteristics of growth and knowledge creation in industrializing economies (Freeman and Louca 2001 is an example of this). It often comes as a surprise to people to learn that a key productivity-growth sector of British industrialization was agriculture, and that British agriculture and food processing developed such epoch-making innovations as replaceable parts, technical codification, assembly lines, large-scale enterprise management systems, and national distributions networks.

This problem is even worse in the innovation studies literature, which far too frequently relies on a Schumpeterian ‘explanation’ of the relation between innovation and growth, looking at a very limited number of technologies that are held to create new industries and drive growth. Economies that do not deploy these technologies/industries are, it is suggested, thereby doomed to slow growth and poverty. A subsidiary argument is that resource-based economies in particular are burdened by a ‘resource curse’, and will remain poor until they shift their economic structures. A big problem in this is that there

is no coherent theoretical explanation of the links between the industries deploying allegedly advanced technologies, and the growth process. At the present time, for example, it is widely argued that growth is driven by ICT, by biotechnology or by nano-engineering, despite the fact that there are major problems in the size and inter-industry effects of these technologies and/or industries.

Two notable empirical features of economic life tend to be ignored in such approaches. The first is persistence and impacts of 'low technology' industries in the world economy. It is not difficult to show that these industries account for the bulk of world output and employment, are growing, are innovative, and deploy advanced knowledge bases. The second feature is the fact resource-based economies are not invariably poor. On the contrary, some of the richest, and/or fastest growing, economies are resource based. These economies include Norway, Sweden, Finland, Canada, New Zealand, Australia and the Netherlands (which is the EU's biggest agricultural producer). We could even include the USA in this list: from one perspective it is the world's largest resource-based economy. These empirical facts lead us to an important question. How have these economies developed, against the conventional wisdom on resources, and what are the implications (a) for their own future development, and (b) for economic development among resource-based economies more widely? What are the appropriate growth-oriented policies for a resource-based economy?

Theories

Within development economics it is sometimes argued that abundant natural resources are actually an obstacle to development. There is a 'resource curse' that keeps developing countries stuck in low value-added and low growth activities. This notion derives from at least three relevant bodies of thought:

- In the 1950s-1970s there were mainstream versus Marxist debates in development theory, in which Marxists took the view that resource specialisation was a basic method of exploitation of poor countries by the rich. The influential

Prebisch/Singer hypothesis argued that the ‘resource curse’ flowed from the declining terms of trade between resources and manufactures. (Here it is worth noting that over the past fifteen years or so, it is the terms of trade of manufactures that have in fact been declining).

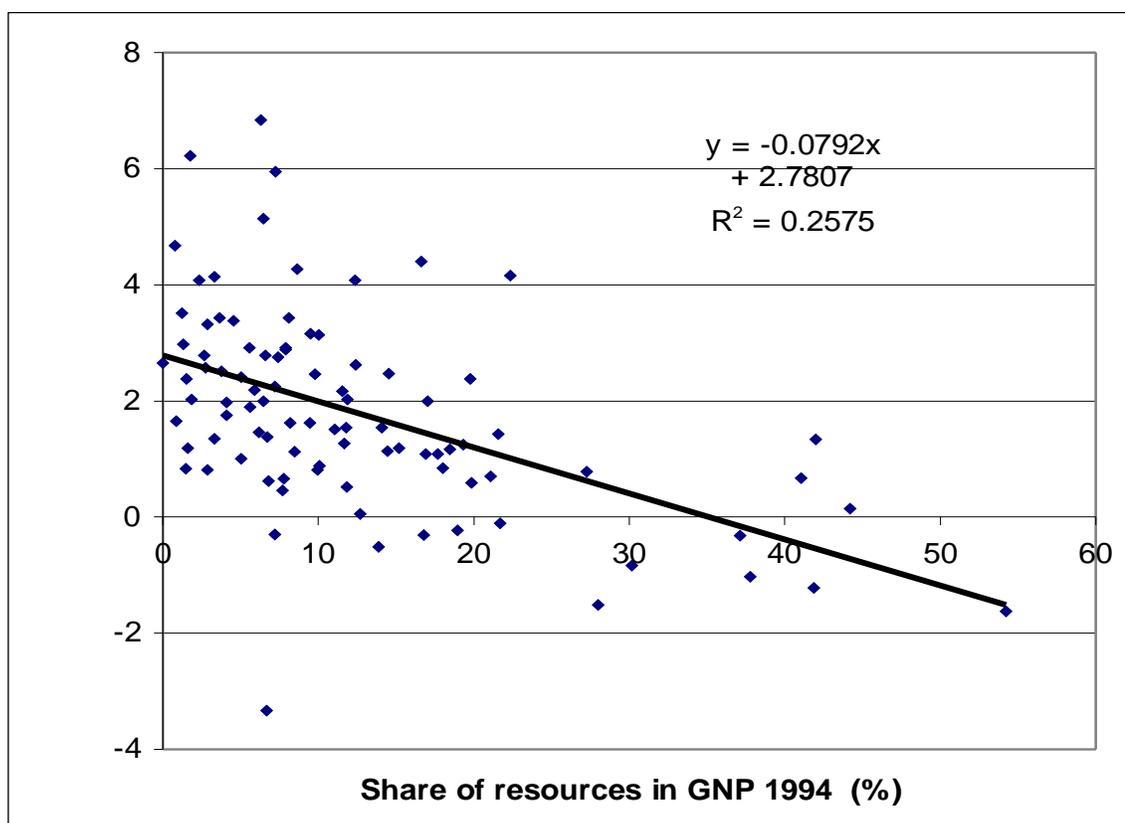
- Sachs and Warner’s influential 1995 NBER paper, ‘Natural resource abundance and economic growth’ formalised the long-standing idea that resources inhibited growth, using regressions linking natural resource industries to growth and trade performance (Sachs and Warner 1995).
- Neo-Schumpeterian ideas about sectoral structure of growth – Chris Freeman, for example, has argued that the key issue is that it is what you do, not how you do it, that matters. The basic challenge of innovation-based development is to get out of resources, and out of low tech, into whatever happens to be driving the Kondratiev wave (at this time held to be ICT, biotech etc) (see Freeman and Louca 2001).

But does the resource curse really exist? And if it does not, what paths into develop exist for resource based economies? In the first place, this requires a look at the evidence on growth and resources.

The Evidence

The evidence used in the ‘resource curse’ literature varies quite considerably. In some cases, the claims are made without any serious reference to evidence at all – that is, highly speculative assumptions are made that are then treated as though they are empirical facts. This is particularly the case in the Schumpeterian literature. Where evidence is sought and presented systematically, it usually takes the form of regressions exploring the relations between industrial shares of natural resources, and GDP growth and trade, with GDP growth, trade growth, investment and so on as the dependent variables. Figure 1 gives an example of this:

Figure 1: Growth and resources, 1960-97



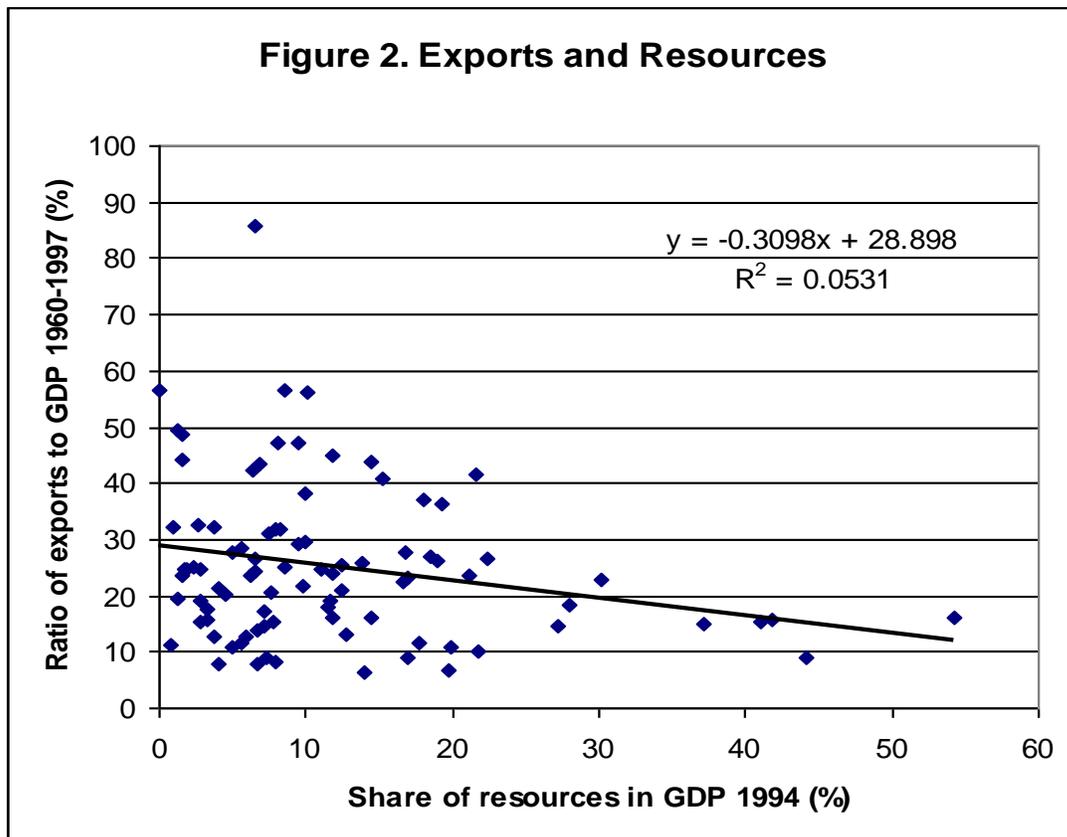
Source: Gylfason, 2004, p.24

Here long-run growth rates are regressed on the share of resources towards the end of the growth period. Quite a lot of the variation seems to be being explained here by the resource share – nearly 26%, which is a lot for one independent variable. However it is worth noting that one factor producing the result appears to be a small number of high-resource/low-growth outlier economies – there are six outlier economies with about 40% of resources in GDP, and low growth rates. Take the outliers away, and it does not look like much will be left of the regression. But a wider problem here is the definition of the independent variable, the share of resources in GDP. This is not in fact a good indicator of whether or not a country is ‘resource based’ – it simply reflects the relative absence of non-resource industries, and so in a way the result is implied by the choice of indicator. A country such as Sweden, which has high resource output per capita, but has succeeded in

creating a large sector of non-resource industries, is simply not going to be measured as a resource-based economy if using this indicator.

Similar problems exist with most such regressions. Figure 2 looks at natural resources and exports.

Figure 2: Exports and Resources



Source: Gylfason 2004, p.6

In this case, very little of the variation in trade ratios is being explained, and once again the regression seems to be heavily influenced by a small number of outlying observations. The explanatory variable – share of resources in GDP – has the same problems that were sketched above.

There is a rather substantial econometric literature on the resource curse, most of which is replicative, and subject to the problems suggested above. A reasonable conclusion after looking at it might be that the existence of a general 'resource curse' has not been adequately demonstrated: it is a problem that is specific to a number of developing countries, and is not a general feature of economic development.

Explanations

Despite the weakness of the evidence on the resource curse, plenty of explanations are offered for it. Most are somewhat speculative. The main economic explanations that are offered for these phenomena are:

- The 'Dutch disease', in which exchange rate appreciation as a result of the resources sector renders domestic activity uncompetitive, and labour supply decreases (as the resources sector draws off key labour inputs from the rest of the economy) combine to inhibit non-resource growth.
- Declining terms of trade in primary commodities and instability in commodities markets prevent capital accumulation and hinder growth.
- Resources create rent seeking behaviour that undermines entrepreneurship and growth.
- Resources sectors generally involve a lack of linkages with the wider economy.

To these, Michael Ross has added a set of potential political explanations. These are:

- Cognitive (resting on the idea that large resource incomes generate short-sightedness among policymakers)
- Societal (in which resources provide an economic, political and military base for the empowerment of elites that hinder growth)
- State-centered (in which large-scale resource income undermines state institutions, or creates cumbersome state enterprises) (Ross, 1999)

However if the data on resource-based economies is not as secure as it might be, then it may be that the problems that the 'resource curse' hypothesis is seeking to explain are not as general as they seem to be. This leaves us with an interesting question: what factors explain growth in successful resource-based economies? This requires a look at the characteristics of resource-based economic development.

Dimensions of Resource-Based Development

Resource-based economies are often characterised by industrial structures with a strong emphasis on agriculture, a small manufacturing sector with a large proportion of output concentrated on low and medium-technology sectors, and a large service sector incorporating a large social and community services element (meaning especially health and education). Natural resources may provide a significant proportion of output, but more commonly a large proportion of exports. Both the gross and business (GERD and BERD) R&D intensities tend to be low. There is usually a technology balance of payments deficit, suggesting significant technology import. Likewise a significant share of gross fixed capital formation is met by imports: so here also there is likely to be a strong level of embodied technology import. Significant natural resources may include agricultural land, timber and forests, fish, hard rock minerals, and oil and gas. These countries often have significant area/population imbalances, and the physical make-up is such that there are communications problems and hence major physical infrastructure challenges.

In a general way such countries as Finland, Sweden, Norway, Denmark, Iceland, New Zealand, the Netherlands, Canada, and Australia share the characteristics described above. These small open economies have rested their development paths on resource-based sectors, and out of them have developed low and medium technology industries that have driven growth within these countries. This has been the case not only historically, but in many instances remains the case today. Even where some countries –

such as Sweden, Finland and the Netherlands – have developed significant high tech sectors, these have supplemented the low and medium tech specializations, but have not replaced them.

The importance of the shared structures and geophysical situations lies in the fact that these comparator countries are not simply advanced economies, but are among the richest in the world. In terms of the underlying productivity measure, output per worker hour, several of them outstrip the United States, and most of them have sustained very high growth rates of output and productivity in recent decades. Most of these countries have not only generated high income levels in terms of GDP per capita, but also maintain major welfare systems related to health, education and social protection. It is worth noting that this prosperity in many cases is relatively recent rather than intrinsic to the situation of the countries. The Nordic area countries in particular were, until comparatively recently, very poor. In the 19th century all of them faced major rural crises, had low levels of income relative to other countries (Norway in the mid-19th century was comparable to Sicily), and had very high rates of out-migration. So, against this background, their development trajectories since the late 19th century have been very spectacular.

How can these development trajectories be understood? I want to suggest three broad mechanisms of development in these economies:

- Development through knowledge upgrading and investment strategies in resource-based industries
- Development through the leveraging of resource bases into downstream industries,
- Knowledge creation via knowledge infrastructures

Development through knowledge upgrading and investment strategies in resource-based industries. Here the point is that resource industries can be the site of major learning processes that permit sustained productivity and output growth. It is not the case that

terms of trade for these products are inevitably declining, and – even if they are – the real issue is overall revenues, not unit prices. The development of sophisticated seismological knowledges and techniques, the construction of large-scale infrastructures, the automation of production technologies and the improvement of logistics can all maintain the viability of resource industries over the long term.

Development through the leveraging of resource bases into downstream industries. Resources are almost invariably capable of development downstream, away from the resources themselves and into related resource-using industries. This strategy has been central to many of the resource-based economies, leading to a degree of historical linkage between past and present specializations. Table 1 below sets out some of these specialisations both from historical and contemporary perspectives.

In developing both upstream and downstream linkages from the resource bases, leading to major cluster development, Sweden shifted from iron ore production to iron and steel, to fabricated metal products (most notably cars and trucks), and then to machine tools and electronic systems. Norway moved from marine transport to shipbuilding to marine electronics, developing the world's first automated navigation systems, and continuing to be a leader in surface and sub-sea marine electronics applications. Finland went from paper production to chemicals for paper, and then to paper machinery (a major sector in which it is a world leader). Of course four of the countries (Canada, Sweden, the Netherlands and Finland) have succeeded in creating important electronics and telecommunications sectors, and the processes through which this happened deserve attention; however in each of these countries electronics remain a relatively small sector, and prosperity continues to depend on continuously upgraded traditional industries (Finland's paper exports are roughly equivalent to its electronics exports). Moreover it remains the case that the Netherlands, Denmark, Australia and New Zealand are heavily agricultural economies, with substantial export earnings from food products (a point which is also true of another allegedly high-tech small economy, namely Israel). It is worth noting that these linkages have underpinned a distinctive approach to economic policy in some of these economies.

Table 1: Historical Industries and contemporary specialisations

Country	Historical growth industries	Some contemporary specialisations
Norway	Fishing Timber products Marine transport Non-ferrous metals Hydro power	Fishing Aquaculture Marine biotechnology Timber products Oil Marine transport Marine electronics (navigation and subsea technologies including sonar and imaging) Non-ferrous metals and aluminum
Sweden	Timber products Iron ore Iron and steel Marine transport	Timber products including advanced building materials and flooring Engineering products Vehicles Telecommunications Aerospace (military and civilian) Ships and boats
Finland	Timber products Machinery Transport equipment (especially ships) Chemicals	Newsprint and high-quality paper Machinery (especially for paper industry) Chemicals (especially for paper industry) Telecommunications equipment Ships and boats
Netherlands	Agriculture Trade and Finance Machinery	Agriculture (including extension into new products, e.g. fresh flowers) Agricultural trading and commodity exchanges Aquaculture (including feedstocks and technology) Electronics Finance and Insurance
Denmark	Agriculture Timber products Shipping	High-value agriculture Domestic and Office Furniture Architecture and interior design Agricultural equipment Transport and ports Electronics Pharmaceuticals

The Swedish economist Erik Dahmen, for example, developed an influential body of analysis based on the concept of “development blocks”, that is mutually supportive industries that could be linked in both the input-out senses, and in terms of shared knowledge bases; this work became a key contributor to the development of innovation system concepts (Dahmen 1970). Much later, it also became the basis of the work of Michael Porter on clusters; here it should be noted that Porter has strongly emphasized the importance of cluster development out of existing industries and resources.

Dahmen’s work both reflected and contributed to a specifically Swedish mode of industrial organization. The key point is that in Sweden, and in the Scandinavia economies more generally, the emergence of linkages and development blocks did not just happen: it was organized. In Sweden a specific form of corporate organization and governance emerged that was central to its industrial development. The main specifically Swedish element is the persistence of concentrated ownership and practical control of key industrial enterprises by family spheres or other conglomerate blockholdings. Sweden is characterised by large-scale blockholdings in significant parts of the industrial system by what are in effect active family-based or bank-based closed-end investment companies; the most famous of these is the investment vehicle of the Wallenberg family, Investor AS. There are at least a dozen such family groupings, often playing an active role in enterprise strategy, organization and operations. This is by no means unknown elsewhere, but the scale and impact of this pattern nevertheless remains a distinctive feature of the Swedish system. The ‘investment trust’ ownership structure also has an institutional form outside of the family groups, based on bank-centred investment companies, which own and control very significant parts of the Swedish economy. So closed-end conglomerate holdings dominate large parts of the economy, and form a core element of the governance system. These holdings have rather deep historical roots, and in some cases even the individual holdings stretch back almost a century. So they impart an important degree of continuity to the Swedish system; at the same time, the fate of these holdings is one of the key elements in shaping change at the present time. Such arrangements are not unique to Sweden. Distinctive, development-oriented governance arrangements can be found across the industries of the Nordic world.

These general points are more widely relevant for small open resource-based economies because they shares the low tech emphases, the resource characteristics, and the widely distributed economic structures of the small economies mentioned. Such an industrial structure is not non-innovative (see Ferranti et al 2002 and Hirsch-Kreinsen et al 2005 for arguments on this point). If we look at the distribution of innovation activity (meaning introduction of new products or processes, or expenditure on innovation) in New Zealand, for example, we find the following:

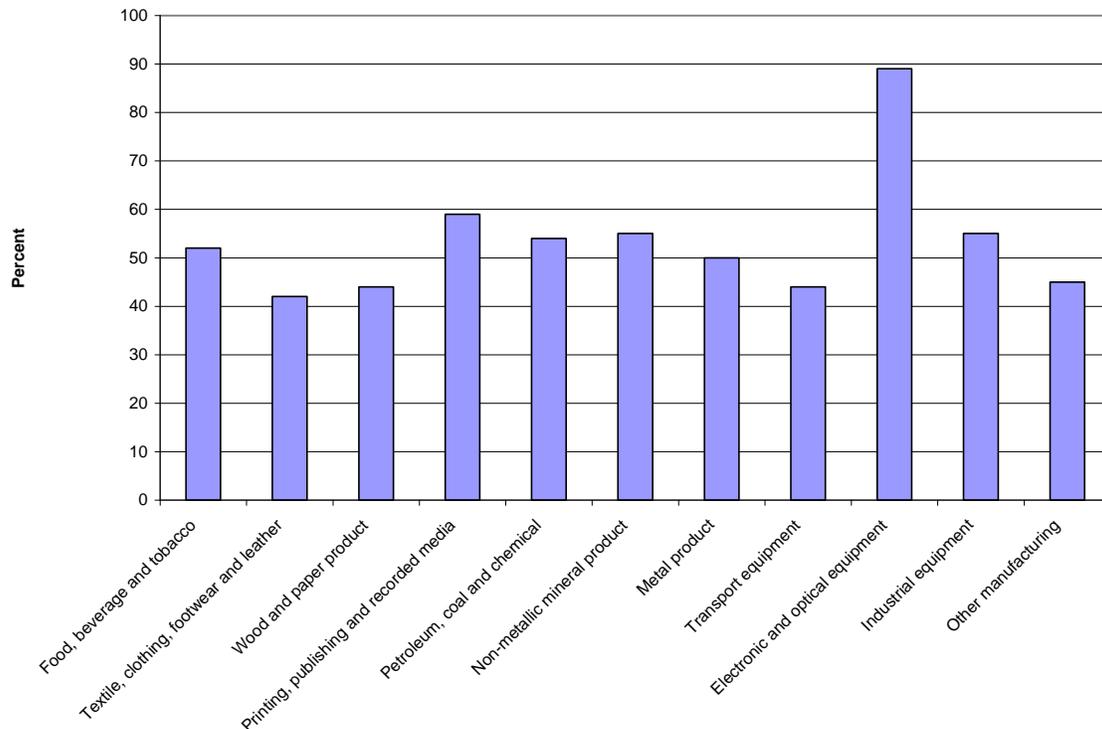
Table 2: Innovation activity in New Zealand: proportion of innovating companies

	n	%
Industry Sector		
Agriculture, Forestry and Fishing	1476	32
Mining and Quarrying	57	37
Manufacturing	3522	56
Electricity, Gas and Water Supply	12	50
Construction	1209	25
Total	6276	44
Services Sector		
Wholesale trade	1767	46
Transport and Storage	885	38
Communication Services	87	41
Finance and Insurance	282	54
Business Services	2181	42
Motion picture, Radio and Television Services	84	61
Total	5286	42
Overall	11562	44

Source: Statistics New Zealand, Innovation in New Zealand, 2003

Firstly, innovation activity is widely distributed across all the major sectors, according with the ‘pervasiveness’ characteristic described above. Figure 3 below shows that within manufacturing, innovation is found across all sectors regardless of their formal classifications of technology intensity. That is, in common with other small open economies, New Zealand has innovative low tech sectors.

Figure 3: Innovation in New Zealand manufacturing sectors (% of innovating companies)



Source: Statistics New Zealand, Innovation in New Zealand, 2003

These results accord quite closely with those of other innovation surveys in small open economies. For example, in all sectors of the Australian economy at least 30 percent of firms are innovating over any 3-year time period. In Australian manufacturing, the most intensively innovating sectors are machinery and equipment and chemicals, each with about 50% of firms innovating. Nevertheless in such ‘traditional’ industries as food products, textiles and metal products between 30 and 35 percent of firms are innovating (see Australian Bureau of Statistics 2005; see also Eurostat 2004).

What follows from this structure is the suggestion that innovation policy for resource-based economies cannot simply be based on high tech sectors, but will have to have an extensive base in the resources and industries that an economy actually possesses. Linkages, development blocks or clusters have not, in similar economies, emerged out of some general propensity to cluster growth: rather, they have emerged from locationally

specific resources, and have developed in rather logical ways both forward and backward. The result is strong ‘vertical’ clusters. For New Zealand, for example, an important current challenge is to technologically upgrade, and to innovate, in such sectors as food and beverages, textiles and clothing, printing and publishing, timber products etc., but also to develop their upstream and downstream potentials.

Such linkages need not be directly into related manufacturing industries, but can also lead to service sector development. The clearest case of this is Australia, where the major financial markets in Sydney are heavily focused on specialised finance for the resource sector. Resource exploration and exploitation involve major risks, and the investment banking and equity markets in Australia (both in Perth and Sydney) are heavily involved in managing the risk spreading portfolio problems of the resource sector. This has over time, led to Sydney evolving into one of the major financial centres of the world – the growth of Sydney as one of the pre-eminent financial centres of the Asia-Pacific region rests in part with its resource-finance background (which continues to be one of its major specialisations).

A final point here relates to knowledge infrastructures. In general, neither resource-based activities nor the industries linked to them are R&D intensive. Rather, they rely on flows of knowledge emanating from infrastructural institutions such as universities and research institutes, as well as embodied R&D in technologies used in capital and intermediate goods. This means that a major focus of public policy for these industries is infrastructural.

Research questions on the resource economies

There are clearly a number of important but unresolved questions concerning resource-based economies. These include:

- What kinds of learning determine the capabilities needed to exploit resource bases? How are successful sectoral innovation systems created that can develop resource sectors?
- How are do institutional structures differ across resource based economies, and to what extent can success and failure be explained by institutional differences? Indeed, what are the relevant institutions?
- Are there spillover effects related to resource extraction? Czelusta and Wright (2004) Wright suggest that ‘if resources are developed through advanced forms of knowledge development, their spillover effects may be just as powerful as anything done in manufacturing’.
- What was the dependence on resources historically? How important was the reliance on resources by such large economies as the USA? (It is important to remember here that Habbakuk’s influential argument was that resource abundance was a contributor to high productivity in the US).
- Is natural resource abundance itself a natural phenomenon? David and Wright suggested that “natural resource abundance was an endogenous, ‘socially constructed’ condition that was not geologically pre-ordained”. How should this relate to potential resources of the future?
- How are allegedly non-renewable resources *extended* through exploration, technological change, advances in country-specific knowledge etc.?
- How have linkages been created historically? Is the view that they are essentially a policy issue correct? What are the contemporary implications?

The issue of how today’s small resource-based economies became so rich is a neglected and important one in economic history. How they might stay rich, however, is a critical

issue in their futures; answering some of these questions might give important pointers to some answers.

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